Conference Programme

9th PAMCA Annual Conference & Exhibition, September 17 - 21, 2023

Organized and hosted by PAMCA Ethiopia Chapter

Theme:

"Reorienting surveillance and management in the context of emerging threats of disease vectors"

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WELCOME ADDRESS

Prof. Charles Mbogo | PAMCA President

Ladies and gentlemen, distinguished participants, and esteemed colleagues,

It is an honour and a privilege to stand before you at the 9th Annual Pan African Mosquito Control Association (PAMCA) Conference and Exhibition, hosted in the historic, magnificent, and vibrant city of Addis Ababa, Ethiopia. As we gather here today, united by a common mission, I am filled with optimism and determination to address one of the most pressing challenges facing our continent: the control of vector-borne diseases.

Africa is a continent of rich diversity, culture, and natural beauty. But it is also a region that has borne the burden of vector-borne diseases, and more so mosquito-borne illnesses for far too long. Diseases such as malaria, dengue fever, Zika virus, and chikungunya continue to take a heavy toll on our communities, affecting not only the health of our people but also impeding economic development and hindering progress towards a brighter future. However, it is not enough to simply gather data. The information we collect must be transformed into actionable insights. This is where the reorientation of management practices comes into play. We must devise strategies that consider the adaptability of vectors, the changing ecological landscapes, and the vulnerability of local communities. It means harnessing community engagement and education to empower people with the tools and knowledge to protect themselves and contribute to vector control efforts.

The concept of reorientation also emphasizes the need for collaboration across disciplines and sectors. Our battle against mosquito-borne diseases cannot be won by entomologists alone. We must engage with public health professionals, epidemiologists, environmentalists, policymakers, and social scientists. The challenges we face are complex, and our solutions must be equally intricate and holistic.

Furthermore, reorienting surveillance and management extends beyond technological and scientific considerations. It demands a shift in our mindset, a willingness to unlearn traditional practices when they no longer serve us, and a commitment to embracing innovation even when it challenges the status quo.

As we engage in discussions, workshops, and presentations throughout this conference, let us remember that our mission transcends geographical boundaries. We are united by a shared goal: to protect the health and well-being of our communities from the threats of disease vectors. The knowledge we exchange, the partnerships we forge, and the strategies we formulate will collectively shape the future of vector borne disease control in the context of emerging threats.

In closing, I am reminded of the words of Nelson Mandela, who once said, **"It always seems impossible until it's done."** The challenges before us may appear daunting, but through our collective determination, innovative spirit, and unwavering commitment, we can and will overcome them. Let this conference be a catalyst for change, a steppingstone towards a future where mosquito-borne diseases and other vector borne diseases no longer threaten the health and prosperity of our beloved Africa.

Thank you and may our deliberations over the course of this conference pave the way for a resilient, adaptable, and effective approach to tackling the emerging threats of disease vectors, and may our shared efforts lead us to a brighter, healthier tomorrow.

Dr. Emma Orefuwa | Ag. Executive Director, PAMCA

Dear delegates, distinguished guests and friends,

It gives me great pleasure to welcome you all to the 9th PAMCA annual conference & exhibition in this most special of cities, Addis Ababa.

It's now a decade since we held our first annual conference in Kenya, and I am heartened to see how the PAMCA community has grown significantly over the years - testament to the fact that our annual meeting serves as a world class, internationally recognised forum, connecting vector control professionals, partners and communities in Africa, one that provides excellent networking, unique perspectives and excellent opportunities for learning from the best in the field.

Due to an unprecedented number of abstract and symposia submissions this year, we have extended the conference to four days instead of three. Our pre-conference events have also increased and span a diverse range of topic areas that not only tackle the science and policy aspects of vector control, but also issues that enable a conducive work environment for all stakeholders to flourish.

Our theme this year is '**Reorienting surveillance and management in the context of emerging threats of disease vector**s ' and this perfectly encapsulates the reason for PAMCA's existence – the recognition that for vector-borne diseases to be eliminated in Africa, we must shift the dial: affected communities and those at the coalface of vector control efforts must play a central role in developing solutions. Those at the forefront of vector control in Africa continue to endorse and see value in the expansion of PAMCA, evident by the recent inauguration of our 19th chapter in Mali and presence of more global partners than ever before. We are excited to witness the growth

trajectory of our dedicated community as we enter a new phase for the organisation, with renewed focus on what PAMCA does best, convening, communicating and advocating country needs across all levels of society.

I'd like to thank all our wonderful partners, sponsors and delegates who continue to amaze me with a level of support and enthusiasm that lets all of us know that we have created and must sustain a movement that is very much valued and needed more than ever. I encourage you to make the most of this unique meeting, to make new connections, absorb all you can and most importantly have fun! I look forward to connecting with as many of you as possible, some old friends and others new, by way of stimulating discussions over common interests.

I wish you a wonderful experience in Ethiopia.

Prof. Delenasaw Yewhalaw | President and Chair, Local Organizing Committee (LOC)

Dear Participants and Delegates,

I am delighted to announce again that this year's Pan-African Mosquito Control Association (PAMCA) Annual Conference and Exhibition will be held on 17-21 September 2023 at Skylight Hotel, Addis Ababa, Ethiopia. The Pan-African Mosquito Control Association Ethiopia Chapter (PAMCA-EC) is very much pleased to host the 9th PAMCA Annual Conference and Exhibition in the African diplomatic capital, Addis Ababa, Ethiopia. We are happy to inform overseas participants coming from Africa and across the globe who travel to Addis Ababa to fly with Ethiopian Airlines, a flagship of Africa that connects every territory across the continent and beyond to avoid travel from problems. Moreover, the venue of the conference, the Skylight hotel is at a walking distance from Addis Ababa Bole International Airport. The Skylight hotel and other luxury hotels located around Skylight provide inclusive services for delegates.

This year's PAMCA conference with the theme "**Reorienting surveillance and management in the context of emerging threats of disease vectors**", will highlight strengthening surveillance and management to enhance control and elimination of mosquito-borne diseases. amidst climate change and other critical regional and global challenges such as resurgence of malaria and other mosquito-borne diseases, vector resistance to insecticides, emergence and spread of invasive malaria and arboviral disease vectors in Africa and elsewhere out of their native territories. This calls for improved and innovative technologies by enhancing domestic and international resource mobilization to sustain intervention. The conference organized relevant and important scientific sessions and symposia to be presented by leading experts, specialists, researchers, country programs and implementing partners to address and seek solutions for emerging regional and global threats. The conference also provides additional platforms for participants and delegates to network, update, exchange knowledge, experience, and develop collaborations.

Finally, on behalf the PAMCA Ethiopia Chapter, Local Organizing Committee, The Ethiopian Ministry of Health and Partners, I kindly invite you to join the 2023 PAMCA conference in September. We greatly look forward to your participation and we are very excited to welcome you home to attend the conference and discover “THE LAND OF ORIGIONS”.

KEYNOTE SPEAKER

Reorienting surveillance and management in the context of emerging threats of disease vectors

Prof. Beyene Petros

Director General, Policy Study Institute, Ethiopia

Prof. Beyene Petros, Professor of Biomedical Sciences, is the Director General of FDRE Policy Studies Institute (PSI). Professor Beyene was born in 1950 in Hadiya Zone Southern Ethiopia. He earned his BSc degree from the former Haile Selassie I University in 1973. He then moved to the United States to continue his higher education. In 1977, he earned his MSc degree from University of Wisconsin, Madison, USA, and his PhD (specializing in Tropical Diseases and Public Health) from Tulane University, USA, in 1986, after completing his dissertation at the Centers for Disease Control and Prevention (CDC) in Atlanta, USA.

Professor Beyene Petros is a prominent politician, educator, and researcher at Addis Ababa University where he has trained and advised dozens of graduate and doctoral students. Prior to his appointment as Director General of PSI, he served in various public institutions, academic societies, and national and international professional associations. Professor Beyene began his academic and research career as Chairman of the Department of Biology at Addis Ababa University from 1986 to 1991 and was also the founder and President of the Biological Society of Ethiopia from 1989 to 1991.

Professor Beyene served as Chairman of the Advisory Committee on Health and Development, WHO /AFRO, from 1997 to 2000, and as Scientific Secretary of the Ethio-Soviet Biological Expedition from 1987 to 1991. Similarly, he served as Chair of the Ethiopian Bioethics Initiative (ETBIN) from 2002 to 2014 and as a member of the Executive Committee of the Pan African Bioethics Initiative (PABIN). In 2013/2014, he was also a visiting professor at Governors State University, Chicago, USA. He also conducted research on the molecular biology of malaria as a Senior Fulbright Fellow at the National Institutes of Health (NIH).

Prof. Beyene has also led the thematic research projects on Malaria and other parasitic diseases at Addis Ababa University. In addition, he has chaired and served on advisory boards and conference organizing committees of many international, continental and national professional associations. Apart from the academic circle, Professor Beyene is revered as the most conspicuous political figure in Ethiopia. Since 1992, he pioneered the formation and leadership of opposition political parties that have worked for good governance and sound

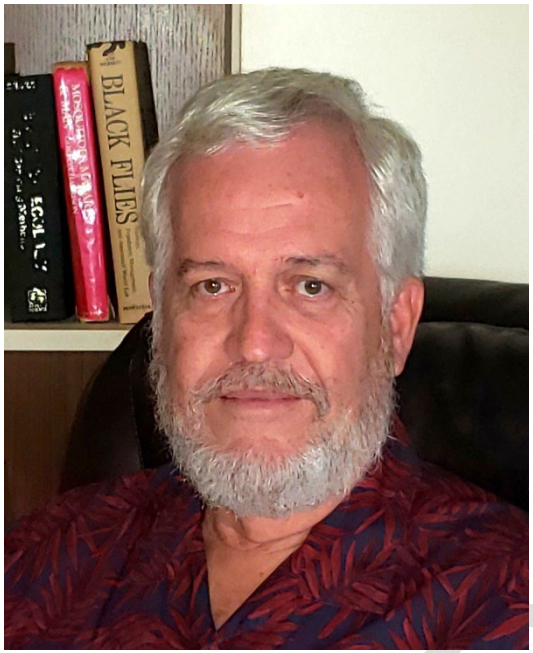
democracy in Ethiopia. Accordingly, he served as Vice Minister of Education in the Transitional Government of Ethiopia, from 1991 to 1993 and as a member of the FDRE House of Representatives from 1991 to 1993 and from 2000 to 2010.

Professor Beyene Petros has won many international and national awards and gold medals for his public engagement, academic achievements, and research leadership. He has published nearly 120 peer-reviewed scientific articles in peer-reviewed journals and co-authored a very popular book on Basic Principles of Biology.

PLENARY TALKS

Plenary Talk 1: Living with mosquitoes: Inevitable reality or an African fallacy? A call to action

Manuel F. Lluberas, PhD



Manuel F. Lluberas is a public health and veterinary entomologist with extensive experience in the design, implementation, evaluation, and capacity building on integrated mosquito and vector management (IVM) obtained during three decades in four continents. Mr. Lluberas served as medical entomologist and medical mobilization planner for the United States Navy a dozen years, reaching the rank of Lieutenant Commander. While in active service, he helped WHO AFRO investigate several outbreaks of fever-of-unknown-origin and malaria outbreaks in Africa, deployed as field entomologist to Ground Forces during the First Gulf War, directed mosquito surveillance and control operations in Florida in the wake of Hurricane Andrew, and in Kansas after the "Great Flood of 1993." His many contributions to Preventive medicine earned him dozens of accolades, decorations, and personal awards, including two selections as finalist for the Charles Stevenson Award for Excellence in Preventive Medicine, the top award in the Navy's Medical Department. Manuel worked as Executive Director for Public Health for H. D. Hudson Manufacturing Company for twenty-seven years. He is President and CEO of Mosquito Den LLC, based in Puerto Rico, and provides consulting services on the control or elimination of hematophagous arthropods to ministries of health and agriculture, private organizations, luxury resorts, and non-governmental institutions around the world. His many contributions and accomplishments include designing the business architecture of the Indoor Residual Spray (IRS) campaigns of the US President's Malaria Initiative for sub-Saharan Africa (PMI), developing and implementing many other vector control campaigns in the continent, the Caribbean Basin, and parts of Asia, and those targeting Chagas disease vectors in South America. He designed and implemented the malaria prevention and control interventions in Banda Aceh and Western Sumatra, Indonesia in the aftermath of the Tsunami of 2005, helped Haiti's Ministry of Health and Population in the aftermath of the earthquake of 2010, and controlled mosquito population explosions after Hurricane Maria in Puerto Rico in 2017.

Manuel helped in the eradication of Chagas Disease vectors from several countries within the Southern Cone Initiative in South America and has shared his expertise with the WHO Global Malaria Program, the Pan American Health Organization, the Food and Agriculture Organization, USAID, the Japanese International Collaboration Agency (JICA), the World Bank, and the Pan Africa Mosquito Control Association. His countless contributions to international public health earned him the Meritorious Service Medal from the American Mosquito Control Association.

Manuel has published over thirty technical, peer-reviewed articles, wrote the first drafts of WHO's Operational Manual on IRS, and has contributed to the publication of four books and two technical manuals on vector control. He holds a Remote Pilot certification as of a small, Unmanned Aerial System (drone), and is certified as Merchant Marine Officer and Master of sailing vessels by the US Coast Guard. He is an avid sailboat racer with multiple podium finishes, is certified as a Small Boat Sailing Instructor by the American Sailing Association and provides simultaneous interpretation from Spanish to English for the American Mosquito Control Association.

ABSTRACT

Malaria has been eradicated or reduced to a point where it is no longer a serious health threat or economic burden to the population in about 100 countries. Almost without exception, this was accomplished by combining active vector population suppression measures and techniques and engaging the local population to make their immediate environment less conducive to the proliferation of mosquito populations. More significantly, every country that achieved eradication did so over two decades ago, long before the establishment of many of the current anti-malaria initiatives, and without the benefit of a vaccine. While much has been said about the expenditures related to malaria control, the funding shortfalls many programs face, and the presence of an "urban" malaria vector in Africa, there has been very little regarding the evaluation of the interventions chosen or the implementation of active, integrated vector control interventions. Moreover, active vector population suppression measures that effectively eliminated or contained malaria in other countries continue to be considered ineffective for Africa without exploring modifications. Continued reliance on passive methods like mosquito nets without implementing active vector control measures that include source reduction, larviciding, and other active measures will guarantee malaria's existence. Examples of well organized, systematic, and integrated vector control interventions that attacked the mosquito from several flanks, included good entomological surveillance and monitoring schemes, and were instrumental in eradicating or reducing malaria to a point where it does not overwhelm the increasing diminishing public health resources are provided.

Delaying implementation of active mosquito control will continue to claim lives at a rate equivalent to approximately four (4) 747 Jumbo airliners full of children under five and pregnant women crashing every day.

Plenary Talk 2: Global Fund Africa Constituency Bureau

Josephat Kakoma | Executive Director, Global Fund Africa Constituency Bureau

Josephat is not a stranger to the African Constituencies, having worked for the Bureau for just over two (2) years when he joined as the Policy Analyst. Prior to joining the Bureau, he worked with USAID/Zambia as Capacity Development (Local Solutions) Advisor in the Health Office where he was the mission's lead for institutional strengthening among local actors, including government and civil society entities. He brings to the Bureau sixteen (16) years of development management experience public health, spanning program management, institutional strengthening and global health policy mostly around Global Fund and PEPFAR (USAID) programming. He worked with the Churches Health Association of Zambia (CHAZ), a Principal Recipient under the Global Fund where he managed their HIV portfolio where he served in various portfolios culminating in Program Manager and later as Planning and Development Manager focused mostly on designing and implementing the organization's strategy. He later joined USAID/Zambia and pioneered the mission's institutional strengthening initiatives among local awardees, including through Government to Government (G2G) awards.

Plenary Talk 3: Special District Model - Reimagining Malaria Control in Africa by Focusing on Local Mosquito Control Programs

J Wakoli Wekesa, PhD

Dr. J Wakoli Wekesa is the District Manager of East Side Mosquito Abatement District, Stanislaus County, Modesto, California. He received his B.Sc. in Zoology in 1987 and M.Sc. in medical and veterinary entomology (1990) both, from the University of Nairobi, and Ph.D. in Entomology from University of California at Davis in 1995. After receipt of his doctoral degree, he held a two-year American Society for Microbiology fellowship postdoc at the Centers for Disease Control and Prevention in Atlanta, Georgia, and a further two-year NIH grant-funded postdoctoral fellowship at the same institution.

In 1999, Dr. Wekesa took up a position with California Department of Public Health in Ontario, California, and a year later moved embarked on a career in local government as the vector ecologist for San Bernardino County Vector Program, under the County's Department of Public Health. He worked here for 12 years before briefly moving to the private sector as the director and laboratory manager of a startup in a clinical laboratory company. He returned to the public sector in 2013 as the Scientific Programs Manager at San Gabriel Valley Mosquito and Vector Control District in Los Angeles County, California. Five years later, he took up a job as the Operations Manager of Coachella Valley Mosquito and Vector Control District in Indio, California. He started his current position in 2019.

He has served in various capacities and overseen many organizations with small and large employees under his supervision. He has published many scientific articles and has been actively involved in this industry over the past 33 years. He has trained, supervised and mentored many employees and scientists. He has been a member of many international organizations serving in different capacities. He is currently the President of the Mosquito Control Association of California, a 64 local mosquito control member agency.

ABSTRACT

Special districts have played a crucial role controlling mosquitoes and mosquito-borne diseases since organized mosquito control became central to improving people's quality of life in the United States. A few years after mosquitos was empirically implicated in transmitting malaria the effort to establish mosquito control operations started in earnest in the United States – New Jersey, California, Florida and

Illinois, etc. The model for this effort has been national and regional planning but locally operated with the focus on controlling the mosquito vector and tangentially controlling the pathogen. How can we re-imagine malaria control in Africa by focusing on controlling the mosquito vector, and empowering local communities to play a central role in such a structure. I discuss this approach to malaria control in the context of special district establishments anchoring mosquito control, and eventually mosquito-borne diseases. Adopting some of these approaches by PAMCA affiliated member nations may help create centers of excellence, the models emulated thereafter by many parts of the continent. I offer some experiences and perspectives gained across several special districts in the US and my own background on malaria research in Africa.

Plenary Talk 4: Women Leading the Charge: Breaking the Gender Barrier in Malaria & Vector-Borne Disease Response

Corine Karema, PhD

Dr. Corine Karema is a distinguished and accomplished Global Health expert specializing in Malaria and Neglected Tropical Diseases (NTDs). Throughout her remarkable career, she has held numerous leadership positions at various levels, contributing significantly to the fight against malaria and vector-borne diseases. She served as the Director of the National Malaria and NTDs Control Program in Rwanda for over a decade, as the Africa Leaders Malaria Alliance Senior Malaria Program officer, and as the Special Advisor to the Board Chair of the Global Fund. Dr. Karema's further played a crucial part in driving the RBM Partnership to End Malaria's efforts during her tenure as the Interim CEO for 15 months, from 2022 to 2023. Her dedication to advancing global health is evident in her role as the 2021 President-Elect of the American Society of Tropical Medicine & Hygiene (ASTMH) Committee on Global Health (ACGH).

Dr. Karema's expertise and experience have made her an invaluable member of several high-level scientific advisory committees and technical expert groups, including those associated with the World Health Organization (WHO), RBM Partnership, and the Global Fund. As a Senior Malaria and NTDs expert, Dr. Karema extends her knowledge and skills to provide technical assistance to international organizations and national malaria and NTDs control and elimination programs worldwide. Dr. Corine Karema holds a medical degree and a master's degree in Epidemiology. Throughout her career, Dr. Karema has exemplified exceptional leadership, dedication, and expertise, making her a role model for women in Global Health. Her contributions have undoubtedly played a pivotal role in advancing the fight against malaria and NTDs, saving countless lives and impacting global health outcomes.

ABSTRACT

The presentation aims to provide a comprehensive examination of the invaluable contributions of women in the fight against malaria and vector-borne diseases (VBDs) while also addressing the structural gender-related barriers they face. It will emphasize the significance of adopting gender-intentional and transformative approaches to end malaria and effectively manage VBDs ultimately. The presentation will spotlight the pivotal role that women have assumed in various aspects of malaria and VBD response. Discussions will delve into the obstacles women often encounter to combat these diseases, such as gender bias, limited access to resources, and societal expectations. Strategies to overcome these barriers will be highlighted, including adopting gender-intentional and transformative approaches to address gender disparities. Empowerment of women as decision-makers and leaders in disease response and women's influence in shaping policies integral to combating malaria and VBDs will be emphasized. The presentation will underscore the broader significance of advancing gender equality in healthcare and research. It will illustrate how promoting women's involvement benefits not only the field of malaria and VBDs but also the advancement of gender equality across various domains. By examining these themes, the presentation seeks to inspire, inform, and encourage PAMCA stakeholders to adopt strategies that promote gender equality and women's empowerment in the fight against malaria and vector-borne diseases. The intention is to drive transformative change, improving disease management, inclusivity, and health outcomes.

Plenary Talk 5: Malaria, eradication and the role of vector control

Helen Jamet, PhD

Helen Jamet has more than 20 years of experience in malaria prevention, research and vector control product development. She joined the Bill & Melinda Gates Foundation (BMGF) in November 2018 after nearly 12 years in the Private Sector, where she held the role of Global Head of Research & Market Access. Helen started her career in Tanzania conducting field research in repellents and mosquito traps. She has always had a keen interest in working on gender integration and capacity building to encourage young scientists to enter the field of entomology.

Helen is the Deputy Director, Vector Control in the Malaria program strategy team at BMGF, where she oversees all investments in Vector Control, including insecticidal interventions and genetically based vector control. Helen is a member of the Infection Innovation Consortium Advisory Panel and a Board Member of the RBM Partnership to End Malaria.

Plenary Talk 6: AUDA-NEPAD's Contribution to Vector Control and Continental Regulations

Jeremy Tinga Ouedraogo, PhD

Dr. Ouedraogo is as a scientist in genetics and plant breeding and got his PhD in Canada. He focused his research on the use of biotechnology and biosafety tools in crops. As a plant breeder, he has established the Plant Genetics and Biotechnology laboratory in the national research system of Burkina Faso. He has contributed to create many cowpea varieties that are released in Burkina Faso as well as in West African countries. From 2007 to 2014 he has been elected Member parliament and nominated minister of animal resources and fisheries in Burkina Faso. From 2016 to end of 2022, He joined the African Union Development Agency-AUDA-NEPAD as Head of the African Union Development Agency (AUDA-NEPAD) regional office for West Africa, Head of the African Biosafety Network of Expertise: An African Union programme established to provide support for the development of functional biosafety regulatory systems that enable access to beneficial technologies while protecting human health and the environment and Coordinator of Integrated Vector Management programme from 2020 to 2022. Since January 2023, He is technical adviser for the AUDA-NEPAD ABNE and the Integrated Vector Management programmes. Dr Ouedraogo served as member of the Board of Trustees of the African Agriculture Technology Foundation (AATF) that is based in Nairobi, Kenya (2016 -2022). He is member of the Africa Harvest International Board of Directors since 2023.

DISCUSSIONS

Panel Discussion 1: Harnessing the capacity of African Institutions for strengthened response against vector-borne diseases

Organizer: Emma Orefuwa; emma.orefuwa.@pamca.org **Co-organizer**: El Hadji Niang elhadji.niang@pamca.org

ABSTRACT

Stronger communities of professionals with relevant expertise based at locally owned and governed institutions has been a subject for intense discussion in recent years and is critical if vector control is to achieve maximum impact across Africa. Indeed, strong capacity for evidence-based decision-making, based on expert analysis and interpretation of monitoring, evaluation and research data, is central to the health and wellbeing of African all countries but is typically weakest in the low-and-middle income countries (LMICs) that need it most.

While greater local ownership and leadership of evidence-based decision-making in Africa has been prioritized by several health sector funders for many years, for several reasons, progress has been far too slow and as such the agenda setting for health development in most African countries is mostly externally driven. Local institutions and indigenous experts in Africa have been slow to embrace knowledge based technical leadership skills that are considered relevant to vector control/elimination. Moreover, the successful delivery of high-quality technical support, science and innovation to enable improved vector control across Africa will require a complex and vibrant community of technical experts with complementary roles, skill sets at the institutional level.

In this session we will capture perspectives from various experts in global health on how independent leadership cadres at African institutions could be more effectively cultivated and sustained going forward.

The overall goal of such targeted leadership cultivation strategies would be to enable African institutions to push past the tipping points in their development trajectories, beyond which they can achieve an unprecedented surge of sustainable growth through collective learning processes that pivot around the survival, successes, and failures of their established and emerging leadership cadres.

While many of the experiences and potential solutions shared will be familiar to members of relevant expert communities across Africa, we nevertheless hope that the considerations and perspectives outlined may provide useful food for thought and action.

Panel Discussion 2: Bridging the Gap “the Dos and Don'ts”: Gender inclusivity in Vector-Borne Disease Research and Control in Africa.

Organizers: PAMCA Women in Vector Control

Women are crucial in combatting vector-borne diseases (VBDs), but they encounter gender-related barriers hindering their involvement. Overcoming these barriers is vital for effective VBD control and elimination. African institutions and women's allies must establish programs to enhance women's participation. The Pan-African Mosquito Control Association (PAMCA) addresses this through its Women in Vector Control (WiVC) Program. This initiative empowers African women to contribute to VBD control, aiming to provide them with skills, confidence, and opportunities for career advancement. Active female participation yields equal employment, better health outcomes, and program sustainability. By involving women in the initiation, planning, and execution of health interventions, improved VBD control practices and gender equality can be achieved. The current PAMCA Women in Vector Control team is constituted by Dr. Damaris Matoke-Muhia (WiVC Program Manager), Dr. Jessy Goupeyou-Youmsi (WiVC Coordinator for West Africa), Rosalia Joseph (WiVC Coordinator for Central & Southern Africa) and Christina Sudi (WiVC Coordinator for East Africa).

ABSTRACT:

Vector-borne diseases continue to pose significant health challenges, particularly in Africa. The burden of these diseases often falls disproportionately on vulnerable populations, including women and children. Despite this, women remain underrepresented in the field of vector-borne disease research and control. This panel discussion seeks to address the gender gap by highlighting the importance of women and their contributions in the fight against vector-borne diseases in Africa. Topics to be covered in the panel discussion include gender inclusivity success strategies, systems and building blocks that have enable women to thrive professionally, further, highlight the pitfalls in the structure and challenges faced by women in vector-borne disease research and control and the role played by men allies in building or dismantling the gender stereotypes. The panel discussion will also explore the potential for collaboration between women's groups, male allies and other stakeholders in the fight against vector-borne diseases. It will provide a platform for sharing experiences and best practices, as well as discussing strategies for empowering women in the field. Ultimately, this panel discussion aims to inspire and equip women to take a more active role in vector-borne disease research and control in Africa, and to promote gender equity in the

field. By breaking down barriers and empowering women, we can build a stronger, more resilient response to the vector-borne disease threat in Africa.

Panel Discussion 3: Pivoting to African-derived and led Impactful Research and Intervention Implementation

Dr. Jaishree Raman, Principal Medical Scientist and Head of the ARMMOR, South African National Institute for Communicable Diseases

Dr. Jaishree Raman is a molecular biologist by training with a strong interest in malaria and public health. Jaishree currently heads the Laboratory for Antimalarial Resistance Monitoring and Malaria Operational Research (ARMMOR) at the NICD. The core focus of ARMMOR is to improve malaria diagnostic and treatment options, to assist South Africa and Africa eliminate malaria, and improve the health and well-being of their populations. ARMMOR hosts the National Surveillance Program for Antimalarial Drug and Diagnostic Resistance Monitoring.

This robust surveillance program enables near real-time tracking of emerging resistance to inform case management policy and prompt containment responses. In partnership with other malaria-endemic countries and research organizations, Dr. Raman's laboratory is currently investigating novel techniques and technologies aimed at improving malaria case detection and treatment practices to achieve malaria elimination. Her research has a strong focus on African solutions for African problems.

Ghislaine Ouedraogo-Ametchie
Women's Health Advocate | Partnership Builder | Social Scientist

Ghislaine Ouedraogo-Ametchie is an African social scientist with over fifteen years of experience working in strategic partnership building, project management and research. Ghislaine's work is at the intersection of malaria elimination and maternal health where her health system strengthening expertise is applied to capacity building for malaria elimination and exploring patient-centered maternity care in high malaria burden countries. At PAMCA, Ghislaine is Program Manager of the flagship Entomological Surveillance Program where she spearheaded a multicounty research project on national malaria elimination capabilities and gender inclusivity in vector control.

Ghislaine's partnership building work brings private sector and government to the table, to address efficient and collaborative ways of addressing public health challenges that disproportionately affect African communities, specifically women. As a social scientist, Ghislaine worked with the Averting Maternal Death and Disability Program (AMDD) at Columbia University. While there, she contributed to health system strengthening by facilitating national facility assessments to determine the availability, accessibility and quality of emergency maternal and newborn care services in Africa.

Ghislaine has a Masters in Public Policy from the University of Minnesota, is originally from

Burkina Faso and currently lives in Abidjan, Côte d'Ivoire.

ABSTRACT

The recent furore over the inequitable access to COVID-19 vaccines once again laid bare the asymmetry in global health, which has deep colonial roots. Global Health policies and resource allocations are generally determined by institutions in the Global North, often with limited consultation with or consideration for people in the Global South. Many of these policies have focused on protecting the global North from emerging diseases that adversely affected the Global South rather than preventing disease progression at a global level. In addition, when novel interventions/technologies are implemented, often little effort is made to adapt them to the local, more poorly resourced setting, greatly reducing the potential positive impact. The Global North's dominance in global health decision-making is also evident in the composition of global health expert committees, technical review committees, and journal review boards. If we wish to attain global equity, a more inclusive approach must be taken, so that all role players have a seat at the table and are involved in making decisions that directly impact them.

During this panel discussion, the panellists will be asked to give their opinion on;

- how they have achieved alignment between country and partner priorities,

- how they balance urgent action, research and innovation
- data ownership, authorship and country-specific operational research
- institution-building and funds diversification

Through these discussions with the panellists and audience, we hope to generate a clear case for the urgent need to shift the paradigm on how decisions are made, to strike a different balance of power to amplify elimination efforts to understand what the major obstacles are, thereby ensuring global health equity in access to resources and global health decision-making bodies.

PRE-CONFERENCE EVENTS

No.:	Title	Organizer	Days	Dates
1	Vector genomics data analysis hackathon & NMCP convening	Elijah Juma, PhD	3	Sept. 14-16, 2023
2.	FNIH decision making workshop	Amelie Wamba, PhD/Emma Orefuwa, DSc and Samson Kiware, PhD	4	Sept. 14-17, 2023
3.	Gene drive short course	Amelie Wamba, PhD/Emma Orefuwa, DSc	3	Sept. 15-17, 2023
4.	Women in Vector Control (WiVC) Workshop	Damaris Matoke-Muhia, PhD	2	Sept. 15-16, 2023
5.	Gene drive policy workshop	Amelie Wamba, PhD/Emma Orefuwa, DSc	1.5	Sept. 16-17, 2023
6.	Foundation gene drive course	Amelie Wamba, PhD/Emma Orefuwa, Dsc	1	Sept. 17, 2023
7.	Surveillance Programme meeting Workshop	Ghislaine Ouedraogo-Ametchie	1	Sept 17, 2023
8	WiVC Mentorship Convening – Cohort 1	Damaris Matoke-Muhia, PhD	1	Sept. 17, 2023

SUMMARY OF THE KEYNOTE ADDRESS, PLENARY TALKS AND PANEL DISCUSSIONS

Name	Presentation title	Presentation type	Dates
Prof. Beyene Petros	Reorienting surveillance and management in the context of emerging threats of disease vectors	Keynote address	Sept. 17, 2023
Manuel F. Lluberas	Living with mosquitoes: Inevitable reality or an African fallacy? A call to action	Plenary Talk	Sept. 18, 2023
Josephat Kakoma	Global Fund funding strategies and opportunities	Plenary Talk	Sept. 18, 2023
Wakoli Wekesa, PhD	Special District Model - Reimagining Malaria Control in Africa by Focusing on Local Mosquito Control Programs	Plenary Talk	Sept. 19, 2023
Corine Karema, PhD	Women Leading the Charge: Breaking the Gender Barrier in Malaria & Vector-Borne Disease Response	Plenary Talk	Sept. 19, 2023
PAMCA	Harnessing the capacity of African institutions for strengthened response against vector-borne diseases	Panel discussion	Sept. 19, 2023
PAMCA WiVC	Bridging the Gap "the Dos and Don'ts": Gender inclusivity in Vector-Borne Disease Research and Control in Africa	Panel discussion	Sept. 19, 2023
Helen Jamet, PhD	Malaria, eradication and the role of vector control	Plenary talk	Sept. 20, 2023
Dr Jeremy Tinga Ouedraogo, PhD	AUDA-NEPAD's Contribution to Vector Control and Continental Regulations	Plenary talk	Sept. 20, 2023
Africa CDC	TBD	Plenary talk	Sept. 20, 2023
Jaishree Raman & Ghislaine O. Ametchie	Pivoting to African-derived and Led Impactful Research and Intervention Implementation	Panel discussion	Sept. 21, 2023

Field event (Optional)

Event	Date	Time	Cost	Lead

Visit to the new Africa CDC HQ in Addis Ababa, Ethiopia	*Sept. 22, 2023*	08:00-12:30PM	USD 15#	Prof. Delenasaw Yawhalaw

SUMMARY OF SYMPOSIA

Index	ID	Symposium title	Thematic area	Organizer	Dates	Time
1	54	IK Smart Light: A new tool to enable more efficient delivery of indoor residual spraying	LLINS, IRS and insecticide resistance management	Inigo Garmendia, PhD	Sept. 18, 2023	14:00 - 15:30
2	232	Why data-based mathematical models matter, and how can they be used to influence policies, save lives, and ensure a long-lasting optimal control of vector-borne diseases	Vector bionomics: vector biology, ecology, taxonomy and population genetics	Misonge K Ivan, PhD	Sept. 18, 2023	14:00 - 15:30
3	417	Larval Source Management, a Tale of Two Continents: Integrated Vector Management in North America and Africa	Larval source management and integrated vector management	Ary Faraji, PhD	Sept. 18, 2023	14:00 - 15:30
4	576	Scaling up Malaria Elimination: Public-Private Partnership and Evidence Based Programming to Boost and Accelerate Progress in North-Western Zambia.	LLINS, IRS and insecticide resistance management	Buumba P Bubala, PhD	Sept. 18, 2023	14:00 - 15:30
5	345	Vector genomics surveillance program in Africa: opportunities, progress, and future outlook	Precision public health and innovations for VBD elimination: artificial intelligence, entomological databases, genomic surveillance	Elijah Juma, PhD	Sept. 18, 2023	14:00 - 15:30

6	75	Field Trials of Malaria Vectors Engineered with Gene-Drive: If Not Now, When?	Precision public health and innovations for VBD elimination: artificial intelligence, entomological databases, genomic surveillance	Ana Kormos, PhD	Sept. 18, 2023	16:00 – 17:30
7	408	Pan African Vivax and Ovale Network (Pavon): Scoping the burden and transmission of *P. Vivax* and *P. Ovale* in Africa	Neglected tropical diseases (NTDs)	Isaac Quaye, PhD	Sept. 18, 2023	16:00 – 17:30
8	397	From research to impact: steps in the development, registration and deployment of a new insecticide chemistry to help tackle the growing threat of insecticide resistance in malaria vectors in sub-Saharan Africa	LLINS, IRS and insecticide resistance management	Ayumi Kawase	Sept. 18, 2023	16:00 – 17:30
9	686	Technical updates about the preparedness, gaps, and response to *Anopheles stephensi* in Africa	New and re-emerging disease vectors, climate change, and One Health	Ayman Ahmed, PhD	Sept. 18, 2023	16:00 – 17:30
10	689	Advancing Evidence for the Global Implementation of Spatial Repellents (AEGIS)	Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health	John Grieco, PhD	Sept. 18, 2023	16:00 – 17:30
11	274	Outdoor mosquito management in Africa	Larval source management and integrated vector management	Beth Ranson	Sept. 20, 2023	16:30 – 18:00

12	569	Alternative high-potential vector control strategies to mitigate insecticide resistance and reduce the malaria burden	LLINS, IRS and insecticide resistance management	Chouaibou S Mouhamadou	Sept. 20, 2023	16:30 – 18:00
13	441	Considerations for transboundary movement of gene drive mosquitoes	Precision public health and innovations for VBD elimination: artificial intelligence, entomological databases, genomic surveillance	Wolfgang Richard Mukabana, PhD	Sept. 20, 2023	16:30 – 18:00
14	488	Improving and validating methods to strengthen the evidence base for innovative vector control tools	LLINS, IRS and insecticide resistance management	Rosemary S Lees, PhD	Sept. 20, 2023	16:30 – 18:00
15	643	Advancing the Malaria and Gender Intersection towards Malaria Elimination: Pathways and Futures	Social science: mainstreaming social science in VBD interventions	Patience G Okyere Asante, PhD	Sept. 20, 2023	16:30 – 18:00
16	518	Controlling Emergent *Anopheles stephensi* in Ethiopia and Sudan (CEASE)	New and re-emerging disease vectors, climate change, and One Health	Alison M Reynolds, PhD	Sept. 21, 2023	11:00 –13:00

CONFERENCE PROGRAM

Opening Ceremony & Welcome Reception

Sunday September 17, 2023: Registration, Keynote Address & Welcome Reception		
Registration begins at 09:00 and runs until 17:00at the registration desk on the main lobby		
Time (EAT)	**Activity**	
17:00 – 21:00	**Opening Ceremony & Welcome Reception** **Room:** Ballroom 1,2,3	
17:00 – 17:30	**Entertainment**	
17:30 – 17:40	Welcoming of dignitaries	MC
17:40 – 17:45	Recognition of sponsors: Sponsors highlight	Video
17:45 - 17:55	Welcome address	Country Chapter Chairperson - Prof Delenasaw Yewhalaw
17:55 – 18:35	Opening remarks by invited dignitaries	PAMCA Executive Director
		USAID/PMI Country Director - Dr Jonathan Ross
		Director Africa CDC – Dr Jean Kayesa
		Director General of AHRI of the Ministry of Health of Ethiopia - Professor Afework Kassu,
		Director General of EPHI of the Ministry of Health of Ethiopia - Dr Mesay Hailu
		President of Jimma University – Dr. Jemal Abafita
		AMCA President
		PAMCA President
		Chief Guest & official opening of the conference

		H.E. Dr. Lia Tadesse, Minister, Ministry of Health of Ethiopia
18:35 – 19:15	Keynote Address	Speaker: Prof. Beyene Petros, Director General, Policy Study Institute, Ethiopia Presentation title: **Reorienting surveillance and management in the context of emerging threats of disease vectors**
19:15 – 20:00	Open discussion	All
20:00 – 21: 00	Welcome reception cocktail	All
	Welcome reception ends	

Day One: Monday September 18, 2023

Time	Activity		
07:00 – 08:30	**Conference registration (Main Registration Desk)**		
08:30 – 09:30	**Plenary Talks 1 & 2** **Room:** Ballroom 1,2,3 - combined **Chair:** Abdoulaye Diabate, PhD **Co-Chair:** Lizette Koekemoer		
08:30 – 09:00	**Plenary Talk 1**: Living with mosquitoes: Inevitable reality or an African fallacy? A call to action Speaker: Manuel F. Lluberas, PhD		
09:00 – 09:30	**Plenary Talk 2**: Global Fund Africa Constituency Bureau Speaker: Josephat Kakoma		
09:30 – 10:15	**Coffee Break/Exhibition Hall open/ Poster session 1 (80 posters) Poster #1 - 80**		
10:15 -12:15	**Parallel Scientific Sessions 1-5**		
10:15 -12:15	**Parallel Scientific Session 1: LLINS, IRS and insecticide resistance management** **Room**: Ballroom 1 **Session Chair**: Basiliana Emidi; **Co-chair**: Magellan Tchouakui		
	Abstract ID	**Presenter Name**	**Abstract title**
	82	Aaron Lartey	Assessing the behaviour of mosquitoes during exposure to different long-lasting insecticidal nets (llins) using the video cone test (vct).

	49	Magellan Tchouakui	A Chlorfenapyr-Based Net Interceptor® G2 Shows High Efficacy Against a Pyrethroid Resistant Anopheles funestus from Central Cameroon
	109	Christabelle Gba Sadia	Impact of agrochemical pollutant mixtures on the selection of insecticide resistance in the malaria vector Anopheles gambiae. Insights from experimental evolution and transcriptomics
	160	Basiliana Emidi	Agricultural pesticides use in rural settings, Mwanza Tanzania: An implication for insecticide resistance among malaria vectors
	177	Joseph D Challenger	Assessing the variability in experimental hut trials evaluating insecticide-treated nets against malaria vectors
	209	Ole Skovmand	Methods used to evaluate Insecticide Treated Nets (ITNs) for prequalification don't support improvements in ITN quality
	238	Germain Gil Padonou	Biochemical resistance mechanisms in *Anopheles coluzzii* from the communes of Porto-Novo and Cotonou, Benin
	92	Constantin Jesukede	Efficacy of Pyrethroid-Pyriproxyfen and Pyrethroid-Chlorfenapyr long-lasting impregnated nets (LLINs) for the control of non-Anopheles mosquitoes: secondary analysis from a cluster randomised controlled trial (CRT)
	202	Olukayode Ganiu Odufuwa	Evidence of the efficacy of insecticide treated eave nets and window screens in the semi field system for the control of pyrethroid susceptible and metabolic resistant disease vector mosquitoes.

Parallel Scientific Session 2: Vector bionomics: vector biology, ecology, taxonomy and population genetics

Room: Ballroom 2

Session Chair: Diego Ayala; **Co-chair**: David P. Tchouassi

Abstract ID	Presenter Name	Abstract title
40	Diego Ayala	Origin and Evolution of wild populations of Anopheles gambiae in Central Africa
470	Victor Balyesima	Frequency and stability of 2La inversions in *Anopheles gambiae* mosquito colonies derived from Uganda field sites
35	Inoussa Toe	Larval ecology and host-seeking and biting behavior of Aedes sp in a context of dengue re-emergence in the city of Ouagadougou
45	Mihretu Tarekegn Nigatu	A survey of malaria vectors and their biting and resting behaviour in the malaria elimination settings of Dembiya District, north-western Ethiopia
271	David P. Tchouassi	Predictive surveillance of arboviral diseases: case study of dengue
351	Dieudonné Diloma SDD Soma	The impact of four years of indoor residual spraying with pirimiphos-methyl and clothianidin on entomological drivers of malaria transmission in Burkina Faso, west africa
359	Nace Kranjc	Utilising natural variation to achieve species- and population-specific sex bias in the Anopheles gambiae complex
377	Etienne Fondjo	Biting and resting behavior heterogeneity of malaria vectors from different geographic localities in Cameroon
383	Fiacre Agossa	First report on genetic diversity in malaria vectors and its implication on the spread of insecticide resistance in the Democratic Republic of Congo

Parallel Scientific Session 3: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health

Room: Ballroom 3

Session Chair: Neil Lobo; **Co-chair**: Givemore Munhenga

Abstract ID	Presenter Name	Abstract title
67	Givemore Munhenga	Continuing development of insecticide resistance in the major malaria vector Anopheles arabiensis in northern KwaZulu-Natal, South Africa
72	Tovi Lehmann	Is the invasion and spread of the urban malaria vector Anopheles stephensi into and across Africa mediated by windborne migration?
118	Onesmo D Mwegoha	Leveraging Community Owned Resource Persons (CORPs) to reach the underserved population through Integrated Community Case Management (iCCM) to fight malaria in Tanzania.
561	Karine Mouline	Wide and sustained long-term target efficacy of an injectable long-acting ivermectin formulation against Plasmodium vectors in the fight against malaria
556	Lazarus Musa Samdi	range expansion of the populations of *Anopheles coluzzii* across five ecozones in Nigeria (2019-2022): implications for malaria transmission dynamics
147	Mgeni M Tambwe	Malaria rapid diagnostic tests reliably detect asymptomatic Plasmodium falciparum in school-aged children that are infectious to mosquitoes
157	Hamidou Maiga	From the Lab to the Field: Long-distance Transport of Sterile Male Mosquitoes
159	Basile Kamgang	Surveillance of *Aedes aegypti* and *Ae. albopictus* during the dengue response outbreak in Sao Tome and Principe in 2022

	163	Neil F Lobo	Human behavior and exposure to mosquitoes
	482	Betwel John Msugupakulya	Changing trends in the proportional contribution of Anopheles vector species to malaria transmission in East and Southern Africa: Implications for vector control
	Parallel Scientific Session 4: Larval source management and integrated vector management, New and re-emerging vectors **Room:** Ballroom 5 **Session Chair**: Manuel F Lluberas; **Co-chair**: Patricia L.V. Belisse		
	Abstract ID	**Presenter Name**	**Abstract title**
	123	Patricia Lucie Vanessa Doumbe Belisse	Assessing malaria transmission and vector dynamic in a context of larviciding trial in the city of Yaoundé, Cameroon.
	244	Eba Alemayehu Simma	Evaluation of the Biological and Residual Activity of Larvicide Formulations (SumiLarvTM 2MR, SumiLarvTM 0.5G & Abate® 1SG) against Invasive Mosquito *Anopheles stephensi* in Ethiopia
	343	Ace North	Modelling the impacts of gene drive releases on the burden of malaria in West Africa
	401	Dereje DA Alemayehu	Mosquito Abatement Through Empowerment (MATE): improving community public health and economic growth, one tractor at a time.
	575	Manuel F Lluberas	Controlling Mosquitoes and Biting Midges Under Challenging Conditions. Proof of Concept?

	74	Stephen O Okeyo	Using transcriptomic data to identify potential markers of transfluthrin insensitivity in Anopheles gambiae ss.
	77	Cynthia CAO Odhiambo	Identification of insecticide resistance markers in *Anopheles arabiensis* and *Anopheles gambiae* from Kenya and Benin using Weighted Gene Correlation Network Analysis.
	570	Helen N Nwanosike	Landscape overview of *Anopheles stephensi*
	Parallel Scientific Session 5: Social Science, Women in science, NTDs, others **Room:** Meeting room 2 **Session Chair**: Ulrike Fillinger; **Co-chair**: Christina Sudi		
	Abstract ID	**Presenter Name**	**Abstract title**
	5	Diakite Cheick Amadou Tidiani	Epidemiology of Rift Valley fever in Mali: case of the regions of Sikasso, Kayes and Segou.
	25	Kallista Chan	Rice farmers' knowledge and practices towards mosquitoes in irrigation schemes in Côte d'Ivoire: a qualitative study
	180	Fadhila Kihwele	Exploring activities and behaviors potentially increases school–age children's vulnerability to malaria infections in south-eastern Tanzania.
	208	Mbida Mbida Jean Arthur	First detection of Trypanosoma Brucei Gambiense in Manoka tse-tse flies in the Littoral Region of Cameroon: epidemiological implications and perspectives
	284	Lydiah Kibe	Innovative Communication Strategies for Enhancing Effective Community Participation in mosquito control in Malindi, Kenya

	600	Abebual Yilak	Morphological and Molecular Identification of Simulium Vectors of Onchocerciasis in Different Ecological Zones of Ethiopia: Parasite-Vector Study
	342	Taneshka Kruger	Leadership and management capacity building: Addressing gaps in NMCPs through an integrated training programme to reach elimination targets
	439	Ulrike Fillinger	Exploration of community priorities, challenges, and opportunities for One Health vector control interventions using horizontal participatory approaches – findings from coastal and western Kenya
	468	Billy L. Amugune	Cost-Effective PCR-Based Identification of Tunga penetrans (Siphonaptera) Larvae Extracted from Soil Samples Containing PCR Inhibitor-Rich Material
12:15 – 13:00	**Parallel Turbo Talks Sessions 1-5 (3 mins lightning presentations) (15 minutes transition break to Turbo Talk Sessions)**		
12:15 – 13:00	**Parallel Turbo Talks Session 1: LLINS, IRS and insecticide resistance management** **Room**: Ballroom 1 **Session Chair**: Samson Kiware **Co-chair**: Margaret Mandi		
	Abstract ID	**Presenter Name**	**Abstract title**
	215	Rhiannan A. E Logan	Improving Malaria Control: The role of UDP-glycosyltransferases in Insecticide Resistance
	221	Mponeja Peter Gitanya	Utilization of electronic system in Targeted distribution campaign (TRC) of Insecticide-treated Nets (ITNs) during COVID-19 pandemic in Southern (Sub-national) Councils of mainland Tanzania: Challenges and lesson learnt.
		Naomi H Urio	Effects of agricultural pesticides on the susceptibility and fitness of malaria vectors in rural south-eastern Tanzania

	356	Nombuso Princess Bhembe	Updates on insecticide resistance status in malaria vector populations and insecticide resistance management in Eswatini
	301	Eric Ali Ibrahim	Characterization of phenotypic resistance in malaria vector species in space and time
	305	Komi Mensah Agboke	Changing climate-associated habitat characteristics drives the spatial and temporal occurrences of resistant Anopheles gambiae
	315	Pierre Marie Sevegnon	Comparative efficacy of three types of dual-active-ingredient insecticidal nets against pyrethroid-resistant Anopheles gambiae in southern Benin
	423	Endalew Zemene	Determination of the residual efficacy of micro-encapsulated pirimiphos-methyl (Actellic®300CS) Insecticide Formulation Applied on Standard Tents Used in Humanitarian Emergencies and Plywood Tiles against Malaria Vectors

Parallel Turbo Talks Session 2: Vector bionomics: vector biology, ecology, taxonomy and population genetics

Room: Ballroom 2

Session Chair: Elijah Juma; **Co-chair**: Romoke T Izekor

Abstract ID	Presenter Name	Abstract title
55	Cheteug Nguetsa Glwadys	IgG anti-gSG6-P1 response as biomarker exploring the seasonal heterogeneity of human exposure to Anopheles gambiae bites in rural area of Cameroon in Central Africa
129	Elodie Vajda	Semi-field evaluations of the impact of novel bite prevention interventions on *Anopheles minimus* landing and key life history traits in Thailand
130	Elodie Vajda	Field evaluation of novel mosquito bite prevention tools against Anopheles mosquitoes in Cambodia

	446	Aboubakar Sanon	Variation of Aedes aegypti life-history traits across different climatic zones of Burkina Faso
	275	Robert Kossivi Ouedraogo	Mating competitiveness of paternal male-bias *Anopheles coluzzii* transgenic males compare to their wild type in insectary, Burkina Faso
	662	Romoke T Izekor	Evidence of high contribution of kdr and GSTE2 in populations of *Anopheles gambiae* suggest multiple insecticide selection pressure in populations of mosquitoes in Nigeria
	652	Javan Chanda	Profiling vector species composition, parasite infection, seasonality, biting and resting behaviour of malaria vectors to guide targeting of vector interventions along Lake Kariba of Southern Zambia
	81	Habtamu A Goshu	Genomic copy number variations for adaptation of livestock to climate resilience
	Parallel Turbo Talks Session 3: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health **Room**: Ballroom 3 **Session Chair**: Fetlework Workineh Asress; **Co-chair**: Jacinta Muli		
	Abstract ID	**Presenter Name**	**Abstract title**
	367	Soumanaba Zongo	Nationwide status of insecticide resistance of the major dengue vector Aedes aegypti in Burkina-Faso
	606	Alemnesh H Bedasso	Malaria vector feeding, peak biting time and resting place preference behaviors in line with indoor based intervention tools and its implication: scenario from selected Sentinel Sites of Ethiopia

	501	Abdoul-Azize Millogo	GIS-based multi-criteria analysis for selection of suitable field site for genetically modified mosquitoes' small-scale testing
	557	Cécile Sadia-kacou	Use of anopheles salivary biomarker to assess seasonal variation of human exposure to anopheles bites in children living near rubber and oil palm cultivations in Côte D'ivoire
	399	Herbert T Nyirenda	Prevalence of Asymptomatic Malaria Infection and Ancillary of Care to Enhance Education Development Among School Age Children Attending School in Mining Regions of North-Western Province of Zambia.
	246	Fetlework Workineh Asress	Development and validation of an empirical model to forecast malaria outbreaks at Amhara Region, Ethiopia: a retrospective follow-up study
	389	Alphonse Traore	Laboratory and field evaluation of MAÏA®, an ointment containing N,N-diethyl-3-methylbenzamide (DEET) against mosquitoes in Burkina Faso
	491	Isaac Lyatuu	Creating geospatial disease heat maps using routine HMIS data and DHIS2
	Parallel Turbo Talks Session 4: LSM, IVM, NTDs, Women in science; social science, precision public health, other **Room**: Ballroom 5 **Session Chair**: Celina Aju-Ameh; **Co-chair**: Lydia Kibe		
	Abstract ID	**Presenter Name**	**Abstract title**
	126	Felista S Tarimo	Perception of autodissemination of pyriproxyfen for malaria control among community members in southern Tanzania
	265	Christina Makungu	Understanding hidden drivers of persistent malaria transmission in rural southern coast of Tanzania: exploring human behaviours, structural factors, and rural livelihoods

	365	Joshua Ogango Otiang	Co-production of a cattle-targeted vector control intervention in coastal and western Kenya - potential role and limitation of veterinary extension service
	374	Daniel Msellemu	Occupational exposure to malaria, leishmaniasis and arbovirus vectors in endemic regions: a systematic review
	Parallel Turbo Talks Session 5: Precision public health, NTDs, Genomics, Social Science, Women in Science; others **Room**: Meeting room 2 **Session Chair**: Ana Kormos; **Co-chair**: Fredrick G Kabbale		
	Abstract ID	**Presenter Name**	**Abstract title**
	203	Jamila Ahmed	Combating vectors with venoms: potential effects of three novel mosquitocidal peptides isolated from spider venoms against Aedes aegypti linnaeus.
	308	Natalia Manas Chavernas	Bed net damage assessment from images using a digital segmentation tool and image processing
	314	Lusungu Kayira	Socio-cultural factors shaping individual nighttime exposure to malaria transmission in Malawi: case of Chikwawa district
	511	Siaka Debe	Seroprevalence and demographic risk factors of dengue fever in Burkina Faso through national survey
	524	Alassane Traore	Assessment of community knowledge on genetic concepts to enhance stakeholder engagement for gene drive technology
	66	Fredrick G Kabbale	Malaria Prevalence among different Age Groups and Gender in Subsistence Crop Farming and Fishing Communities in Greater Kamuli District, Uganda: Implications for Control

	590	Temesgen Ashine Amenu	The spatiotemporal occurrence and peri-domestic infestation of Anopheles stephensi in selected towns across varying eco-epidemiological settings of Ethiopia
	121	Bertha Kasonde	Prevalence of dhps K540E and A581G mutations in Plasmodium falciparum isolates among asymptomatic parasitaemic pregnant women attending antenatal care booking in Nchelenge district Northern Zambia
13:00 – 14:00	**Lunch Break (Exhibition Hall open/ Poster session 1 (80 posters) Poster #1 - 80**		
14:00 – 15:30	**Parallel Symposia 1 - 5**		
14:00 – 15:30	**Parallel symposium Session 1 (ID 54):** IK Smart Light: A new tool to enable more efficient delivery of indoor residual spraying **Organizer:** Inigo Garmendia, PhD **Room:** Ballroom 1		
	Parallel symposium Session 2 (ID 232): Why data-based mathematical models matter, and how can they be used to influence policies, save lives, and ensure a long-lasting optimal control of vector-borne diseases **Organizer**: Misonge K Ivan, PhD **Room**: Ballroom 2		
	Parallel Symposium Session 3 (ID 417): Larval Source Management, a Tale of Two Continents: Integrated Vector Management in North America and Africa **Organizer:** Ary Faraji, PhD **Room**: Ballroom 3		
	Parallel Symposium Session 4 (ID 576): Scaling up malaria elimination: Public-private partnership and evidence-based programming to boost and accelerate progress in north-western Zambia. **Organizer:** Buumba P. Bubala, PhD		

	Room: Ballroom 5
	Parallel Symposium Session 5 (ID 345): Vector genomics surveillance program in Africa: opportunities, progress, and future outlook **Organizer:** Elijah Juma, PhD; **Co-organizer**: Alistair Miles, PhD **Room:** Meeting room 2
15:30 – 16:00	**Tea break (Exhibition Hall open/ Poster session 1 (80 posters) Poster #1 - 80**
16:00 – 17:30	**Parallel Symposia 6 - 10**
16:00 – 17:30	**Parallel Symposium Session 6 (ID 75)**: Field Trials of Malaria Vectors Engineered with Gene-Drive: If Not Now, When? **Organizer:** Ana Kormos, PhD **Room:** Ballroom 1
	Parallel Symposium Session 7 (408): Pan African *Vivax* and *Ovale* network (pavon): scoping the burden and transmission of *P. vivax* and *P. ovale* in Africa **Organizer:** Isaac Quaye, PhD **Room**: Meeting room 2
	Parallel Symposium Session 8 (397): From research to impact: steps in the development, registration and deployment of a new insecticide chemistry to help tackle the growing threat of insecticide resistance in malaria vectors in sub-Saharan Africa **Organizer**: Ayumi Kawase **Room:** Ballroom 3
	Ballroom 5

	Parallel Symposium Session 9 (686): Technical updates about the preparedness, gaps, and response to *Anopheles stephensi* in Africa **Organizer:** Ayman Ahmed, PhD **Room:** Ballroom 5
	Parallel Symposium Session 10 (ID 689): Advancing Evidence for the Global Implementation of Spatial Repellents (AEGIS) **Organizer:** John Grieco, PhD **Room:** Ballroom 2
17:30	**Day One ends**
18:30 – 22:00	Quiz Night – PAMCA/Vestergaard **Room:** Jazz Club, Skylight Hotel

Day Two: Tuesday September 19, 2023

Time	Activity		
07:00 – 08:30	**Conference registration (Main Registration Desk)**		
08:30 – 09:30	**Plenary Talks 3 & 4** **Room**: Ballroom 1,2,3 - combined **Chair**: Charles Wondji; **Co-chair**: Nsa Dada		
08:30 – 09:00	**Plenary Talk 3**: Special District Model - Reimagining Malaria Control in Africa by Focusing on Local Mosquito Control Programs Speaker: Wakoli Wekesa, PhD		
09:00 - 09:30	**Plenary Talk 4**: Women Leading the Charge: Breaking the Gender Barrier in Malaria & Vector-Borne Disease Response Speaker: Corine Karema, PhD		
09:30 – 09:50	**Wellcome Trust Funding Opportunities**		
9:50 – 10:20	Coffee Break/Exhibition Hall open/ Poster session 2 (80 posters) Poster #81-- 160,		
10:20 – 12:00	**Parallel Scientific Sessions 6 - 10**		
10:20 – 12:00	**Parallel Scientific Session 6: LLINS, IRS and insecticide resistance management** **Room**: Ballroom 1 **Session** Chair: Sarah Moore; **Co-chair**: Krijn P Paaijmans		
	Abstract ID	**Presenter Name**	**Abstract title**
	325	Sié Hermann Pooda	Evaluation of the systemic insecticidal effects of ivermectin treated cattle on Aedes aegypti, vector of arboviruses

	332	Sarah J Moore	Considerations for more accurate bio efficacy testing of insecticide treated nets (ITNs) and indoor residual spraying (IRS) for metabolic resistant mosquitoes
	376	Andrew C Glover	Identifying optimal mass distribution campaign intervals to improve malaria control
	236	Aminata Bah	Assessment of efficacy of Pirimiphos-methyl on sprayed surfaces in The Gambia
	420	Krijn P Paaijmans	The real entomological impact of IRS when considering implementation practices, human behavior and vector bionomics
	631	Amen N Fadel	The Rise of Mortality of Pyrethroid-Resistant *Anopheles gambiae* sensu lato from Chad Republic after synergist bioassays with piperonyl butoxide is suggesting evident support of deployment of PBO-Insecticide Treated Nets
	460	Isaac J Stopard	Comparing the epidemiological impact of dual active ingredient nets in pilot implementation programmes and cluster randomised control trials
	245	Eba Alemayehu Simma	Determination of the Residual Efficacy of Broflanilide (VECTRONTM T500) Insecticide for Indoor Residual Spraying
	647	Samuel S Gomez	Phenotypic insecticide resistance status and molecular detection of resistance mutations in *Anopheles gambiae* sensu lato in The Gambia.
	Parallel Scientific Session 7: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health **Room**: Ballroom 2 **Session Chair**: Mercy Opiyo; **Co-chair**: Mauro Pazmino		
	Abstract ID	**Presenter Name**	**Abstract title**

	176	Steven Gowelo	A digital question-based entomological surveillance planning tool increases knowledge acquisition and self-efficacy in users
	545	Edwige Guissou	Effect of parasite density on the extrinsic incubation period (EIP) of *Plasmodium falciparum* for *Anopheles gambiae*
	183	Abdoulaye Niang	Implementation Of a New Vector Surveillance System to Anticipate the Impact Assessment of the Novel Genetic Technologies in Burkina Faso
	184	Mercy Opiyo	Development, piloting, and evaluation of an Entomological Adaptive Sampling Framework (EASF) in Mozambique and Ghana
	204	Wilfred Ouma Otambo	Influence of landscape heterogeneity on entomological and parasitological indices of malaria in Kisumu, Western
	234	Ramziyath R Agbanrin Youssouf	Evaluation of the trophic behaviour of *Aedes aegypti* in the city of Cotonou in southern Benin
	335	Twig Mudenda	Understanding the role of understudied female anophelines in a low transmission setting, southern Zambia.
	258	Mauro Pazmino	The effect of temperature on aging rates in *Anopheles gambiae* s.l.: Improving model generalization for infrared spectroscopy-based surveillance
	259	Gift Mwaanga	Residual bio-efficacy of attractive targeted sugar bait stations targeting malaria vectors during seasonal deployment in western province, Zambia.
	214	Kevin Thiongo	Prevalence of pfdhfr and pfdhps mutations in Plasmodium falciparum associated with drug resistance among pregnant women receiving IPTp-SP at Msambweni County Referral Hospital, Kwale County, Kenya

	Parallel Scientific Session 8: Precision public health and innovations for VBD elimination: artificial intelligence, entomological databases, genomic surveillance, new and re-emerging disease vectors, climate change, One health **Room**: Ballroom 3 **Session Chair**: Josephine Malinga; **Co-chair**: Nick Golding		
	Abstract ID	**Presenter Name**	**Abstract title**
	32	Gilles Yemien	Identification of yellow-g in *Anopheles gambiae* and design of molecular strategy to study its function, in view to genetically control malaria vectors
	33	Odette Nabasnogo Zongo	In silico analysis and design of a molecular construct to target the beta tubulin2 gene in *Anopheles gambiae*
	34	Grégoire Sawadogo	Identification of odorant co-receptor gene in *Anopheles gambiae* and in silico design of strategies to study its function in a vector control perspective
	113	Genevieve Tchigossou	Prevalence of Microsporidia MB, a symbiotic microbiome of Anopheles gambiae sl. in rice production areas in Benin
	243	Prashanth Selvaraj	Microsporidia MB: Evaluating the impact of symbiont-based malaria vector control via EMOD, an agent-based model of vector genetics and malaria transmission
	282	Tibebu Habtewold	Anopheles gambiae population replacement for malaria elimination in Africa using gene drive
	637	Josephine Malinga	Accelerating malaria prevention through model-informed product selection and design: insights from vaccines, monoclonal antibodies, and chemoprevention drugs
	425	Nick Golding	Mapping the current and potential future distribution of *Anopheles stephensi* in Africa

	536	Dominic P Dee	MINT, an online tool to support decisions on vector control against malaria
	58	Lizette L Koekemoer	Development of endectocide pipeline for screening novel compounds
	Parallel Scientific Session 9: Vector bionomics: vector biology, ecology, taxonomy and population genetics **Room**: Ballroom 5 **Session Chair**: Lindelwe Mabika; **Co-chair**: Sanjay Curtis Nagi		
	Abstract ID	**Presenter Name**	**Abstract title**
	405	David Audu	Impact of herbal and synthetic antimalarial medications on mosquito gut microbiota and enzyme activities.
	416	Danspaid P Mabuka	Evaluating interactions between larval predators and genetically engineered *Anopheles coluzzii.*
	454	Lindelwe Mabika	Assessment of outdoor biting patterns of Anopheles mosquitoes sampled from animal shelters in Umkhanyakude and Zululand Districts: implications to current malaria elimination strategies
	411	Oumou kalsom Gueye	Introgression with reproductive isolation between *An. coluzzii* and *An. gambiae* populations in central and south-eastern Senegal.
	466	Thomas O Onchuru	Microsporidia MB and Anopheles gambiae interaction dynamics and its relevance in developing a symbiont-based strategy to control malaria
	499	Narcisse NBB Basosila	Study of the behavior and entomological parameters of *Anopheles* in two health zones in the province of north-Ubangi, Democratic Republic of Congo in 2021
	503	Sanjay Curtis Nagi	Parallel evolution in mosquito vectors: A novel locus confers resistance to Pirimiphos-methyl in *Anopheles gambiae* s.l

	562	Henrique Silveira	Anopheles mosquitoes bred without blood for malaria research and control
	615	Ayodele S Babalola	Potential geographical spread of yellow fever vectors (Aedes spp) in relation to human population density in Lagos State, Nigeria: a maximum entropy (MaxEnt) modeling approach
	Parallel Scientific Session 10: Larval source management and integrated vector management (Student track – student competition) **Room**: Meeting room 2 **Session Chair**: Diane Leslie Nkahe; **Co-chair**: Arega Tsegaye		
	Abstract ID	**Presenter Name**	**Abstract title**
	99	Arega Tsegaye	Anopheles larval habitats seasonality and environmental factors affecting larval abundance and distribution in Arjo-Didessa sugar cane plantation, Ethiopia
	24	Kallista Chan	Suppressing the breeding of malaria vectors in African rice fields: the effects of rice cultivation practices on rice yield, water productivity and greenhouse gas emissions in lowland irrigation schemes
	104	Hudson Onen	Predators of *An. gambiae* sensu lato larvae exhibit adaptive patterns of predation and mobility in a semi-field experiment
	125	Mame Fatou Tall	Experimental evaluation of the residual efficacy of two insects' growth regulators for a potential use as complementary LSM strategies to control malaria vectors in Senegal
	190	Denis Richard Kailembo	Community-based biolarviciding for malaria control in tanga region, Tanzania

	218	Chi T Fru	Larvicidal activity of *Momordica foetida* (cucurbitaceae), *Gnidia glauca* (thymelaeaceae) and V*epris soyauxii* (rutaceae) extracts on *Anopheles gambiae* s.l. (culicidae) and acute oral toxicity
	219	Diane Leslie Nkahe	Contribution of larviciding with biological compounds to the management of pyrethroid resistance in a population of *Anopheles gambiae* s.l. expressing high resistance intensity.
	220	Nina Ghislaine Yensii	Contribution of vectomax®g, a larvicide for the control of mosquito densities and malaria transmission in some districts in the city of Yaoundé
12:00 – 13:00	**Parallel Turbo Talks Sessions 6 -10 (3 min lightning presentations) (15 minutes transition break to Turbo Talk Sessions)**		
12:150 – 13:00	**Parallel Turbo Talks Session 6: LLINS, IRS and insecticide resistance management** **Room**: Ballroom 1 **Session Chair**: Eric Ochomo; **Co-chair**: Magellan Tchouakui		
	Abstract ID	**Presenter Name**	**Abstract title**
	364	Oswald Djihinto	Copy number variation in sensory appendage protein coding genes in the malaria-transmitting vectors *Anopheles coluzzii* and *Anopheles gambiae*
	407	Sabina C Eze	Insecticide resistance in vector control: Knowledge gap and way forward
	462	Abel Agbevo	Experimental hut evaluation of the efficacy and wash resistance of two alpha-cypermethrin and piperonyl butoxide nets (DuraNet®Plus and DuraNet®Plus 2.0): a multi-centre study against pyrethroid-resistant malaria vectors in Benin, Cameroon and Cote D'Ivoire.

	452	Godwill Mlambo	Bio-efficacy Re-evaluation of Actellic 300 CS for Indoor Residual Spray Against Anopheline Mosquitoes Under Field Conditions in Solwezi District of North-Western Province.
	522	Benjamin Djantio Menze	Experimental hut trials reveal a greater loss of the efficacy for the pyrethroid-only nets than with PBO-based nets from the mass distribution campaign 2018-2021 against resistant malaria vectors in Cameroon
	604	Emile F S Tchicaya	Experimental hut evaluation of a pyriproxyfen treated net against resistant *An. gambiae* (Tiassalé strain) mosquitoes
	683	Harrysone Etemesi Atieli	Wind-assisted high altitude dispersal of mosquitoes and other insects in East Africa
	620	Luis B Constantino	Insecticide resistance profile of *Anopheles funestus* in Mopeia district, a high malaria transmission area in Central Mozambique.
	263	Grâce Odéra Nianga Bikouta	Evaluation of the durability of long-lasting insecticidal nets in Djoumouna from Brazzaville Congo
	Parallel Turbo Talks Session 7: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health **Room**: Ballroom 2 **Session Chair**: Immo Kleinschmidt; **Co-chair**: Edith E.L Chepkorir		
	Abstract ID	**Presenter Name**	**Abstract title**
	317	Alice M. Mungo	Blood-meal sources and malaria positivity rates of primary and secondary vectors in a malaria endemic area of western province, Zambia.
	358	Selemani C Mmbaga	Investigating factors associated with vectors densities, composition and biting pattern across different setting of Tanzania to Inform Control Strategies.

	479	Fatuma Juma Matwewe	Increasing capacity for evaluating transgenic mosquitoes as a population replacement strategy in malaria-endemic settings
	502	Edith E.L Chepkorir	Circulation of mosquito-borne Alphaviruses and Orthobunyaviruses in two geographically distinct Ecozones of Kenya
	653	Justin Kumala	Exposure to malaria vector bites in relation to human sleeping patterns in rural Malawi
	580	Mary Olamide Akinwola	Malaria vaccine information in Africa: an analysis of the quality and engagement of Tiktok videos
	552	Immo Kleinschmidt	How much does outdoor biting contribute towards malaria burden?
	610	Abdiaziz A Gosar	Development of Malaria Pf/Pan antigen detection kit in Kenya; towards the realization of local manufacture of medical devices
	Parallel Turbo Talks Session 8: Vector bionomics: vector biology, ecology, taxonomy and population genetics, LSM, NTDs, others **Room**: Ballroom 5 **Session Chair**: Sarah J Moore; **Co-chair**: Joseph Chabi		
	Abstract ID	Presenter Name	Abstract title
	119	Achaz-Achim Mawugnon Agolinou	In silico design of molecular model to study the SIFamide gene function in Anopheles gambiae olfactory system, in a perspective of genetic control of the vector

	96	Joseph N Gichuhi	The malaria transmission-blocking symbiont, Microsporidia MB, exhibits an environment-modulated interaction with *Anopheles arabiensis* at the Ahero irrigation scheme, Kenya
	379	Adriana Adolfi	Understanding the role of the antennae in the mosquito behavioural response to insecticide-treated bed nets
	472	Rabiatou A Diarra	Testing configurations of attractive toxic sugar bait (ATSB) stations in Mali, West Africa, for improving the control of malaria parasite transmission by vector mosquitoes and minimizing their effect on non-target insects
	526	Irene R Moshi	Assessing the readiness and Feasibility of Larval Source Management in Rural Districts in Tanzania
	539	Temple K Mumba	Scaling up LSM, evaluating a pilot Larval Source Management (LSM) program; a vector Ccntrol intervention in mining and surrounding communities in North-Western Province of Zambia.
	211	David M Mburu	Leveraging on geospatial modelling for inferences on ecological relationship among mosquitoes, tsetse flies and ticks' bionomics along the Kenyan coast
	277	Fekadu Massebo	Species diversity, blood meal sources and infection rates of Anopheles mosquitoes in rural and urban settings in southwest Ethiopia: an implication for malaria control
	Parallel Turbo Talks Session 9: Precision public health, NTDs, LSM, Women in Science, Social Sciences, other **Room**: Meeting room 2 **Session Chair**: Lizette L. Koekemoer; **Co-chair**: Zawadi Mboma		
	Abstract ID	**Presenter Name**	**Abstract title**

	224	Mbaihondoum Jacob	Perceptions and practices of rural communities regarding dracunculiasis behavior change education in Chad
	422	Roy Faiman	IDX - An AI based imaging and identification tool for Vector Identification with a prototype algorithm for select African species
	426	Gerry Ryan	Mapping the abundance of *Anopheles gambiae* across Africa
	495	Basiliana Emidi	"How can you refuse when someone is helping you?" Community perception, acceptability, and support for establishing and sustaining 'women champions in vector control' group at the community level in Mwanza, Tanzania
	500	Mark Wamalwa	Harnessing data science and machine learning to unveil mechanisms that characterize vectors of diseases
	609	Mohamed Jumanne	Field studies on epidemiologically important aspects of the reproductive biology of female *Anopheles funestus* in southeastern Tanzania
	174	Zawadi M Mboma	Feasibility and community acceptance of insecticide treated eave nets and insecticide treated window screens in Tanzania.
12:00 - 13:00	**Social Science Special Session** **Moderator**: Ghislaine Ametchie; **Co-moderator**: Lea Pare Toe **Room**: Ballroom 3		
13:00– 14:00	**Lunch Break (Exhibition Hall open/ Poster session 2 (80 posters) Poster #81-- 160**		
14:00 – 17:00	**Panel Discussions 1 & 2** **Room**: Ballroom 1,2,3combined		

14:00 – 15:30	**Panel Discussion 1**: Harnessing the capacity of African institutions for strengthened response against vector-borne diseases **Moderator**: Emma Orefuwa; **Co-moderator**: El hadji Niang
15:30 – 17:00	**Panel Discussion 2**: Bridging the Gap "the Dos and Don'ts": Gender inclusivity in Vector-Borne Disease Research and Control in Africa **Moderator**: Christina Sudi; **Co-moderator:** Jessy Goupeyou-Youmsi
17:00 – 17:30	Tea break; (Exhibition Hall open/ Poster session 2 (80 posters) Poster #81-- 160
	Day Two Ends - Free evening – No event planned

Day Three: Wednesday September 20, 2023

Time	Activity
07:00 – 8:30	**Conference registration (Main Registration Desk)**
08:30 – 9:00	**Plenary Talks 5, 6 & 7** **Room**: Ballroom 1,2,3 - combined **Chair**: El Hadji Niang; **Co-Chair**: Luna Kamau
08:30 – 09:00	**Plenary Talk 5**: Malaria, eradication and the role of vector control **Speaker**: Helen Jamet
09:00 - 09:30	**Plenary Talk 6**: AUDA-NEPAD's Contribution to Vector Control and Continental Regulation **Speaker:** Dr Jeremy Tinga Ouedraogo
09:30 – 10:00	**Plenary Talk 7**: TBD **Speaker**: Africa CDC

10:00 – 10:30	**Coffee Break/Exhibition Hall open/ Poster session 3 (80 posters) Poster #161 - 240**		
10:30 - 12:00	**Sponsors presentations**		
10:30 - 12:00	Sponsor presentations **Room**: Ballroom 1,2,3 - combined		
12:00 – 13:00	**Student poster competition (15 minutes transition break to poster competition session)**		
12:15 – 13:00	Student poster competition **Room**: Ballroom 1,2,3 – combined **Chair**: Samson Kiware; **Co-chair**: Joseph Chabi		
13:00 – 14:00	**Lunch Break (Exhibition Hall open/ Poster session 3 (80 posters) Poster #161 - 240**		
14:00 - 16:00	**Parallel Scientific Sessions 11 - 15**		
14:00 -16:00	**Parallel Scientific Session 11: LLINS, IRS and insecticide resistance management** **Room**: Ballroom 1 **Session Chair:** Julien Z.B. Zahouli; **Co-chair**: Mame Niang		
	Abstract ID	**Presenter Name**	**Abstract title**
	582	Julien Z.B. Zahouli	Semi-field efficacy of PermaNet Dual® (a new deltamethrin-chlorfenapyr net) against pyrethroid-resistant Anopheles gambiae populations from Côte d'Ivoire
	588	Eliningaya J Kweka	Efficacy of In2Care® EaveTubes against wild populations of malaria vectors in a small-scale field study at Kagera Sugar Ltd, Misenyi, Tanzania

	604	Emile F S Tchicaya	Experimental hut evaluation of a pyriproxyfen treated net against resistant *An. gambiae* (Tiassalé strain) mosquitoes
	645	Patrick Tungu	Non-inferiority experimental hut and community (Phase III) cluster randomized indoor residual spraying evaluation trials of VECTRONTM T500 against malaria vectors in Tanzania.
	660	Moussa BM Cisse	Large-scale village field trials: Residual efficacy of Ficam® VC (WP-SB) and Fludora® Fusion (WP-SB) in indoor residual spraying against pyrethroid resistant *Anopheles gambiae* s.l. in Mali
	670	Tolulope Oyeniyi	Towards Management of Insecticide Resistance in Nigeria: Village scale Evaluation of VECTRON T500 against Populations of Anopheles coluzzii resistant to pyrethroids but susceptible to organophosphate
	675	Elias Niyituma	Impact of new insecticide-treated nets and indoor residual spraying on entomological indicators of malaria transmission in Rwanda
	398	Koama Bayili	Screening male mosquitos' resistance to insecticides in perspective to release sterile/transgenic males in Burkina Faso
14:00 -16:00	406	Njelembo J Mbewe	Efficacy of dual insecticide (chlorfenapyr+ deltamethrin) partially treated nets against *Anopheles arabiensis:* roof vs sides vs whole treated nets.
	Parallel Scientific Session 12: Vector bionomics: vector biology, ecology, taxonomy, and population genetics **Room**: Ballroom 2 **Session Chair**: Penny Hancock; **Co-chair:** Rita Mwima		
	Abstract ID	**Presenter Name**	**Abstract title**
	640	Chrysanthi Taxiarchi	Genetic approaches to constrain gene drives in Anopheles mosquitoes

	657	Luciano Michaël Tantely	Environmental and climatic drivers of the abundance of *Anopheles gambiae* s.l., *An. coustani* and *An. squamosus/cydippis* in five provinces of Madagascar.
	667	Rocco D'Amato	Gene drive and anti-drive genetic control tools for Anopheles gambiae: a lesson from large cage studies
	9	Rita Mwima	Succession Mechanisms of the Major *Anopheles gambiae* s.l Complex Malaria Vectors in Sub-Saharan Africa: A Narrative Review
	240	Esinam Abla Akorli	Prevalence of Microsporidia mb among field collected Anopheles mosquitoes may be associated with geographical factors of breeding niches across Ghana.
	549	Xenia karlsson	Modelling the use of genetically engineered underdominance in management of insecticide resistance and control of insect vector/pest densities
	286	Penny Hancock	Models to inform monitoring to detect impacts of gene drive releases on malaria vector suppression in African field trials
	477	Joseph Chabi	Profiling insecticide resistance of *Anopheles gambiae* (s.l.) for prioritization and deployment of ITNs in Senegal
	541	Joachim Nwezeobi	Population structure and signals of selection in *Anopheles funestus* mosquitoes across sub-saharan Africa
14:00-16:00	**Parallel Scientific Session 13: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health** **Room**: Ballroom 3 **Session Chair**: Joel C Mouatcho; **Co-chair**: Brenda Onyango		
	Abstract ID	**Presenter Name**	**Abstract title**

	327	Gabriel O Kotewas	Effectiveness of indoor residual spray on malaria control; a review of the malaria cases among children under five years in Rachuonyo north sub county, Homa Bay county, Kenya.
	339	Rock Aikpon	Increase in the malaria entomological inoculation rate following indoor residual spraying (irs) withdrawal in Atacora, Benin
	375	Billy L. Amugune	Comparative efficacy of two new light traps for consideration of use in surveillance of malaria-vectors
	400	Daniel Nguiffo Nguete	Plasmodium malariae contributes to high levels of malaria transmission in a forest-savannah transition area in Cameroon
	403	Brenda Onyango	Molecular surveillance leads to the first detection of *Anopheles stephensi* in Kenya
	438	Megan A Riddin	Understanding the entomological drivers of malaria transmission in high-burden villages in Vhembe District, Limpopo Province, South Africa.
	442	Nellie Kaunde	Quantifying predictors of human-to-mosquito malaria parasite transmission in southern Malawi
	481	Joel Lutomiah	Arboviral disease outbreaks in Kenya: a historical perspective, current trends and the role of vector surveillance in early detection
	487	Joel C Mouatcho	So near but so far away: Indoor versus outdoor malaria transmission in an area targeted for malaria elimination
	513	Domonbabele François de Sales Hien	Contrasting effects of the alkaloid ricinine on the capacity of *Anopheles gambiae* and *Anopheles coluzzii* to transmit *Plasmodium falciparum*
14:00-16:00	**Parallel Scientific Session 14: LLINS, IRS and insecticide resistance management (Student track – Student Competition)**		

	Room: Ballroom 5 **Session Chair**: Joel O. Odero; **Co-chair**: Shaaban M Magorwa		
	Abstract ID	Presenter Name	Abstract title
	12	Abdoul-Aziz Maiga	First report of V1016I, F1534C and V410L kdr mutations associated to pyrethroid resistance among Aedes aegypti from Niamey, Niger
	47	Judith Sinkanako Banda	Assessing the preferred resting sites of anopheles mosquitoes inside houses in Chikwawa district, Malawi
	139	Isaiah Debrah	Insecticide Resistance and Whole Transcriptome Profiles *of Anopheles funestus* Population in western Kenya
	155	Joel O. Odero	Phenotypic and molecular insecticide resistance monitoring of *Anopheles funestus* mosquitoes to guide malaria control efforts in Tanzania.
	158	Ambrose Oruni	A 2-year temporal investigation of insecticide resistance in *Anopheles funestus* from Uganda reveals an escalation with no association to known molecular markers
	194	Idriss Nasser Ngangue Siewe	Association between g119s mutation (ace-1) and detoxification genes with bendiocarb and malathion resistance in two major malaria vector populations in Cameroon.
	217	Shaaban M Magorwa	Reorienting Vector Surveillance and Management in the Context of Emerging Threats: report on the mosquito larvae spraying exercise held on March 15, 2022 at Kigoma / Ujiri Municipal Council

14:00-16:00	**Parallel Scientific Session 15: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health** **Room**: Meeting room 2: **Session Chair**: Alison M Reynolds**; Co-chair**: Joel Lutomiah		
	Abstract ID	**Presenter Name**	**Abstract title**
	525	Mark Wamalwa	The exigent threat of the alien invasive *Anopheles stephensi* in Africa
	543	Lucy Njeri Wachira	Entomological surveillance of malaria vectors in Turkana County, an arid and Semi-arid region in Kenya
	550	Soumyadipta Acharya	Towards Community Based Vector Surveillance through VectorCam, a novel artificial intelligence –based tool for mosquito identification
	558	Alex Makunin	ANOSPP: amplicon sequencing for high throughput Anopheles mosquito species identification and Plasmodium presence status
	437	Joyce Nyirongo	Characterizing human reservoirs of *P. falciparum* transmission
	622	Gerard F Killeen	The subtle art of herding cats: Cultivating cadres of expert leaders who are individually independent but nevertheless collaborate and learn together as effective teams
	664	Thiery Nirina Jean Jose Nepomichene	Field assessment of resting boxes for the surveillance of malaria vectors in the Central Highlands of Madagascar
	44	Zarat O Iwalewa	Species Composition, Blood Meal Preference and Sporozoite Infectivity of Malaria Vector in an Agrarian Community Adjourning Osogbo, South-Western, Nigeria

	64	Tatiane Assatse	*Anopheles funestus* populations across Africa are broadly susceptible to neonicotinoids but with signals of possible cross-resistance from the GSTe2 gene
	292	Jaelsa Mira Goncalves Moreira	Status of WHO malaria elimination certification in Cabo Verde
16:00 – 16:30	**Tea break (Exhibition Hall open/ Poster session 3 (80 posters) Poster #161 - 240**		
16:30 – 18:00	**Parallel Symposia 11 - 15**		
16:30 – 18:00	**Parallel Symposium Session 11 (ID 274): Outdoor mosquito management in Africa** **Organizer**: Beth Ranson **Room**: Ballroom 1		
	Parallel Symposium Session 12 (ID 569): Alternative high-potential vector control strategies to mitigate insecticide resistance and reduce the malaria burden **Organizer**: Chouaibou S Mouhamadou **Room**: Ballroom 2		
	Parallel Symposium Session 13 (ID 441): Considerations for transboundary movement of gene drive mosquitoes **Organizer**: Wolfgang Richard Mukabana, PhD **Room**: Ballroom 3		
	Parallel Symposium Session 14 (ID 488): Improving and validating methods to strengthen the evidence base for innovative vector control tools **Organizer**: Rosemary S. Lees, PhD **Room**: Ballroom 5		

	Parallel Symposium 15 (ID 643): Advancing the Malaria and Gender Intersection towards Malaria Elimination: Pathways and Futures **Organizer**: Patience G Okyere Asante **Room**: Meeting room 2
18:00	Day Three Ends
18:30 – 22:00	**African Cultural Night Experience** **Venue**: Team Ethiopian Restaurant

Day Four: Thursday September 21, 2023

Time	Activity		
07:00 – 08:30	**Conference registration (Main Registration Desk)**		
08:30 – 10:30	**Panel Discussion 3 & PAMCA New Board Introduction** **Room**: Ballroom 1,2,3 - combined		
08:30 – 09:30	**Panel Discussion 3**: Pivoting to African-derived and led Impactful Research and Intervention Implementation **Moderators**: Jaishree Raman & Ghislaine Ouedraogo-Ametchie		
09:30 - 10:30	**PAMCA New Board Introduction**		
10:30 – 11:00	**Coffee Break/Exhibition Hall open/ Poster session 4 (90 posters) Poster # 241 -330**		
11:00 – 13:00	**Parallel Scientific Sessions 16 – 19 and Symposium 16**		
11:00 – 13:00	**Parallel Scientific Session 16: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health (Student track – student competition)** **Room**: Ballroom 1 **Session Chair**: Marilene M. Ambadiang; **Co-chair:** Paul C Mrosso		
	Abstract ID	**Presenter Name**	**Abstract title**
	192	Assalif Demissew	Impact of irrigation induced environmental modification on the dynamics, seasonality and behavior of malaria vectors; and the risk of transmission in Ethiopia: The case of Arjo-Didessa Sugarcane Irrigation Scheme

	199	Janice S Maige	Assessing shifts in biting patterns of *Anopheles gambiae* and *Anopheles funestus,* the major malaria vectors in southeastern Tanzania
	216	Marilene M. Ambadiang	Unravelling the phenotypic and genomic divergence within sub-populations of the major malaria vector *Anopheles gambiae*
	264	Gabin Arnaud AT Tepa Njiguet	Molecular Drivers of Multiple and Elevated Resistance to Insecticides in a Population of the Malaria Vector *Anopheles gambiae* in Agriculture Hotspot of West Cameroon
	289	Paul C Mrosso	Optimising adult mosquitoes housing to increase mating success in colonised *Anopheles funestus*
	300	Mahamadi Kientega	Genetic structure of *An. gambiae* s.l (Diptera: Culicidae) populations in Burkina Faso, west Africa
	378	Gloria Salome Gabriel Shirima	Investigating the impact of larviciding as a supplementary malaria vector control tool in rural southeastern Tanzania: a simulation study.
	413	Najat F Kahamba	Associations between land cover characteristics and aquatic habitats of the malaria vector, *Anopheles funestus*, during the dry season
	467	Estelle L. Dembele	Characterization of natural infections with the bacterial strain Wolbachia w-Anga in mosquitoes of the Anopheles gambiae complex in Western Burkina Faso
	611	Djepand Ngognouak Thierry	Comparison of the impact of VectoMaxG, Spinosad and S-Methoprene larvicides on non-target fauna: larvicide effective against malaria and environmentally friendly
11:00 – 13:00	**Parallel Scientific Session 17: LLINS, IRS and insecticide resistance management** **Room**: Ballroom 2 **Session Chair**: Camille Dossou; **Co-chair**: Eliningaya J Kweka		
	Abstract ID	**Presenter**	**Abstract title**

	655	Ndey Bassin Jobe	Repelling mosquitoes with electric fields using standard house electrical wires
	535	Gonse Marius Zoh	Evaluation of Interceptor® G2 LN patch versus whole Interceptor® G2 LN against insecticide resistant Anopheles gambiae s.l. in experimental huts at MBe, Côte d'Ivoire.
	574	Cyrille Ndo	L119f-gste2 metabolic resistance allele affects vector competence of *Anopheles funestus*
	595	Eliningaya J Kweka	Bioefficacy of Vectron in Experimental huts against laboratory and wild populations of mosquitoes in Magugu, Northern-Tanzania
	598	Julien Z.B. Zahouli	Space spray efficacy of Fludora Co-Max EW against insecticide-resistant *Aedes aegypti*, *Culex quinquefasciatus* and *Anopheles gambiae* mosquitoes from Côte d'Ivoire
	485	Mouhamadou Bassir Faye	Patterns of Insecticide Resistance in *Anopheles funestus* populations in Central Senegal
	626	Nelly Manuela Ms Tchatchoua Tatchou	Functional validation of the role of CYP6P4a and CYP6P4b duplicated genes in pyrethroid insecticide resistance in *Anopheles funestus*; a major African malaria vector
	638	Tagne Djoko Simeon Carlos	A single mutation in the P450 gene CYP9K1 is driving pyrethroid resistance in the major African malaria vector *Anopheles funestus* leading to reduced efficacy of bed nets
	169	Kenio Mawa Benson	Efficiency of World Health Organization (WHO) Tunnel test under varied exposure time and duration: considerations for laboratory animal ethics
	649	Javan Chanda	Pyrethroid Resistance in Anopheles arabiensis Patton along Lake Kariba of Southern Zambia is Driven by Metabolic Mechanisms and its Implications on Malaria Elimination Programme
	Parallel Scientific Session 18: LLINS, IRS and insecticide resistance management (Student track – Student Competition) **Room**: Ballroom 3 **Session Chair**: Emmanuel Mbuba; **Co-chair**: Zawadi Mboma		

	Abstract ID	Presenter	Abstract title
	577	N'tamon N'tamon Romeo	Identification and characterization of Anopheles breeding habitats in Dabakala, central-east Côte d'Ivoire
	269	Ashu Fred Ayukarah	Vegetable oil surfactants are synergists that can bias neonicotinoid susceptibility testing in adult mosquitoes
	295	Polius G Pinda	Relationships between biological age, distance from aquatic habitats and pyrethroid resistance status of *Anopheles funestus* mosquitoes in south-eastern Tanzania
	353	Fedinand Ong'wen	Developing a cattle-based pyriproxyfen delivery tool for malaria mosquito control
	355	Riccado Feudjio Thiomela	First indoor residual spraying in Cameroon highlights a great potential of Fludora® fusion (mixture of deltamethrin and clothianidin) to better control the wild pyrethroid-resistant malaria vectors *Anopheles funestus* and *An. gambiae*
	363	Thomas W Syme	PermaNet® Dual, a new deltamethrin-chlorfenapyr mixture net, shows improved efficacy against pyrethroid-resistant *Anopheles gambiae* sensu lato: a laboratory and experimental hut evaluation
	385	Judith Sinkanako Banda	The effect of repeated washing of the royal guard, interceptor g1 and g2 nets on blood feeding behavior and survival of Anopheles' mosquitoes
	404	Esdras Mahoutin Odjo	What can be learned from the residual efficacy of three formulations of insecticide (pirimiphos-methyl, clothianidin and deltamethrin mixture, and clothianidin alone treated on walls at large scale in community trial in two departments of North Benin, West Africa?
	453	Emmanuel Mbuba	Field durability monitoring of pyrethroid plus piperonyl-butoxide insecticide-treated nets under operational settings in Bagamoyo Tanzania: Preliminary findings

	603	Hamisi J Kunambi	Sterilized Anopheles funestus can autodisseminate sufficient pyriproxyfen to breeding sites under semi-field settings
	Parallel Scientific Session 19: Vector bionomics: vector biology, ecology, taxonomy and population genetics & Vector surveillance, new and re-merging vectors, community-based surveillance, epidemiology, disease control programs and global health **Room**: Meeting room 2 **Session Chair**: Eric Ochomo; **Co-chair**: Jonathan Kazungu Karisa		
	Abstract ID	**Presenter**	**Abstract title**
	573	Athanase Badolo	Bionomics of Aedes aegypti populations from Burkina Faso: Implications for Aedes-borne disease control
	480	Augustino T Mmbaga	Current and future opportunities of autodissemination of pyriproxyfen approach for malaria vector control in urban and rural Africa
	564	Prisca S. L. Pare	The Paradox of Plant Preference: Why the malaria vectors Anopheles gambiae and Anopheles coluzzii select suboptimal food sources for survival and reproduction?
	521	Nathan R Rose	Scaling New Biological Vector Control Solutions: Developing A New Targeted, Self-Limiting Solution for Control of the Invasive Malaria Vector, Anopheles stephensi
	618	Judicael Ouedraogo	Evaluation of the specific characteristics of visual markers related to the attractiveness of Anopheles coluzzii swarms in Burkina Faso
	654	Jonathan Kazungu Karisa	A decision-tree approach to cost comparison of different workflows for measuring entomological indices in malaria surveillance

	114	Brice Natchema Soh Fonkou	Entomological surveys in two contrasted epidemiological settings in Cameroon reveal that the extremely high malaria transmission in the main African malaria vector Anopheles funestus is associated with GSTe2 metabolic resistance
	168	Mercy J Tuwei	Application of MALDI-TOF MS in parity status analysis of field collected malaria vectors
	175	Prisca Asiimwe Kweyamba	Sub-lethal exposure to chlorfenapyr kills Plasmodium parasites in surviving insecticide-resistant Anopheles mosquitoes
11:00 – 13:00	**Parallel Symposium 16 (ID 518): Controlling Emergent Anopheles stephensi in Ethiopia and Sudan (CEASE)** **Organizer**: Alison M. Reynolds, PhD **Room**: Ballroom 5		
13:00 – 14:00	**Lunch Break (Exhibition Hall open/ Poster session 4 (90 posters) Poster # 241 -330**		
14:00 – 15:30	**Closing Ceremony & PAMCA Awards** **Room:** Ballroom 1,2,3 - combined		
14:00 – 14:10	Introduction of PAMCA Awards	MC	
14:10 – 14:40	WiVC Excellence Awards	PAMCA WiVC	
14:40 - 15:10	Closing remarks	Chair, PAMCA-EC Chapter PAMCA Executive Director PAMCA President Formal announcement of the next conference host – PAMCA Côte d'Ivoire	
15:10 – 15:20	**Guest of Honor, Closing remark**	**H.E Dr. Dereje Duguma State Minister, Ministry of Health of Ethiopia**	

15:20 – 15:30	Vote of thanks	PAMCA Director of Scientific Programs – Dr. El Hadji Niang
15:30 – 16:00	**Coffee break (Exhibition Hall closes, take down of exhibition booths and poster panels)**	
16:00 – 17:00	**PAMCA Business Meeting**	
17:00	**PAMCA 2023 Conference Ends**	

Day Five: Friday September 22, 2023

Time	Activity
08.00 - 12.00	Visit to the new Africa CDC HQ in Addis Ababa, Ethiopia

LIST OF ABSTRACTS

SYMPOSIA ABSTRACTS

Parallel Symposia 1-5

ABS-54

IK Smart Light: A new tool to enable more efficient delivery of indoor residual spraying

Iñigo Garmendia (Goizper S.Coop)

Description and Justification

Indoor residual spraying (IRS) is an effective tool but training IRS teams and insuring efficient and effective spraying of communities is limited by technical and logistical challenges. IVCC and Goizper Group, working with IRS implementers, have developed a new tool, the IK Smart Light. The device provides immediate feedback to spray operators to help them deliver accurate target dosage of insecticide. It also assists supervisors and program managers to train spray operators more efficiently and each device collects data during use which allows to monitor spray applications in real time. The spray data can be uploaded to the cloud and visualized remotely to alert managers about potential problems immediately. Prototypes were piloted in Mozambique (2022-2023) and Ghana (2021-2022) getting very positive feedback from spray operators and supervisors' because they consider that the IK Smart Light can help them improve spraying performance and manage more efficient and effective programs in the future.

Keywords: IRS, Smart, Spraying quality, Efficient, training cost reduction, better supervisionbetter spraying

ABS-232

Why data-based mathematical models matter, and how can they be used to influence policies, save lives, and ensure a long-lasting optimal control of vector-borne diseases

Misonge K Ivan (Center for research in Infectious Diseases)*; Charles S. Wondji (Center for research in Infectious Diseases); Thomas S. Churcher (Imperial College London); Prashanth Selvaraj (Bill and Melinda Gates Foundation); Ramses Djidjou-Demasse (Institute de la recherché pour le Développement); Samson Kiware (PAMCA); Kuipou William (Center for research in Infectious Diseases)

Description and Justification

Vector-borne diseases in general, and malaria in particular, remain a constant threat to humans living in tropical regions of the planet. Despite the huge number of financial and technical efforts, the propagation of those diseases persists, thanks to the capacity of the main vectors to adapt, and evolve genetically and physiologically. From the experimental standpoint, it is not always easy to explain and hypothesize the direction of those changes, hence the necessity to use mathematical approaches that are based on the known biology and data obtained from past observations. Our contention is that applying mathematical techniques to vector biology and environmental challenges may either improve the existing control strategies or yield a set of new ones with higher-order efficiency proficiency. During this symposium, we shall discuss the mathematical principles at the heart of modeling infectious disease control. The topics to be discussed include gene drive techniques, the spread of resistance under selection pressure & antimalarials (drugs, vaccines), optimal control, within-host malaria evolution, behavioral resistance, and cost-effectiveness. The symposium shall be an opportunity for theoreticians and experimentalists to gain insights into biologically-related mathematical models. The fact that we will emphasize mathematical modeling and data-based mathematical evidences makes it an exciting and unique opportunity through which mathematicians, biology, computer scientists, and policymakers shall be able to navigate through the contents of the different activities at an easy pace.

Keywords: Malaria, Mathematical models, Vector control, vector resistane, transmission dynamics, cost effectiveness, control strategies

ABS-417

Larval Source Management, a Tale of Two Continents: Integrated Vector Management in North America and Africa

Organizer: Ary Faraji, PhD, Salt Lake City Mosquito Abatement District, Salt Lake City, Utah, USA

Description and Justification

As the momentum and effort to reduce malaria transmission in Africa has begun to move beyond the key component focus on long-lasting insecticide treated bed nets (LLINs) and indoor residual spraying (IRS), controlling *Anopheles* mosquitoes in the larval stage before they can become vectors can also be a key component of vector management. This symposium will highlight current approaches for integrated vector management (IVM) with an emphasis on larval source management (LSM) in the United States and also include African programs conducting IVM and LSM. Symposium speakers will exhibit how LSM is conducted in the USA, on a large scale, and also emphasize the good work that is being conducted in Africa utilizing LSM. This symposium will hopefully serve to increase collaborations and partnerships between the North American and African continents regarding mosquito control.

The lineup of speakers includes:

- Dr. Ary Faraji from Salt Lake City Mosquito Abatement District in Utah, USA.
  Topic: ***Integrated Mosquito Management for Mosquitoes in the High Elevation and Arid Environments of Salt Lake City, Utah, USA***
- Dr. Mark Breidenbaugh from Northwest Mosquito and Vector Control District in California, USA.
  Topic: ***Larval Source Management for Mosquitoes in Southern Californian, USA***
- Dr. Marc Clifton from North Shore Mosquito Abatement District in Illinois, USA.
  Topic: ***Integrated and Larval Source Management for Mosquitoes in the Upper Midwest of the United States***
- Mr. Mark Smith from Metropolitan Mosquito Control District in Minnesota (biggest users of Bti in the USA).
  Topic: ***Larvicides and Larval Control Measures for Mosquitoes in the Northern United States***
- Mr. Dennis Wallette from Tangipahoa Mosquito Abatement District in Louisiana, USA.
  Topic: ***Killing Skeeters the Louisiana Way, an Overview of Larval Control within a Program in the Southern United States***
- Dr. Mohamed Traore and Dr. Gunter Mueller from University of Bamako in Mali (will cover a new LSM and IVM project in Mali).
  Topic: ***A pilot study in integrated vector control management in Mali, West Africa, a collaboration between two mosquito control district of USA and Africa, a first of its kind.***
- Dr. Christian Atta-Obeng from National Malaria Elimination Program in Ghana will cover LSM and IVM from Ghana.
  Topic: ***Private Sector led Community Larval Source Management: Lessons for large scale LSM towards malaria elimination***
- Dr. Emmanuel Hakizimana from Rwanda Biomedical Centre Ministry of Health will cover LSM and malaria control in Rwanda (hopefully drones as well).
  Topic: ***Using Larval Source Management to complement Core Vector Control Interventions in Malaria Control, Experience of Rwanda.***

Keywords: Integrated Vector Management, Larval Source Management, Larvicide, Bti, Mosquito Control District

ABS-576

Scaling up Malaria Elimination: Public-Private Partnership and Evidence Based Programming To Boost and Accelerate Progress in North-Western Zambia.

Buumba P Bubala (Ministry of Health)*; Kylie Van der Merwe (First Quantum Minerals Limited); Mark Divall (First Quantum Minerals Limited); Guillaume Isonga (Ministry of Health); Godwill Mlambo (First Quantum Minerals); Temple Kahilu Mumba (First Quantum Minerals Limited); Herbert T Nyirenda (First Quantum Mineral Limited)

Description and Justification

The symposia will focus on scaling up surveillance and malaria elimination programmes using a multi-sectoral approach. Ministry of Health in partnership with First Quantum Minerals Limited have in the last decade developed and implemented malaria control programs, vector surveillance and research aimed at malaria elimination in vulnerable communities. The goal of the symposia is to strengthen scientific rigor in malaria elimination research and programming by harnessing private sector participation. The objective is to share evidence-based research, surveillance and malaria programs supported and implemented in partnership with the private sector. The symposia will have four(4) sessions with four(4) speakers. The symposium will commence with an introductory presentation on public-private partnership driven malaria programs followed by scientific sessions on evidence based research: Evaluation of the larva source management program; malaria prevalence and ancillary of care among school going children; and Bio-efficacy Re-evaluation of Actellic 300 CS for Indoor Residual Spray Against Anopheline Mosquitoes Under Field Conditions in North-Western Zambia. Public-private partnership is cardinal in supporting and strengthening malaria elimination, vector surveillance and research especially in malaria endemic regions. Public-private partnerships have contributed substantially to malaria control and elimination. This symposium will share practical experiences from a viable public-private partnership driven malaria control and elimination programme. The proposal is in tandem with PAMCA's sub thematic areas of interest and the overall theme of Reorienting vector surveillance and management in the context of emerging threats. This is a vital opportunity to showcase public-private partnership contribution and disseminate evidence based findings and strategies for regional integration.

Keywords: Public-Private Partnership, Multi-Sectoral Approach, IRS, Actellic 300, Larval Source Management, Zambia

ABS-345

Vector genomics surveillance program in Africa: opportunities, progress, and future outlook

Elijah Juma (Pan-African Mosquito Control Association)*; Alistair Miles (Welcome Sanger Institute, UK); Eric O Ochomo (Kenya Medical Research institute); Nsa Dada (Arizona State University); Luc Djogbenou (Université d'Abomey-Calavi (UAC - Entrée principale)); Vikki Simpson (Wellcome Sanger Institute, UK); Christopher Clarkson (Wellcome Sanger Institute, UK)

Description and Justification

The malaria control landscape is changing rapidly with the introduction of new dual active ingredient insecticides-based long-lasting insecticidal nets (dual AI LLINs), third generation indoor residual sprays (3GIRS among others. This creates new selection pressures to the mosquito vectors leading to development of new insecticide resistance variants within 12-18 months and reaching fixation within a short period of time (5-10 years). Over the past six years since 2018, PAMCA, in partnership with the MalariaGEN group at Wellcome Sanger Institute, UK, has supported multi-country studies on *Anopheles* genomic surveillance in nine African countries, stewarded by 11 Principal Investigators (PIs). The goal of the projects was to collect, collate, and curate essential genomic data on *Anopheles* genetic diversity, population structure and history, and the linkages with vector ecology and malaria epidemiology. Phase II of these studies currently involve filling gaps in the genomic surveillance program through creating a sustainable indigenous capacity for bioinformatics to facilitate acquisition, storage, and analysis and utilization of the sequencing data generated from the phase I projects and new genomics projects to be conceptualised in future genomic surveillance efforts in Africa. The symposium will provide a platform for PIs of the genomic surveillance projects to present the findings of their studies. Updates will also be given on the progress that the partnership has made in strengthening vector genomics capacity in Africa through targeted trainings in bioinformatics, and data analysis, to support vector genomics work in Africa. The symposium will explore the utility that genomic surveillance provides to NMCPs, the progress made in strengthening genomic surveillance in Africa, and the challenges in institutionalising strong genomic surveillance systems in the continent.

Keywords: Genomics surveillance, whole-genome sequencing, bioinformatics, insecticide resistance

Parallel Symposia 6-10

ABS-75

Field Trials of Malaria Vectors Engineered with Gene-Drive: If Not Now, When?

Ana Kormos (UCMI)*; Greg Lanzaro (UCMI); Joao Pinto (UCMI); Lodney Nazare (UCMI); Adionilde Aguiar (Ministry of Health STP)

Description and Justification

The 2022 WHO World Malaria Report highlights the ongoing and emerging threats in the fight against malaria as well as the need for new and improved tools including genetically engineered mosquitoes (GEM). While the transition of this technology from laboratory to field is progressing, a confined field trial has not yet been done and traditional malaria controls are threatened by vector and parasite resistance, human resistance, distribution challenges, limits in financial investment, and changing environments. As the conference considers the broad theme of reorienting vector management in the context of emerging threats, we propose it will be of interest and importance for the PAMCA

audience to consider how novel vector management tools are designed to address these threats and to identify roadblocks in advancing GEM strategies. This symposium expands on the general interest in GEM with a comprehensive discussion surrounding the critical importance of conducting a confined field trial for proof of concept and advancement of the technology for broad use and application. We will assess the factors impeding progress field trial baseline data considerations, trial design, and the ethical and social considerations that accompany that design. The symposium will consist of a 5-minute introduction, followed by 4 15-minute talks from the University of California Malaria Initiative (UCMI). The UCMI program has been working in partnership with the government of the Republic of Sao Tome and Principe since 2019. The first talks will focus on the importance of considering novel technology for malaria control in Africa and the need for a field trial to advance this technology and its potential in addressing emerging threats. The last two talks will focus on baseline data studies prior to a trial, the development of the trial design, as well as the social and ethical considerations to be integrated into this work followed by 30 minutes for general questions and discussion.

Keywords: malaria, gene drive, field trial, engagement, emerging threats, innovative technologies, trial design, vector surveillance,

ABS-408

Pan African Vivax and Ovale Network (Pavon): Scoping the burden and transmission of *P. vivax* and *P. ovale* in Africa

Isaac Quaye (Pan African Vivax and Ovale Network, Regent University College of Science and Technology)*; delenasaw yewhalaw (Tropical and Infectious Diseases Research Center, Jimma University); Ben Gyan (Noguchi Memorial Institute for Medical Research, University of Ghana); Nancy Quashie (Noguchi Memorial Institute for Medical Research, University of Ghana); Mimie Bitshi (Pan African Vivax and Ovale Network, Regent University College of Science and Technology); Djeunang Bruna (Pan African Vivax and Ovale Network (PAVON))

Description and Justification

The Pan African Vivax and Ovale Network (PAVON) is an African professional network focusing on *Plasmodium vivax* and *ovale* (*Pv* and *Po*) burden, prevalence and drivers of transmission patterns in sub-Saharan Africa. The network is made up of 7 English speaking and 7 French speaking countries across east, west central, and southern Africa. The network works in close collaboration with National Malaria Programs (NMPs) of countries within the Network, assisting in the elimination agenda with data collected in field surveys of neglected non-falciparum malaria particularly *Pv* and *Po.* PAVON is committed to building capacity in diagnostic skills (microscopy and molecular) and surveillance within the network, to assist the NMPs malaria elimination agenda in line with the current aim of the global health community. PAVON is also examining probable vectors of Pv and Po within the network countries that are assisting in transmission of the parasites. Human resource

capacity and competence in diagnostics and surveillance is needed, considering the hypnozoite forms of these parasites that sustain transmission but are out of reach for detection and treatment. We offer support to graduate students' studies with a specific objective to determine not only *P. vivax* and *P. ovale* prevalence and transmission but also vector bionomics, to understand the relapse phenomenon and transmission that can help NMPs on test and treat recommendation from WHO. It will also assist with profiling transmission intensities for targeted intervention with primaquine. The results generated should be of interest to PAMCA membership as PAVON seeks partnership with PAMCA member countries in its goals. Some questions of interests are: How do sub-Saharan Africans with Duffy antigen negativity sustain Pv transmission? Which vectors play leading roles in the transmission? By holding this symposium new ideas could be generated for collaborative activities.

Keywords: PAVON, *Plasmodium vivax, Plasmodium ovale*, transmission, vectors

ABS-397

From research to impact: steps in the development, registration and deployment of a new insecticide chemistry to help tackle the growing threat of insecticide resistance in malaria vectors in sub-Saharan Africa

Principal organizer: Mr MAEZAWA Takeo, Mitsui Chemicals Crop & Life Solutions, Inc. Takeo.Maezawa@mitsuichemicals.com
Co-organizers /Moderator: Dr Keziah Malm, Ghana NMCP, kezmalm@yahoo.com>

Description and Justification

Rotation of insecticides with different MoA for IRS is recommended for improving malaria vector control and managing insecticide resistance in sub-Saharan Africa. Till recently, there were only two MoA available for implementation of IRM, limiting options for countries on product choice, and making the emergence of resistance more likely. Therefore, new MoA products must be developed, registered, and deployed. In this symposium, we will demonstrate the steps involved in the characterisation of the meta-diamide insecticide TNBL in terms of its efficacy against key malaria vector species and its development as the IRS product, VT500. We will then illustrate the required steps for the WHO prequalification of VT500, including the conduct of a two-arm non-inferiority cluster randomized community trial in Benin, and for the registration of this product in Africa, including the conduct of experimental hut and small-scale community trials. Finally, we will discuss the deployment of VT500 by NMCP to control mosquito vectors of malaria and share details on a suitable methodology for monitoring the susceptibility of vector populations to TNBL. There is widespread resistance to older insecticide chemistries used in IRS products such as PY and there is also evidence of emerging resistance to OPs in some countries. Without robust IRM, using at least 3 MoA, resistance is likely to

develop and spread at an accelerated rate. The objective of this symposium, using the novel meta-diamide insecticide TNBL and the IRS product VT500 as an example, will be to guide the PAMCA membership through the key steps required to develop a new IRS product, to register it through WHO PQT/VCP and regulatory authorities in sub-Saharan Africa, and to make it available to NMCPs to control malaria vectors and to facilitate IRM through IRS product rotations. The symposium will also provide NMCPs with a forum to discuss how they can monitor the susceptibility of vector populations to TNBL.

Speakers:

1. Ms KAWASE Ayumi, Mitsui Chemicals Crop & Life Solutions, Inc., Ayumi.Kawase@mitsuichemicals.com
2. Dr. Corine Ngufor, London School of Hygiene and Tropical Medicine, corine.ngufor@lshtm.ac.uk
3. Dr. Mbanga Muleba, Tropical Diseases Research Centre, mbangamuleba@gmail.com
4. Dr. Delenasaw Yewhalaw (Jimma University) delenasawye@yahoo.com
5. Dr. Christen Fornadel, IVCC, Christen.Fornadel@ivcc.com
6. Ms. Otubea Owusu Akrofi, Ghana NMCP, otbansah@gmail.com

Keywords: Malaria, IRS, Vector control, Insecticide resistance, IRM, New mode of action, Meta-diamide, VECTRON T500

ABS-686

Technical updates about the preparedness, gaps, and response to *Anopheles stephensi* in Africa

Ayman Ahmed (University of Khartoum)*

Description and Justification

Anopheles stephensi is an invasive malaria vector that is originally endemic in south-east Asia and Arab Peninsula. However, since 2012 is rapidly emerging and spreading in Africa. *An. stephensi* is competent in transmitting different malaria parasites including *Plasmodium falciparum* and *P. vivax*. Unfortunately, due to major differences in the bionomics of this vector from the local endemic vectors of malaria in Africa such as the biology, breeding, feeding, and resting behaviors, vectors surveillance and control systems in Africa are struggling in detecting, reporting, and controlling this vector. Here, in this symposium we are offering up to date technical guidelines and recommendations to support national malaria control programs, particularly their integrated vectors management departments in building their capacity, guiding the decision making and development of their national policies, and informing their implementation. These technical updates will include the World Health Organization (WHO) current initiative and recommendation for the surveillance and control of *An. stephensi* in Africa.

Also, reflections from the ongoing Global Fund assessment of the capacity, surveillance, control, and available resources to respond to *An. stephensi* in the affected and at risk countries in Africa. Additionally, we will bring expertise from endemic countries with success in control of *An. stephensi* to exchange experiences and best practices with African vector control programs including the planning and implementation of cost-effective vector control surveillance approach and interventions toward *An. stepehnsi*. Furthermore, the opportunity to integrate the surveillance and control of *An. stephensi* with the surveillance and control of the co-breeding Aedes vectors of arboviruses will be discussed from the perspectives of feasibility and cost-effectiveness.

Keywords: Invasive vectors; *Anopheles stephensi*; Vector Surveillance and control; Prepareness and response in Africa

ABS-689

Advancing Evidence for the Global Implementation of Spatial Repellents (AEGIS)

John Grieco (University of Notre Dame); Emanuel M Muta (Pan-African Mosquito Control Association)*

Description and Justification

Goals of malaria elimination and eradication and the expanding scope of Aedes-borne viruses (ABVs) like dengue require the development of new, vector control tools to complement available interventions in order to meet public health demands. Spatial Repellents (SR) are one such tool. SRs are products designed to release volatile chemicals into the air and prevent human-vector contact within the treated space thus reducing pathogen transmission. A number of clinical trials have demonstrated positive impact against malaria using SRs, however data is still lacking to confidently support use for public health. The AEGIS program will evaluate a novel, scalable SR vector control product with the potential to contribute to dramatic gains in malaria and ABV control in a variety of relevant contexts. This will be achieved through three cluster-randomized-controlled trials in Kenya, Mali, and Sri Lanka, one operational research study in Uganda, and the integration of social science at several study sites. The evidence generated is meant to provide data on SR impact, feasibility, and safety to fill the current gaps required for an endorsement by the WHO for a global SR policy recommendation. Such a recommendation will support disease endemic countries in the adoption and implementation of SR products and strategies in national vector control programs.

Keywords: Spatial Repellents

Parallel Symposia 11-15

ABS-274

Outdoor mosquito management in Africa

Moderator: Beth Ranson, Global Content Marketing & Digital Development Manager, Valent BioSciences LLC.
Beth.ranson@valentbiosciences.com

Description and Justification

Mosquito control efforts in Africa have heavily relied on indoor-based interventions, such as bed nets and indoor residual spraying. While these interventions primarily target Anopheles mosquito species responsible for transmitting malaria and lymphatic filariasis, they solely address adult mosquito species that feed and rest indoors during nighttime. To address the plasticity of mosquito vectors and their ability to bite both indoors and outdoors at various times, it is imperative to complement existing interventions with outdoor control tools. Unlike Africa, most regions worldwide have successfully employed outdoor mosquito control interventions and operational programs, leading to the elimination of malaria and the control of nuisance biting in the U.S. and Europe. This symposium aims to provide an in-depth exploration of current outdoor mosquito control programs globally, their remarkable impact, and the potential tools that can be adapted to effectively manage mosquito-borne diseases in Africa. With a diverse range of speakers, we will select presentations based on their relevance and time allotted. The symposium will cover a wide array of topics.

Speakers:

- Silas Majambere, Ph.D.; Valent BioSciences
  Topic: ***Bridging Larval Source Management (LSM) with an African perspective: Leveraging local insights for effective implementation***.
- Sophie Diarra, Ph.D.; Swiss Tropical and Public Health Institute
  Topic: ***Unveiling the Economics of LSM/Outdoor Mosquito Control: Analyzing the cost-effectiveness and long-term benefits.***
- Sarah Moore, PD, Ph.D.; Ifakara Health Institute
  Topic: ***Overcoming Challenges in Urban Mosquito Control Programs current trends in controlling container mosquitoes in large urban cities***.
- Sarah Wheeler (recorded), Steven Ramos, Tony Hedley and Gary Goodman; Sacramento-Yolo Mosquito & Vector Control
  Topic: ***Lessons from Rice Field Rural Programs in the U.S.: Adaptation and application in African settings.***

- Mamy Ingabire, Charis Unmanned Aerial Solutions
  Topic: ***Unmanned Aerial Systems (UAS) in Mosquito Control: Harnessing technology for enhanced surveillance and interventions. Challenges and current trends for using drones in mosquito control.***
- Mark Clifton, Ph.D.; North Shore Mosquito Abatement District
  Topic: ***Historical Use of Larviciding and Adulticiding in Mosquito Control Programs. Evolution of larviciding and adulticiding with special reference to current practices***.

ABS-569

Alternative high-potential vector control strategies to mitigate insecticide resistance and reduce the malaria burden

Chouaibou S Mouhamadou (Centre Suisse de Recherches Scientifiques)*; Karine Mouline (Institut de Recherche pour le Développement); Frederic Simard (Institut de Recherche pour le Developpement); Cyrille Ndo (Centre for Research in Infectious Diseases)

Description and Justification

Insecticide resistance in malaria vectors impair the effectiveness of insecticide-treated nets and contributes to increased malaria incidence. Complementary innovative vector control strategies are needed to progress toward disease elimination. This session presents 4 high-potential vector control strategies that could help overcoming the insecticide resistance problem. The first presentation describes the concept, development, and recent field data of a mosquito-net trapping device that can be clipped on any type of mosquito-net. Trapping nets (T-Nets) capture mosquitoes regardless of their resistance status. The mass mosquito trapping should lead to a decline in the vector's populations and malaria incidence. Ivermectin mass administration as a systemic insecticide could help controlling insecticide resistance. However, efficacy is hampered by the product short remanence. In the second presentation, we review current work on Long-Acting Ivermectin Formulations (LAIFs) targeting 2-to-6-months sustained efficacy. We further discuss how to embed malaria control using LAIFs in a One-Health approach. Housing improvement strategy can reduce vector density indoors. This strategy is described as an important but under-promoted intervention due to the lack of local evidence in malaria control and implementation cost. The third presentation provides more evidence that this is a low cost and sustainable intervention that can help controlling malaria transmission, particularly where insecticide resistance threatens ITNs effectiveness. Sterile Insect Technique (SIT) involves rearing radio-sterilized male mosquitoes and then releasing them to mate with wild females. As these females do not produce any offspring, the vector population declines over time. The SIT has been successfully implemented to suppress major insect pests. The fourth presentation will describe current SIT developments and its potential to control *Plasmodium* vectors regardless of their resistance status.

Keywords: Malaria vector control, Insecticide resistance management, Alternative high-potential vector control strategies.

ABS-441

Considerations for transboundary movement of gene drive mosquitoes

Wolfgang Richard Mukabana (African Institute for Development Policy - AFIDEP)*; Rose Oronje (African Institute for Development Policy - AFIDEP); Patricia Stella Nekesa Wamukota (African Institute for Development Policy); Sandra Okech (African Institute for Development Policy - AFIDEP)

Description and Justification

Gene-drive mosquitoes (GDMs) are one of the major ideas being championed by various actors for malaria control and elimination in Africa. The GDMs are intended to achieve area-wide control by rapidly introducing infertility or modification genes throughout a naturally interbreeding population of malaria mosquitoes. To date, no field trials of GDMs have been performed. One of the critical factors to consider for future implementation is the potential for transboundary movement of GDM mosquitoes, given their ability to independently move across political borders. Acknowledging the fact that countries with laws that regulate GMOs require that any genetically modified product must undergo necessary approvals to be legally present in the country, it is likely that transboundary movements of released mosquitoes will render them illegal in the receiving country. This might consequently lead to political fallouts. We propose to host a symposium at the 2023 PAMCA meeting to deliberate on mechanisms that may facilitate decision making at regional level and guidelines that may address potential transboundary issues that arise from the release of GDMs for malaria control in Africa. The role of non-state actors, including product developers, in helping to resolve potential transboundary issues applicable to GDMs will also be addressed.

Keywords: gene drive mosquitoes, transboundary movement,

ABS-488

Improving and validating methods to strengthen the evidence base for innovative vector control tools

Rosemary S Lees (Liverpool School of Tropical Medicine)*; Angus Spiers (Innovation to Impact); Katherine Gleave (LSTM); Agnes Matope (Liverpool School of Tropical Medicine); Sarah J Moore (Ifakara Health Institute)

Description and Justification

New technologies and chemistries are strengthening the toolbox available for the control of vector-borne diseases. The decision to deploy new vector control tools should be supported by robust entomological evidence, comprising data collected using appropriate and validated methods. With the widespread expansion of pyrethroid resistance, it is imperative we make the best use of new chemistries that will target resistant mosquito populations and give implementers options to proactively manage resistance. Standard protocols are available for evaluating the bioefficacy of vector control tools, such as insecticide-treated nets (ITNs), however these were primarily developed to measure the fact acting lethality of pyrethroids and are not adequate for capturing the full range of insecticidal modes of action (MoA) now available. To facilitate effective choice, use and monitoring of new tools, it is crucial that appropriate methods are validated and widely available to measure the end points relevant to their active ingredient/s with sufficient accuracy, sensitivity and reproducibility. This symposium will open with a discussion of issues and opportunities surrounding efforts to improve entomological testing efficacy of insecticide-based products, with a particular focus on next-generation ITNs. We will then discuss a proposed method validation framework, and present case studies to demonstrate effective examples of method validation. We have developed for manufacturers and the research and implementation community a standardised framework for validating methods, made freely available for wide adoption, along with proof of principle case studies to demonstrate the applicability of the framework for entomological and analytical methods in a lab and semi-field setting.

Keywords: Methods validation, product evaluation, resistance monitoring, innovation, prequalification

ABS-643

Advancing the malaria and gender intersection towards malaria elimination: Pathways and futures

Principal organizer: The Global Malaria and Gender Community of Practice (CoP)
Co-organizer: Centre for Gender Studies and Advocacy. University of Ghana, Legon.
Moderator: Professor Irene Kretchy, School of Pharmacy, University of Ghana, Legon. Ikretchy@ug.edu.gh.
Description and Justification

Achieving malaria elimination by the 2030s may not happen without comprehensively integrating gender in malaria programs, policies, and strategies. Whereas malaria's impact on pregnant and post-natal women has received significant attention, the malaria and gender intersection among other female patients, caregivers, healthcare providers and household heads has not received adequate attention. Gender-transformative approaches to malaria elimination have huge potential for ending malaria as well as creating progressive gender

norms in malaria-endemic counties, hence yield the acclaimed Double Dividend. In this roundtable, we would explore the multisectoral pathways and futures for advancing the Double Dividend agenda for malaria and gender intersection in policies, programs, and strategies. This symposium introduces social science perspectives into the malaria elimination conversation at the PAMCA conference, by highlighting the malaria and gender intersection.

Speakers:

- Dr. Deborah Atobrah, Director, Centre for Gender Studies and Advocacy. University of Ghana, Legon. datobrah@ug.edu.gh.
  Topic: ***Multidisciplinary and Multi-Sectorial Approaches towards Creating Viable Pathways for Malaria Elimination***.
- Collete Morlino, Policy Officer, Malaria No More, UK. colette.morlino@malarianomore.org.uk
  Topic: ***Embedding gendered approaches & advocacy into research and programmes and translating that work to further advocacy & policy change***.
- Alexandra Wharton-Smith, PMI Institutional Support Consultant, USAID. alexa.international@gmail.com
  Topic: ***Integrating Gender into National Malaria Strategic Plans in African Countries: The Role of Policymakers and Implementers in Malaria Elimination?***
- Dr. Jonathan Kayondo, Principal Investigator, Target Malaria in Uganda/Senior Research Officer, Department of Entomology, Uganda Virus Research. Institute.jkayondo@gmail.com
- Topic: ***The generation and use of sex-disaggregated data in malaria elimination: The way forward***.

Keywords: Malaria and Gender Intersection, Malaria Elimination, Pathways and Futures

Parallel Symposium 16

ABS-518

Controlling Emergent *Anopheles stephensi* in Ethiopia and Sudan (CEASE)

Alison M Reynolds (LSTM); Alison M Reynolds (Liverpool School of Tropical Medicine)*; Anne L Wilson (LSTM); Yehenew Ebstie (AHRI); Eba Alemayehu Simma (Jimma University); Hmooda Toto Kafy (Advisor FMOH Sudan); Tristan Dennis (Liverpool School of Tropical Medicine); Rayyan Ibrahim (University of Khartoum); Fatou Jaiteh (Institute of Tropical Medicine)

Description and Justification

The spread of *Anopheles stephensi* is a threat to malaria control and elimination across Africa. Programmes need to reorientate to address this, and focus on increasing our understanding of the vector, its role in transmission and what multisectoral and locally targeted vector control approaches will have most impact. The CEASE Consortium takes an interdisciplinary, multi-sectoral approach to address key research questions on this invasive vector across Ethiopia and Sudan. This symposium brings together latest Consortium findings. Presentations will firstly summarise findings of country-specific longitudinal vector surveillance over 12 months, including immature and adult vector abundance, sporozoite positivity and blood meal composition. The third presentation will summarise population genetics study results in Sudan, whole genome sequencing-based analyses to investigate origins and routes of vector spread, and to identify dispersal barriers and genomic adaptation. Fourthly we will describe facility-based case control studies being implemented to understand the contribution of *An. stephensi* and other risk factors to malaria transmission in urban settings. Lastly, we will summarise socio-ecological factors which influence malaria risk in diverse settings, how this information can be utilised to develop effective and acceptable multi-sectoral, locally targeted vector control strategies to combat further *An. stephensi* spread. *An. stephensi*, recently detected in the Horn of Africa, has been associated with increased malaria risk, particularly in urban settings. It is critical to define current and potential future distribution of the vector, invasion routes, contribution to transmission, and the most effective control strategies to combat further spread. Our symposium fits well with this year's conference theme and we have an equitable panel of leading African scientists working in vector control.

Keywords: *An Stephensi*, malaria, invasion, spatial distribution, case control, socio-economics, multisectoral, genomics

SCIENTIFIC SESSIONS ABSTRACTS

Day 1

Parallel Scientific Session 1: LLINS, IRS and insecticide resistance management

ABS-38

Contrasting resistance patterns to type I and II pyrethroids in two major arbovirus vectors *Aedes aegypti* and *Aedes albopictus* in the Republic of the Congo, Central Africa

Theodel A Wilson-Bahun (University of Marien Ngouabi) *; Basile Kamgang (Centre for Research in Infectious Diseases); Aurélie Yougang (Center for Research in Infectious Diseases); Arsene Lenga (University of Marien Ngouabi); Charles Wondji (Center for Research in Infectious Diseases)

In the Republic of Congo, with two massive outbreaks of chikungunya observed this decade, little is known about the insecticide resistance profile of the two major arbovirus vectors *Aedes aegypti* and *Aedes albopictus*. Here, we established the resistance profile of both species to insecticides and explored the resistance mechanisms to help Congo to better prepare for future outbreaks. Larval stages of *Ae. aegypti* and *Ae. albopictus* were sampled in May 2017 in eight cities of the Republic of the Congo and reared to adult stage. Larval and adult bioassays, and synergist (piperonyl butoxide [PBO]) assays were performed based on WHO guidelines. F1534C mutation was genotyped in both species and the polymorphism of the sodium channel gene assessed in *Ae. aegypti*. Larval bioassays showed full susceptibility to temephos. while adult bioassays showed high resistance level was observed to DDT in both species countrywide (21.9–88.3% mortality). All but one population (*Ae. aegypti* from Ngo) exhibited resistance to permethrin but showed a full susceptibility to deltamethrin in almost all locations. Resistance was also reported to propoxur in *Ae. aegypti* likewise in two *Ae. albopictus* populations (Owando and Ouesso), and the remaining were fully susceptible. Both species also showed a full susceptibility to fenitrothion. A full recovery of susceptibility was observed in *Ae. aegypti* and *Ae. albopictus* when pre-exposed to PBO and then to propoxur and permethrin respectively. The F1534C kdr mutation was not detected in either species. The high genetic variability of the portion of sodium channel spanning the F1534C in *Ae. aegypti* further supported that knockdown resistance probably play no role in the permethrin resistance. Our study showed, for both Aedes species, a full susceptibility to organophosphates, and a various resistance profile to other insecticide class tested. Furthermore, we highlighted the implication of metabolic resistance.

Keywords: *Aedes aegypti*, *Aedes albopictus*, Insecticide resistance, Resistance mechanism, Republic of the Congo

ABS-82

Assessing the behaviour of mosquitoes during exposure to different long-lasting Insecticidal Nets (LLINS) using the Video Cone Test (Vct).

Aaron Lartey (University of Ghana)*; Jewelna Akorli (Noguchi Memorial Institute for Medical Research); Godwin Amlalo (Noguchi Memorial Institute for Medical Research); Samuel Akporj (Noguchi Memorial Institute for Medical Research); Rebecca Pwalia (Noguchi Memorial Institute for Medical Research); Ibrahim K Gyimah (Noguchi Memorial Institute for Medical Research); Samuel Opoku Darkwah (Noguchi Memorial Institute for Medical Research); Joannitta Joannides (Noguchi Memorial Institute for Medical Research); Akua Danquah (Noguchi Memorial Institute for Medical Research); Eleanore Sternberg (Tropical Health); Abigail Bawua (University of Ghana); Samuel Dadzie (Noguchi Memorial Institute for Medical Research).

Mosquitoes are increasingly building resistance to insecticides present in Long-Lasting Insecticidal Nets (LLINs), necessitating the development of robust vector control tools and bioefficacy testing protocols. The Video Cone Test (VCT) is an extension of the WHO cone bioassay that incorporates a behavioural record of mosquito interactions with LLINs. The objective of this study is to evaluate the behavioural characteristics of mosquitoes when exposed to different types of LLINs. This experimental study involved exposing 2-5-day-old mosquitoes to various types of LLINs (PermaNet® 2.0, PermaNet® 3.0, and Olyset®) for varying lengths of time (1, 2, 3, 4, 5, and 6 minutes) using the WHO cone bioassay. Mosquito behaviour was recorded using a smartphone while the mosquitoes were exposed to the LLINs. The behaviour was depicted as the mosquito's activity or movement in different regions of the cone (Region-0, Region-1, Region-2, and Region-3). After exposure, the mosquitoes were given access to a 10% sugar solution, and mortality was recorded 24 hours later. The number of activities observed in each cone region differed significantly between the two mosquito strains ($p<0.05$), with Region-1 recording the highest activity in both strains. Olyset® did not exhibit significant differences between the two strains in any of the regions ($p>0.05$), whereas PermaNet® 2.0 and PermaNet® 3.0 showed variations between the strains in Regions 1, 2, and 3 ($p<0.05$). All regions of the cone were strongly associated with mortality ($p=0.000$), with Regions 2 and 3 exhibiting the strongest associations (coefficients = 1.661457 and 1.35458, respectively). The results from this study suggest that different LLINs exhibit distinct effects on mosquito behaviour, and the WHO cone bioassay, with the addition of a camera component, can provide valuable information on mosquito behaviour.

Keywords: Malaria, Bioassay, ITN, Insecticide resistance, Mosquito, Anopheles, Pyrethroid, Behaviour, Vector, Bednet, LLIN

ABS-49

A chlorfenapyr-based net interceptor® G2 shows high efficacy against a pyrethroid resistant *Anopheles funestus* from central Cameroon.

Magellan Tchouakui (Centre for Research in Infectious Diseases)*; Riccado Feudjio (Centre for Research in Infectious Diseases); Elysee Nchoutpouen (Centre for Research in Infectious Diseases); Benjamin Djantio Menze (CRID); Raymond Tabue (Ministry of Public Health, National Malaria Control Program); Cyrille Ndo (Department of Biological Sciences, Faculty of Medicine and Pharmaceutical Sciences, University of Douala); Joel Ateba (Ministry of Public Health, National Malaria Control Program); Charles Wondji (Department of Vector Biology, Liverpool School of Tropical Medicine)

The increasing reports of resistance to pyrethroid insecticides associated with reduced efficacy of pyrethroid-only interventions highlight the urgency of introducing new non-pyrethroid-only control tools. Here, we investigated the performance of PBO-pyrethroid (PermaNet 3.0 (P3.0)) and dual active ingredients (AI) nets (Interceptor G2 (IG2)) and Royal Guard (RG)) against pyrethroid-resistant malaria vectors

in Cameroon. The efficacy of these tools was first evaluated on *Anopheles gambiae* and *Anopheles funestus* s.s using cone/tunnel assays in five sites across the country. In addition, experimental hut trials (EHT) were performed to evaluate the performance of these nets in semi-field conditions where *An. funestus* predominate using unwashed and 20 times washed nets. Furthermore, pyrethroid-resistant markers were genotyped in dead vs alive, blood-fed vs unfed mosquitoes after exposure to these nets to evaluate the impact of known pyrethroid resistance markers on performance of the new nets. IG2 was the most effective net against wild pyrethroid -resistant *An. funestus* followed by PermaNet 3.0. In EHT, this net induced up to 87.8% (95% CI 83– 92%) mortality and 55.6% (95% CI 48– 63%) after 20 washes whilst unwashed pyrethroid-only net (Royal sentry) killed just 18% (95% CI 13–23%) of host-seeking *An. funestus*. The unwashed P3.0 killed up to 54% (95% CI 44–63%) of field-resistant mosquitoes and 47% (95% CI 38– 57%) when washed 20 times. IG2 and P3.0 also provided better personal protection (blood feeding inhibition 66.2% and 92.8%) compared to pyrethroid-only net RS (8.4%) and RG (77.84%). Interestingly, a negative association was found between kdrW and the chlorfenapyr-based net IG2 ($\chi 2 = 138$; $P < 0.0001$) with RR mosquitoes predominantly found in the dead suggesting that the efficacy of chlorfenapyr-based nets could be enhanced by some mechanisms of resistance against pyrethroids explaining the greater efficacy of IG2 nets.

Keywords: malaria, Anopheles, insecticide resistance, dual active ingredient LLINS, Interceptor G2

ABS-109

Impact of agrochemical pollutant mixtures on the selection of insecticide resistance in the malaria vector *Anopheles gambiae*. Insights from experimental evolution and transcriptomics

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Univ. Grenoble-Alpes); Stephane Reynaud (Laboratoire d'Ecologie Alpine (LECA) UMR 5553, Univ. Grenoble-Alpes) ; Chouaibou S Mouhamadou (Centre Suisse de Recherches Scientifiques).

There are several indications that pesticides used in agriculture contribute to the emergence and spread of resistance of mosquitoes to vector control insecticides. However, the impact of such indirect selection pressure has rarely been quantified and the molecular mechanisms involved are still poorly characterized. In this context, experimental selection with different agrochemical mixtures was conducted in *An. gambiae* and the impact on insecticide resistance was evaluated by phenotypic and molecular approaches. Mosquito larvae were selected for 30 generations with three different mixtures of agrochemicals containing insecticides, non-insecticides compounds and both agrochemical types. Each five generations, the resistance of adults to deltamethrin and bendiocarb was monitored using bioassays. The frequencies of the kdr (L1014F) and Ace1 (G119S) target-site mutations were evaluated every 10 generations. Gene expression and polymorphism variations associated with each selection regime were investigated after 30 generations by RNA-seq. Larval selection with agrochemical mixtures did not affect bendiocarb resistance and did not select for Ace1 mutation. Contrastingly, an increased deltamethrin resistance was observed in the three selected lines as compared to the control line. Such increased resistance was associated with an increased frequency of the Kdr mutation in the insecticide, non-insecticide and mix lines. RNA-seq identified 63 candidate resistance genes over-transcribed in at least one selected line as compared to the non-selected line. These include genes coding for detoxification enzymes or cuticular proteins previously associated with insecticide resistance, and other genes potentially associated with chemical stress response. Polymorphism analyses identified several genes under selection in each line across multiple genomic loci supporting a multigenic adaptive response to agrochemical mixtures.

Keywords: *Anopheles gambiae*, Agrochemical pesticides, Resistance selection, Metabolic resistance, Transcriptomics

ABS-160

Agricultural pesticides use in rural settings, Mwanza Tanzania: An implication for insecticide resistance among malaria vectors.

Basiliana Emidi (National Institute for Medical Research, Tanzania)*; Ziada Kiwanuka (National Institute for Medical Research, Tanzania); Selina Antony (National Institute for Medical Research, Tanzania); Geraldine Foster (Liverpool School Of Tropical Medicine, Pembroke Place, Liverpool, L3 5QA, UK); Philip McCall (Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, L3 5QA, UK); Priscille Barreaux (Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, L3 5QA, UK); Hilary Ranson (Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, L3 5QA, UK); Alphaxard Manjurano (National Institute for Medical Research, Tanzania).

Malaria is a major public health problem in Tanzania whereby about 93% of the population is living at endemic risk. The use of indoor vector control interventions has contributed to the reduction of malaria in sub-Saharan Africa. These interventions are challenged by the rapid increase in insecticide resistance among malaria vectors. The higher resistance among mosquito vectors is linked to the use of agricultural pesticides. There is limited information on agricultural pesticide use in many parts of Tanzania. Therefore, the present study was conducted to assess the agricultural pesticides use in three rural districts in Mwanza region. Data were collected through conducting interviews with small-scale subsistence farmers whereby a total of 160 farmers were interviewed. During the interview, farming practices, various agricultural pesticide usage practices, and knowledge of pesticide use among farmers were assessed. The present study has revealed that the use of agricultural pesticides is common among small-scale subsistence farmers. The study has shown variations in the frequency of herbicides, insecticides, and fungicides use. Most of the respondents reported using insecticides (n=92, 96.7%). Mixing multiple insecticides in one spray tank was also reported by 34.8% of the respondents. The study also found that many farmers stored remaining mixed, diluted, or undiluted pesticides for use during the next farming season. Lack of training on the proper use of pesticides among farmers was pointed out by most respondents (n=92, 98.9%). The study provides important information on the use of agricultural pesticides in rural settings. It has also highlighted the need for further research on the impact of agricultural pesticides on insecticide resistance among malaria vectors. These findings have important implications for the development of policies for promoting safe use of agricultural pesticides.

Keywords: Insecticide resistance, malaria vectors, agricultural pesticides, Mwanza, Tanzania

ABS-177

Assessing the variability in experimental hut trials evaluating insecticide-treated nets against malaria vectors

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Experimental hut trials (EHTs) can be used to evaluate indoor vector control interventions, such as insecticide-treated nets, against malaria vectors in a controlled setting. It is important that these studies are powered to answer the research question being posed. We have utilized data collected for a recent systematic review of EHTs, to help us understand the typical level of variability found in this assay. Using simulation-based methods, we explore the implications that this variability has for study power. The EHT data that we analyzed displayed a wide variation in both the number of mosquitoes entering the huts (ranging from 1.6 to 32.5 mosquitoes per hut per night) and the overdispersion (i.e., variation not otherwise explained) in mosquito mortality. We demonstrate the consequences of these findings using both superiority and non-inferiority trials. Our framework permits the measurement error of the assay to be reliably assessed. EHTs play an important role in the evaluation of indoor vector control interventions. Therefore, it is important to ensure that these studies are well powered. In this work we provide guidance that could help researchers to plan future studies.

Keywords: Vector control, malaria vectors, insecticides, trial power

ABS-209

Methods used to evaluate Insecticide Treated Nets (ITNs) for prequalification don't support improvements in ITN quality.

Ole Skovmand (MCC47) *; Rune Bosselman (Vegro); DM Tran (Biolytrics Laboratories); Sarah J Moore (Ifakara Health Institute)

WHO test methods for insecticide-treated nets (ITNs) simulate ITN performance under user conditions by washing the ITNs 20 times at an interval based on the time it takes an ITN to become fully insecticidal again after washing. These methods don't reflect reality for ITNs designed to kill pyrethroid resistant mosquitoes. Methods: literature review and series of experiments on ITN washing combining biological and chemical data and Electron Microscope imaging to outline modifications to ITN testing methods that will advantage better performing ITNs. Results: Threshold for Deltamethrin surface concentration is 1mg/m^2 to kill > 80% of susceptible mosquitoes. The few prequalified Deltamethrin ITNs that met this surface concentration had a release rate of 3- 5% (equal to 95-97% Wash Resistance Index) to retain 1mg/m^2 after 20 washes. Many ITNs designed for resistant mosquito control were prequalified using arbitrary regeneration times based on susceptible Anopheles strain as 100% mortality is achieved long before the insecticide is chemically regenerated after wash. Therefore, nets are washed at too short intervals resulting in too little wash-off compared washing in the field. Furthermore, many ITNs pass the 20-wash criterion on knockdown, that requires 8 times lower insecticide than that for the mortality criterion. Chemical analysis of ITNs with two active ingredients showed the surface concentrations of the non-pyrethroid reduced much faster than pyrethroid. Field evaluations of nets with chemical analysis revealed that wash-off in field use is 5-10 times higher than wash-off in the laboratory. In real use, no ITN resists 20 washes. ITN test methods need to reflect chemical laws and the real use of ITNs. Using mortality

endpoints requires a greater insecticide concentration on the net surface over the 20 washes. This requires an optimized release rate, which can only be determined by measuring surface concentration chemically.

Keywords: LLIN, Efficacy, Test methods, WHO, ITN, Quality Control, improved efficiency

ABS-238

Biochemical resistance mechanisms in *Anopheles coluzzii* from the communes of Porto-Novo and Cotonou, Benin.

Germain Gil Padonou (Centre de Recherche Entomologique de Cotonou)*; Tatchémè Filémon Tokponnon (Centre de Recherche Entomologique de Cotonou); Rock Aikpon (Ministry of Health Benin/ National Malaria Control Program); Keller Alphonse Konkon (Centre de recherche entomologique de Cotonou/Ministère de la santé du Bénin); Mahouton David Zoungbedji (Centre de Recherche Entomologique de Cotonou); Albert Sourou Salako (Centre de Recherche Entomologique de Cotonou); Isidore Hoyochi (Centre de Recherche Entomologique de Cotonou); Razaki A. Osse (Centre de Recherche Entomologique de Cotonou/Université Nationale d'Agriculture); Lamine Baba-Moussa (Laboratoire de Biologie et de Typage Moléculaire en Microbiologie, Faculté des Sciences et Techniques, Université d'Abomey-Calavi); Martin AKOGBETO (Centre de Recherche Entomologique de Cotonou).

Malaria is mainly transmitted in Benin by *Anopheles coluzzii* and *Anopheles gambiae* s.s., two sibling species of the *Anopheles gambiae* complex. In a context of high insecticide pressure exerted on these vectors, particularly in urban areas where anthropization is increasing, mechanisms of resistance, in particular biochemical resistance, have been developed. To investigate the biochemical resistance mechanisms of *Anopheles coluzzii* to pyrethroids and to provide appropriate guidance to the public health decision-makers, we collected *An. gambiae* s.l. larvaes in the district of Porto-Novo and Cotonou located in southern Benin. Thus, WHO susceptibility tube testing was performed by exposing females Anopheles gambiae s.l. field collected as larvae to deltamethrin 0.05%, permethrin 0.75%, and bendiocarb 0.1%. Molecular species identification was performed through Sine PCR and the detoxification enzymes (oxidase, Glutathion-S-Transferase, and esterase) sought in *An. coluzzii*. In the two study communes, resistance to deltamethrin and permethrin, and possible resistance to bendiocarb were observed. PCR results revealed that *An. coluzzii* was in the majority in both Cotonou (75%) and Porto-Novo (62,5%). The biochemical analyzes showed a significantly higher activity of oxidases in *An. coluzzii* in Cotonou ($p<0.0001$) compared to the susceptible reference strain *An. coluzzii* N'gousso, so was the trend for GST activity in both Cotonou ($p<0.0001$) and Porto-Novo ($p=0.0015$) for the same species. Similarly, an over-expression of the esterases activity was also observed in Porto-Novo relative to the susceptible reference strain *An. coluzzii* N'gousso. Overall, our results suggest that pyrethroid-PBO nets could provide greater control of *An. coluzzii* populations in Cotonou and Porto-Novo.

Keywords: *Anopheles coluzzii*, metabolic resistance, detoxification enzymes, Porto-Novo, Cotonou.

ABS-92

Efficacy of Pyrethroid-Pyriproxyfen and Pyrethroid-Chlorfenapyr long-lasting impregnated Nets (Llins) for the control of non-Anopheles mosquitoes: secondary analysis from a cluster randomised controlled trial (CRT)

Constantin Jésukèdè Adoha (Centre de Recherche Entomologique de Cotonou)*; Arthur Sovi (London School of Hygiene and Tropical Medicine); Boulais Yovogan (Centre de Recherche Entomologique de Cotonou); Bruno Akinro (Centre de Recherche Entomologique de Cotonou); Manfred Accrombessi (London School of Hygiene and Tropical Medicine); Edouard Dangbenon (Centre de Recherche Entomologique de Cotonou); Esdras Mahoutin Odjo (Centre de Recherche Entomologique de Cotonou (CREC)); Hermann W. Sagbohan (Centre de Recherche Entomologique de Cotonou); Casimir D. Kpanou (Centre de Recherche Entomologique de Cotonou); Germain Gil PADONOU (Centre de Recherche Entomologique de Cotonou); Louisa A. Messenger (University of Nevada); Clément Agbangla (Faculté des Sciences et Techniques de l'Université d'Abomey-Calavi); Corine Ngufor (London School of Hygiene and Tropical Medicine); Jackie Cook (London School of Hygiene and Tropical Medicine); Natacha Protopopoff (London School of Hygiene and Tropical Medicine); Martin C. Akogbeto (Centre de Recherche Entomologique de Cotonou)

Failure to control nuisance of mosquitoes may potentially affect adherence to vector control tools. The present study compared the vector density of Culex spp and Mansonia spp in clusters receiving dual active ingredient (a.i.) LLINs and the standard pyrethroid-only LLIN arms. Seasonal abundance of these mosquito species was also assessed. 85,723 Culex spp and 144,025 Mansonia spp were caught over the study period using human landing catches indoor and outdoor. The density of Culex and Mansonia was reduced in all three arms over the study period. There was no evidence of a significant reduction of the indoor or outdoor density of Culex spp in either dual a.i. long lasting net arms as compared to the standard pyrethroid only net arm [(indoor DR=0.9 (95% CI: 0.4-2.4), p=0.8817 for the alphacypermethrin-pyriproxyfen LLIN, indoor DR=0.6 (95% CI: 0.2-1.5) p=0.2793 for the alphacypermethrin-chlorfenapyr LLIN]. No evidence for a difference in density between arms was observed for Mansonia spp. A high density of Culex spp was found both in rainy and dry seasons, while for Mansonia spp this was mainly observed during the rainy season. These results suggest that the novel insecticides on the dual a.i. LLIN did not have additional impact on these species. Either because pyrethroids might still be effective against those species or on the contrary the second a.i. does not provide an additional effect due to 1/insecticide resistance or 2/ a concentration not optimal for these species. Further work is required to determine the reason of this lack of impact.

Keywords: Interceptor G2® LLIN, Royal Guard® LLIN, Interceptor® LLIN, Culex spp, Mansonia spp

ABS-202

Evidence of the efficacy of insecticide treated eave nets and window screens in the semi field system for the control of pyrethroid susceptible and metabolic resistant disease vector mosquitoes.

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Despite of the extensive use of available tools to control malaria, it continues to persist especially in sub-Saharan Africa. To reduce the burden of the disease, additional tools are required. Insecticide treated eave nets and windows screens (ITENs & ITWS) are simple house modification tool, developed to control malaria and other vector borne diseases in unimproved houses. This tool is incorporated with 120 mg/m^2 deltamethrin and 95 mg/m^2 of piperonyl-butoxide (PBO). This study assessed the performance of ITENs and ITWS in Tanzania, East-Africa. A randomised Latin square design (4x4) was conducted in four experimental huts covered in a large cage built in a semi field system to allow recapture of mosquitoes inside and outside of the huts. Four treatment arms were evaluated: 1) new ITENs & ITWS, 2) 12-months naturally-aged ITENs & ITWS, 3) 12 months field-used Olyset Plus (Standard of care in Tanzania) and 4) no treatment. The study was performed for 32 nights using a minimum of 30 laboratory-reared individual mosquitoes per night per chamber. Pyrethroid-resistant Anopheles arabiensis, An. funestus (FUMOZ) and Culex quinquefasciatus as well as susceptible Aedes aegypti mosquitoes were used. Recaptured mosquitoes were assessed for mortality, feeding inhibition and hut entry endpoints. New ITENs & ITWS induced higher 72-hour mortality than field-used Olyset Plus ITNs against all mosquito species tested. The 72-hour mortality was similar between aged ITENs & ITWS and field-used Olyset Plus against An. arabiensis (61% vs 66%), Ae. aegypti (33% vs 34%), and Cx. quinquefasciatus (33% vs 33%), except for An. funestus (64% vs 78%). New, and aged ITENs & ITWS reduced mosquito hut entry and blood feeding at higher proportions than field-used Olyset Plus against all mosquito species tested. ITENs and ITWS are efficacious tools for controlling malaria and dengue vectors as well as nuisance biting mosquitoes in a semi-field setting.

Keywords: Insecticide treated eave nets and window screens, ITENs, ITWS, Semi field system, Malaria, vector-borne diseases, Tanzania

ABS-40

Origin and Evolution of wild populations of *Anopheles gambiae* in Central Africa

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Since its discovery, *Anopheles gambiae* has amazed the scientific community by its ability to thrive across sub-Saharan Africa. This adaptation is driven by its close relation to humans, who provide blood meals, shelters, and breeding sites. In return, *An. gambiae* transmits malaria across the continent. Therefore, understanding the mechanisms for human adaptation is decisive for the successful control of malaria in Africa. In the last years, we discovered stable populations of *An. gambiae* and *An. coluzzii* in La Lopé National Park, Gabon, Central Africa, far away from any human presence. In order to better understand the origin and evolution of wild populations, we carried out an extensive fieldwork in sylvatic and domestic settings within the park. We then studied their ecological and behavioral traits and we dissected the genetic basis of *An. coluzzii* adaptation across an anthropogenic gradient. Overall, our outcomes evidenced their outstanding phenotypic and genetic plasticity. Both mosquitoes adapted to park and village, remaining intact their host preference to human. Moreover, *An. coluzzii* exhibited strong gene flow between sylvatic and domestic populations but with multiple signals of local selection. Our results have a direct impact on malaria control strategies. The insecticide susceptibility of sylvatic populations may limit the spread of resistant genes in villages surrounding the park. However, natural areas can act as refugees for malaria mosquitoes, escaping of vector control measures and representing an epidemiological risk for zoonotic vector borne diseases. more studies are need to better characterize vector populations in natural areas across Africa.

Keywords: Adaptation, sylvatic, evolution, malaria control

ABS-470

Frequency and stability of 2La inversions in *Anopheles gambiae* mosquito colonies derived from Uganda field sites

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Chromosomal inversions occur after breakage and re-attachment of reversed sections of a chromosome and can suppress recombination drastically in the heterozygote state. Consequently, inversions can influence selection pressure for traits that fall within the inverted region. The 2La inversion is well-documented in *An. gambiae* and has been extensively studied due to its association with drought resistance and Plasmodium susceptibility. In this study a recently colonized strain obtained from a Ugandan field site was assessed for its 2La inversion: Standard(2La), Heterozygotes (2L+a / 2La) & Homozygous inverted (2L+a). This study characterised the 2La inversion of a Ugandan population and subsequent stability for > 60 generation when maintained under artificial laboratory conditions with potentially different selection pressure compared with field. A laboratory colony was founded in June-2018 from a Uganda field site and has been continuously maintained to more than 70 generations. From generation 10 to 60, 10 adults were genotyped every 5 generations. PCR amplification was performed on individual samples using a multiplex of universal (DPCross5), a 2La and 2L+a specific primer. The mosquito population was polymorphic for the 2La locus, exhibiting 2 co-dominant alleles 2La and 2L+a. A Chi-square statistical analysis was performed and showed no significant difference between the total number of observed and expected genotype frequencies across all the 60 generations based on the Hardy-Weinberg equilibrium. The mosquito population was polymorphic and genetically stable for the 2La inversion for > 60 generations after colonization. This confirmed selection pressure under laboratory did not impact L2a inversion genotypes. This is relevant to vector control methods using lab grown modified mosquitoes as absence of assortative mating is important for maintaining genetic diversity among the wild type colonies.

Keywords: 2La INVERSIONS , *Anopheles gambiae* Mosquito, generations,

ABS-35

Larval ecology and host-seeking and biting behavior of Aedes sp. in a context of dengue re-emergence in the city of Ouagadougou.

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Dengue has re-emerged in recent years in Burkina Faso. In the absence of an effective vaccine and treatment, control of the Aedes vector remains the key strategy for responding to epidemics and sustainably controlling disease transmission. The objective of the present study was to investigate the larval ecology and host-seeking and biting behavior of Aedes sp. in the city of Ouagadougou. A total of 60 concessions

in the districts of Bogodogo and Nongremasson were visited per month during the period from August to November 2021 for larval surveys and adult collection. All water containers were characterized, inspected and immature stages collected. Adults were captured inside and outside the houses using battery-powered hoovers and double-net human traps. The origin of the blood meal of *Ae. aegypti* was determined using multiplex PCR. *Aedes aegypti* was the predominant species and colonized various types of water containers, however abandoned containers and tires were the most productive sites (df=7; p<0.0001). The main entomological risk indices Breteau index, container index and house index were above the WHO threshold values and varied by month (df=4; p<0.0001). *Aedes aegypti* was more active outdoors than indoors with humans as the preferred host (83.7%). Host-seeking and biting activity of Aedes was most intense from 6am to 8am and 4pm to 7pm. This activity seemed to be positively associated with high humidity. These results confirm the high risk of arbovirus transmission in Ouagadougou and provide basic information on the bioecology of *Ae. aegypti* that can contribute to the implementation of a sustainable arbovirus control strategy in Burkina Faso.

Keywords*: Aedes aegypti*, larval ecology, host seeking behavior, dengue, Ouagadougou.

ABS-45

A survey of malaria vectors and their biting and resting behaviour in the malaria elimination settings of Dembiya District, north-western Ethiopia.

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Despite the progress in scaling up the intervention tools in Ethiopia, malaria is still a major health problem. Therefore, continuous monitoring of the local vector behavior and ecology is relevant to designing evidence-based malaria control strategies. This study investigated the species composition and the biting and resting behaviors of Anopheles mosquitoes in selected localities of Dembiya District. Adult Anopheles mosquitoes were sampled indoors and outdoors from June 2018 to May 2019 by using CDC light traps, pyrethrum spray catches, artificial pit shelters, and mouth aspirators. Anopheles mosquitoes were identified at the species level. Their blood source and Plasmodium sporozoite infections were determined using an Enzyme-linked immunosorbent assay. PCR was used for the identification of sibling species of *An. gambiae* s.l. Anopheles mosquitoes belonging to 11 species were identified from 2,055 collected mosquito specimens. *Anopheles pharoensis* and *An. arabiensis* was the dominant species in both Guramba Bata and Arebiya study sites. The CDC light traps caught the highest number of Anopheles mosquitoes in both study sites. The density of outdoor host-seeking and resting Anopheles mosquitoes was higher outdoors than indoors (P ≥ 0.05). The human blood indexes (HBI) of indoor and outdoor host-seeking *An. arabiensis* were 17.4% and 15.3%, respectively. The entomological inoculation rate (EIR) of outdoor host-seeking *An.*

arabiensis was 4.7 infective bites/person/year. Additionally, the outdoor EIR of host-seeking *An. coustani* was 25.7ib/p/year. The indoor and outdoor density of host-seeking and resting Anopheles mosquitoes was comparably high in the Dembiya district. This contrast with the fact that the area is known for the long-term implementation of vector control strategies. Therefore, re-evaluating vector control strategies considering vector and host behaviour is mandatory to eliminate malaria in the study area.

Keywords: *Anopheles arabiensis*, *Anopheles pharoensis*, blood meal, host-seeking, resting, malaria.

ABS-271

Predictive surveillance of arboviral diseases: case study of dengue.

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Dengue is an infectious viral disease primarily spread to humans by the bite of the mosquito Aedes aegypti. The disease is gaining a foothold in Africa evident from frequent outbreaks in the recent past. In many African countries, its impact is undetermined or at best grossly underestimated due to paucity of active surveillance, poor disease reporting systems, and lack of appropriate point-of-care diagnosis. A study was instituted to track adult population dynamics of Ae. aegypti, weekly over a longitudinal scale in an urban focus of coastal Kenya, endemic for dengue. The specimens were analyzed by RT-PCR and virus culture for infection with dengue and other viruses. Abundance of Ae. aegypti followed a seasonal pattern that correlated with weather parameters. Dengue virus, Chikungunya virus and other orthobunyaviruses were detected in Ae. aegypti mosquitoes, remarkably at specific times that did not coincide with periods of peak vector abundance. Detection of these viruses during the inter-epidemic period is remarkable and highlights the value of predictive surveillance targeting vectors that is essential to provide an early warning of the presence of viruses to reduce the potential for human disease. The study also provides data on vector ecology in relation to climatic conditions and defining periods of low and high virus infection rates important for risk mapping of disease spread.

Keywords : Dengue, arbovirus surveillance, *Aedes aegypti*, urbanisation.

ABS-351

The impact of four years of Indoor Residual Spraying with pirimiphos-methyl and clothianidin on entomological drivers of malaria transmission in Burkina Faso, west Africa.

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Since 2018, indoor residual spraying (IRS) has been performed by the National Malaria Control Program in the high-burden districts of Kampti and Solenzo using SumiShield® 50 WG (clothianidin: neonicotinoid), Actellic® 300CS (pirimiphos-methyl: organophosphate) and Fludora Fusion® WP-SB (clothianidin + deltamethrin: pyrethroid) in Burkina Faso. Routine entomological surveillance was conducted to measure the impact of IRS on entomological drivers of malaria transmission. *Anopheles gambiae* s.l. were sampled monthly from June to December by human landing and pyrethrum spray catches in two sprayed and two unsprayed sentinel sites to measure entomological inoculation rates (EIRs). The residual activity of insecticides was also assessed using the WHO cone test. After the first round of IRS in 2018, there was a significant decrease in malaria transmission in all sprayed districts compared with unsprayed districts as shown by reduced EIR (RR=19.75, CI95%= [8.71–33.45], P<0.001). From 2019 to 2021, the EIR was significantly lower in Kampti compared to Gaoua (unsprayed district) (RR=13.12, CI95%= [4.35.71–21.18] P<0.001). In Solenzo, the EIR varied from one year to the next, but the reduction was not significant. SumiShield® 50 WG and Fludora Fusion® WP-SB lasted more than 7 months covering the malaria transmission period, compared to Actellic® 300CS, which lasted 5 months. These findings highlight varying entomological impact of the IRS at the two sites, to reduce malaria transmission.

Keywords: IRS, residual malaria transmission, Burkina Faso

ABS-359

Utilizing natural variation to achieve species- and population-specific sex bias in the *Anopheles gambiae* complex.

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Genetic approaches for vector control primarily involve reducing the reproductive capacity of insect populations. In *Anopheles gambiae* mosquitoes, one effective method involves using endonucleases, such as CRISPR-Cas9, to cleave a highly repetitive and conserved rRNA gene in the ribosomal locus on the X chromosome during spermatogenesis. This leads to damage to X-bearing sperm and a strong male

bias in the progeny. In caged mosquito populations, this has been proven to be a good strategy for population suppression. We have recently used a combination of long-read sequencing and bioinformatic methods to achieve the assembly of the ribosomal locus, previously only partly assembled due to its repetitive nature. We used DNA sequencing data to investigate natural sequence variation at the locus in different Anopheles species and various populations of the *Anopheles gambiae* complex across Sub-Saharan Africa. Leveraging this variation, we identified target sites that allowed us to design species-specific gRNAs that would limit the application of the X-shredding strategy with CRISPR-Cas9 only to the target species or population. Experiments to test the specificity of this approach are currently underway for *Anopheles gambiae* and *Anopheles arabiensis*, the two major vectors of malaria. This tool would enable a way to limit the activity of a transgenic strain, which also offers an answer to issues raised in the context of transgene transboundary movement.

Keywords: Population suppression, vector control, *Anopheles gambiae*, *Anopheles arabiensis*, sex bias, ribosomal repeats, CRISPR-Cas9.

ABS-377

Biting and resting behavior heterogeneity of malaria vectors from different geographic localities in Cameroon.

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Malaria vector biting and resting behavior is essential for vector control decision making and tool effectiveness. The National Malaria Control Program(NMCP) in Cameroon has prioritized mass and routine distribution of insecticide treated nets (ITNs) as the sole malaria vector intervention. With the recent introduction of new types of ITNs, understanding vector behaviors can help assess and inform on the effectiveness of tools. Entomological surveillance was conducted bimonthly from November 2021-September 2022 in five sites

representing different geographies. Human landing catches (HLCs) were done indoors and outdoors in three houses from 6 p.m.-10 a.m. and pyrethrum spray catches (PSCs) in 20 houses. *Anopheles gambiae s.l.* was the primary vector in all sites and comprised 69% (6,056/8,781) of Anopheles collected by HLCs and 89% collected by PSCs (5,093/5,687). The mean indoor hourly peak human biting rate was higher at night than the early morning (6-7 a.m.) at all sites: Gounougou (3.8 bites/person/hour at 4-5 a.m. vs 1.3 b/p/h), Simatou (3.2 b/p/h at 2-3 a.m. vs. 2.0 b/p/h), Mangoum (1.2 b/p/h at 9-10 p.m. vs 0.2 b/p/h), Nyabessang (0.14 b/p/h at 2-3 a.m. vs 0.0 b/p/h) and Bonabéri (1.1 b/p/h at 1-2 a.m. vs 0.14 b/p/h). Similar trends were observed outdoors. In Gounougou, Simatou, and Mangoum, indoor biting continued until 10 a.m., whereas in Nyabessang and Bonabéri, indoor biting was observed only until 7 a.m. *An. gambiae* s.l. were endophagic in the two northern sites (mean of 53%). The mean indoor resting density was also high in the northern sites—44.1 females/room in Simatou and 41.2 in Gounougou. These results show that the vectors bite similarly indoors and outdoors and until late in the morning in some sites and can help guide Cameroon's NMCP to select the appropriate/complementary and targeted vector control tools to reduce malaria burden.

Keywords: Malaria, entomological surveillance, human landing catch, pyrethrum spray catch, hourly biting rate, endophagic index.

ABS-383

First report on genetic diversity in malaria vectors and its implication on the spread of insecticide resistance in the Democratic Republic of Congo.

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Widespread pyrethroid resistance across the Democratic Republic of Congo, constitutes a serious threat to the effectiveness of bed nets. Prioritized deployment of newer nets is required, which would be aided by improved knowledge of the genetic continuity of malaria vectors and the distribution of resistance mechanisms. Three study sites were sampled: Kimpese in the south-west, Mikalayi in south-central and Kapolowe in the south-east, within each of which mosquito collections were performed in three sub-sites. *An. gambiae* were collected and used for whole genome sequencing pyrethroid resistance characterization. 2153 Anopheles mosquitoes were collected across the sites of which *An. gambiae s.l*. and *An. funestus s.l*. were the dominant species. *Anopheles gambiae* resistance to each of three pyrethroids was present in every sub-site, but varied among localities, with Kimpese significantly more resistant. From whole genome sequences variability in genetic structure was evident, with both differentiation and homogeneity observed between pairs of locations separated by hundreds of kilometers. Surprisingly, differentiation was also found between the subsites of Kimpese, despite separation of tens of kilometers. Genome-wide analyses revealed pronounced signals of selection on chromosome 2R (around the VGSC target site gene), 2L (around the Cyp6 P450 gene cluster) and X (around the Cyp9K1 and cytochrome P450 reductase (CPR) genes). Promising novel resistance markers were detected in the Kimpese sub-sites; a high frequency duplication of Cyp9K1, and nucleotide polymorphisms in CPR, which were near-absent elsewhere. The results highlight remarkable geographical variation in genomic differentiation among DRC *An. gambiae* populations. This study provides a first investigation of the genomic differentiation and adaptive diversity of *An. gambiae* populations and provides candidate metabolic resistance markers for further evaluation as part of molecular surveillance program.

Keywords: *An. gambiae s.l*., resistance mechanisms, genetic structure, Malaria.

ABS-67

Continuing development of insecticide resistance in the major malaria vector *Anopheles arabiensis* in northern KwaZulu-Natal, South Africa.

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Malaria incidence in South Africa is highest in the three endemic provinces. The contribution to malaria transmission by several mosquito species, variation in their resting behaviors and low levels of insecticide resistance make it necessary to periodically monitor vector populations. This study aimed to assess Anopheles species assemblage and collecting insecticide susceptibility data for *An. arabiensis.* Anopheles specimens were collected from Jozini, northern KwaZulu-Natal from November 2019 to April 2021. Progeny of wild-collected *An. arabiensis* females were used for standard insecticide susceptibility tests and synergist bioassays. In total, 16 Anopheles species were collected. These included members from the An. gambiae complex (*An. arabiensis*, *An. merus*, and *An. quadriannulatus*), members from the *An. funestus* subgroup (*An. vaneedeni* and *An. parensis*), and one each from the *An. minimus* subgroup (*An. leesoni*) and the *An. rivulorum* subgroup (*An. rivulorum* s.s). *Anopheles arabiensis* contributed 85.6% (n=11 062) of the total catches. Samples for subsequent insecticide susceptibility bioassays were selected from *An. arabiensis* families. There was low-level resistance to DDT, permethrin, deltamethrin, bendiocarb, and full susceptibility to pirimiphos-methyl. Synergist bioassays using piperonyl butoxide and triphenyl phosphate suggest oxygenase-based pyrethroid and esterase-mediated sequestration of bendiocarb. These low levels of resistance are unlikely to be operationally significant. It is concluded that northern KwaZulu-Natal Province remains receptive to malaria transmission despite ongoing control and elimination interventions. This is due to the perennial presence of *An. ar*abiensis and other secondary vector species. The continued detection of low-frequency insecticide resistance in *An. arabiensis* is cause for concern and requires periodic monitoring for resistance frequency and intensity changes.

Keywords: Insecticide resistance, northern KwaZulu-Natal, *Anopheles arabiensis*

ABS-72

Is the invasion and spread of the urban malaria vector *Anopheles stephensi* into and across Africa mediated by windborne migration?

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The invasion of the urban malaria vector *Anopheles stephensi* into Africa is a serious public-health threat and a challenge to malaria elimination. Whereas malaria in Africa has been primarily a rural problem, the recent establishment and expansion of the invasive urban Asian vector *Anopheles stephensi* will likely drastically increase the risk in Africa, elevating urban malaria. It is widely believed that this incursion and subsequent spread was mediated by transport on ships, airplanes, and cars. Here, we examine the geographic, genetic, and related data and propose that the invasion and spread of *An. stephensi* in Africa has been mediated primarily by high-altitude windborne migration. The key evidence supporting windborne invasion and spread include) the gradual range expansion over several decades exhibits an unmistakable diffusion process, ii) distribution that does not concentrate near major sea ports, airports, or even main highways, but is correlated with predominant winds, iii) genetic evidence of high diversity that is incompatible with a single introduction such as by a ship and similarity between populations from southern Arabia (Yemen) with those in Africa, and iv) low tolerance of *An. stephensi* eggs to desiccation limiting their capacity for long travel, but strong capacity of gravid Anopheles females to be carried by wind for tens or hundreds of kilometers. To our knowledge, no *An. stephensi* mosquitoes were intercepted on ships or other vehicles, nor in high altitude (>100 m above ground); however, sampling should be carried out to evaluate both possible modes of transport. The possibility of windborne migrations of gravid *An. stephensi* should be incorporated in surveillance efforts while testing this and the transport of these mosquitoes in human vehicles in tandem. Understanding the contributions of the different mechanisms of spread is critical to mitigating the impact of *An. stephensi* and other invasive vectors in future.

Keywords: Urban malaria, invasive mosquito, windborne-migration, dispersal, global-health,

ABS-118

Leveraging Community Owned Resource Persons (CORPs) to reach the underserved population through Integrated Community Case Management (iCCM) to fight malaria in Tanzania.

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Malaria modeling in Tanzania demonstrates that case management (CM) should target ≥85% malaria cases appropriately managed in high malaria transmission areas to increase CM effectiveness and decrease transmission. Tanzania's policy against the use of community Health Workers (CHW) for CM creates a gap at the community level, which is addressed through the deployment of Community Owned Resource Persons (CORPs). CORPs are qualified medical personnel at the community who are either retired or unemployed whom the National Malaria Control Program (NMCP) utilizes to promote the early recognition, prompt testing and appropriate treatment of malaria among all age groups in areas with limited access to facility-based health care providers. CORPs were mapped in 10 high malaria councils to establish an equitable and efficient system for delivery of community malaria case management (CMCM) services. The mapped villages had high malaria risk, were hard to reach as well as had overstretched health services. The service operates within the routine delivery system by using current logistic and M&E frameworks. Sensitization was done with regional and council health management teams, and CORPs were trained. 104 (33%) CORPs were mapped in 311 villages that also have 434 CHWs. Between June and December 2022, CORPs attended to 35,409 patients and tested 33,030 (93.3 %) for malaria. Among them, 10,631 (32%) had confirmed malaria. Community level diagnosis accounts for 5% of national malaria cases and 16% in those Councils during the reporting period. CMCM promotes the early recognition, prompt testing and appropriate treatment of malaria among all age groups in areas with limited access to facility-based health care providers. Recommendation for effective CMCM in Tanzania the Ministry of Health through the NMCP need to review protocol for CMCM implementation, advocate for using CHWs in place of CORPs; and review data collection and support supervision tools to address challenges.

Keywords: Integrated Community Case Management (iCCM)

ABS-561

Wide and sustained long-term target efficacy of an injectable long-acting ivermectin formulation against Plasmodium vectors in the fight against malaria.

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Mass drug administration of ivermectin to humans as a systemic insecticide could help circumventing the Plasmodium vectors resistance problem that impairs malaria control. However, the short product remanence at mosquitocidal plasma concentrations in the hosts hampers efficacy, which thus require repeated dosing so full coverage of transmission period is achieved. Long-Acting Ivermectin Formulations (LAIFs) that deliver ivermectin at mosquitocidal concentrations for more than one month could be a substantial advantage in the fight against malaria. In the IMPACT project, three LAIF candidates targeting 2-to-3-months sustained mosquitocidal efficacy, were formulated using BEPO® technology and injected to calves. Efficacy against *An. gambiae* was determined through survival experiments, and the pharmacological properties of ivermectin and its metabolites were characterized using nonlinear mixed-effects modelling. A lead formulation was selected and further tested in Burkina Faso. Calves were exposed to wild Anopheles using a “Greco-Latin Square” design representing 72 night-calves per month for 3 consecutive months. In addition, in vitro experiments were used to characterize the mosquito-lethal effects of treated calve plasma on the primary Southeast Asian malaria vectors; *An. dirus* and *An. minimus*. Data showed properties compatible with a sustained exposure to ivermectin and the 3”-O-demethyl ivermectin metabolite for at least 3 months after a single injection. During this time period, wild Anopheles from 10 species in Western Africa and colony-reared *An. dirus* and *An. minimus* from Southeast Asia that fed on treated calves were 3 to 10 times more likely to die than those fed on control-animals. Dose-response models will compare susceptibility between species and resistance backgrounds and help to understand metabolite effects. Our results will provide crucial data on this innovative LAIF with promising epidemiological relevance towards a phase-1 trial in humans.

Keywords: Resistant Anopheles, Ivermectin, Long Lasting Formulation, wide effect, sustainable

ABS-556

Range expansion of the populations of *Anopheles coluzzii* across five ecozones in nigeria (2019-2022): implications for malaria transmission dynamics

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Malaria remains a leading cause of morbidity and mortality in Nigeria where *Anopheles gambiae* s.s. has been the predominant vector species responsible for its transmission in the drier Sahel ecozone of the country. However, recent investigations have shown a shift in vector composition. We investigated these changes and the potential implication on the role of other members of the *An. gambiae* s.l. group in malaria transmission across other ecozones. Species-specific PCR and *Plasmodium falciparum* circumsporozoite protein assay data on 11,427 *An. gambiae s.l.* samples collected by human-baited CDC Light Traps and Pyrethrum Spray Catches from 2019 through 2022 were grouped according to ecozones. The proportions of *An. gambiae s.l*. species members were calculated, and annual changes analyzed using chi-square. Over the three-year period, the proportion of *An. coluzzii* across all ecozones increased significantly from 16% to 78.8% ($p<0.0001$), with varying changes reflected in the Sahel (4.6 to 85.5%), Forest Savannah (12.8 to 75%), Guinea Savannah (9.6 to 76%), Rainforest (38.9 to 79.7%), and Mangrove (32.4 to 82.4%) ecozones. These increases were statistically significant ($p<0.0001$) indoors in all ecozones except the Rainforest and outdoors in all ecozones except for the Mangrove ($p=0.045$). In contrast, the proportions of *An. gambiae* s.s. and *An. arabiensis* decreased significantly ($p<0.0001$) in all ecozones from 2019 (65% and 19%) to 2022 (20.1% and 1.2%), respectively. Despite these shifts in vector composition, the sporozoite infectivity rate contributions of *An. gambiae s.s.* from 2019 to 2022 (0.5 to 11.1%) remained greater than rates from *An. coluzzii* (0.3 to 6.7%) ($p=0.296$) and *An. arabiensis* (0.9-2.9%) ($p=0.220$), though the differences were not significant. These findings suggest a significant shift in the dominant malaria vector species in Nigeria across all ecozones from *An. gambiae s.s*. to *An. coluzzii* with no significant changes in sporozoite infectivity rates

Keywords: *Anopheles coluzzii* distribution, five ecological zones, malaria, Nigeria

ABS-147

Malaria rapid diagnostic tests reliably detect asymptomatic *Plasmodium falciparum* in school-aged children that are infectious to mosquitoes.

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Asymptomatic malaria infections (Plasmodium falciparum) are common in school-aged children. This group represents a disease-transmitting reservoir. To detect such infections, convenient, rapid and reliable diagnostic tools are needed. In this study, malaria rapid diagnostic tests (mRDT), light microscopy (LM) and quantitative polymerase chain reaction (qPCR) were used to evaluate their performance in detecting asymptomatic malaria infections that are infectious to mosquitoes. 170 asymptomatic school-aged children (6-14 years old) from the Bagamoyo district in Tanzania were screened for Plasmodium spp. infections using qPCR, mRDT (SD BIOLINE) and LM. Blood from *P. falciparum* positive children was serum replaced with naïve serum and fed to female *Anopheles gambiae sensu stricto* mosquitoes via direct membrane feeding assays (DMFAs). Mosquitoes were dissected for oocyst infections on day eight post-infection. The *P. falciparum* prevalence in study participants was 31.7% by qPCR, 18.2% by mRDT, and 9.4% by LM. Approximately one-third (31.2%) of asymptomatic malaria infections were infectious to mosquitoes in DMFAs. In total, 297 infected mosquitoes were recorded after dissections, from which 100% (297/297), 94.9% (282/297) and 84.2% (250/297), derived from qPCR, mRDT, and LM respectively. Blood samples from four out of fifteen individuals were infectious to 85% (253/297) of all mosquitoes. The mRDT can be used reliably to detect children carrying gametocyte densities sufficient to infect high numbers of mosquitoes. Malaria transmission may be maintained by a small proportion of asymptomatic schoolchildren who are potentially infectious to mosquitoes.

Keywords: Malaria diagnostics, *Plasmodium falciparum*, asymptomatic malaria, malaria transmission, *Anopheles gambiae sensu stricto*, game.

ABS-157

From the lab to the field: long-distance transport of sterile male mosquitoes

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Pilot programmes of the sterile insect technique (SIT) may rely on importing significant and consistent numbers of high-quality sterile males from a distant mass-rearing factory. As such, long-distance mass-transport of sterile males may contribute to meet this requirement if their survival and quality are not compromised. This study therefore aimed to develop and assess a novel method for long-distance shipments of sterile male mosquitoes from the laboratory to the field. Series of long-distance shipments from Seibersdorf in Austria to Dakar in Senegal were performed. In addition, different types of mosquito compaction boxes and a simulated transport of marked and unmarked sterile males was assessed in terms of survival rates/recovery rates, flight ability and morphological damage to the mosquitoes. The novel mass-transport protocol allowed long-distance shipments of sterile male mosquitoes from Seibersdorf to Dakar for up to four days with a non-significant impact on survival (> 90% for 48h of transport and between 50 and 70% for 96h depending on the type of mosquito compaction box), flight ability and damage. In addition, a one-day recovery period for transported mosquitoes post transport increased sterile male escape ability by more than 20%. This novel system for long-distance mass-transport of mosquitoes may therefore be used to ship sterile males worldwide for journeys of two to four days. This study demonstrated that the protocol can be used for standard routine mass-transport of marked or unmarked chilled male mosquitoes required for the SIT or other related genetic control programs.

Keywords: Mass rearing; sterile insect technique; mosquitoes, transboundary shipment; sterile insect technique

ABS-159

Surveillance of *Ae. aegypti* and *Ae. albopictus* during the dengue response outbreak in Sao Tome and Principe in 2022.

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During the past two decades there was a rise of the number of cases of dengue in the tropical world including the Central Africa region. Indeed, in 2022 an outbreak was reported in Sao Tome and Principe. The control of the outbreak was focused on vector control based on identification and destroying or treating of the larval habitat and establishing the profile of Aedes to insecticide resistance. Entomological surveys were performed in 7 health districts of Sao tome and Principe during the dry (June) and raining (November) seasons in 2022. In each district a minimum of three neighborhoods were selected and in each neighborhood around 15 houses were prospected. All potential Aedes larval habitats were recorded and inspected to find the presence of immature stage of Aedes. These stages were collected and transported in the insectary, reared until adult stages before morphological identification. The entomological risk of transmission was assessed using Stegomyia indices. Adult mosquitoes from F1 were used to perform bioassays using 7 insecticides (0.25% pirimiphomethyl, 0.03% deltamethrin, 0.40% permethrin, 0.05% alphacypermethrin, 0.1% bendiocarb, 1% fenitrothion and 4% DDT). *Aedes aegypti* and *Ae. albopictus* were found in all seven health districts of Sao Tome and Principe with high prevalence of *Ae. aegypti* in the most urbanized district (Agrua Grande). Both Aedes species bred mainly in used tires, discarded tanks and water storage containers but in the raining season the contribution of bamboo and snail shells was remarked. In both periods of surveys, the Breteau, house and container indices were higher than threshold established by WHO to indicate higher risk of dengue transmission. All the insecticides tested were susceptible except DDT and bendiocarb. This survey generated baseline data which significantly help the ministry of health to set up a strategy plan to control dengue in Sao Tome and Principe.

ABS-163

Human behavior and exposure to mosquitoes

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Human landing catches (or their proxies) are conventionally utilized to understand man biting rates and hence exposure. Data from several countries (Bangladesh, Cambodia, Ecuador, Indonesia, Namibia and Panama) have demonstrated that these biting rates may not be equitable to exposure especially when evaluating an intervention. Human behavior was characterized in parallel with vector behaviors, and intervention use, towards developing a human-behavior based adjusted biting rate. Data from multiple sites demonstrates that human behavioral observations (HBOs) enable a more accurate measurement of intervention-related exposure along with gaps in protection. These methodologies can be adapted for multiple intervention types. Characterizing interactions between vectors, the human host and

interventions allows malaria control and elimination programs to understand, adapt and respond to residual transmission, as well as spatial and temporal changes that occur in dynamic transmission settings.

Keywords: Human behavior, malaria.

ABS-482

Changing trends in the proportional contribution of Anopheles vector species to malaria transmission in East and Southern Africa: Implications for vector control

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Malaria transmission in Africa is facilitated by multiple species of Anopheles with different behaviors, vectorial capacities and respond differently to interventions. This review analyzed the contribution of different vectors to malaria transmission across East and Southern Africa after years of ITN and IRS implementation. We searched Pubmed, Global Health, and Web of Science online databases for articles reporting sporozoite rates for different species in East and Southern Africa published between 2000 and 2022. We extracted data on study characteristics, biting rates, sporozoite infection, and EIR. Data obtained were used to calculate the proportional contribution of each species to malaria transmission in each study site. Descriptive statistics were used to describe trends over time. Most studies conducted before 2011 indicated *An. gambiae s.l* as the most important vector in malaria transmission while most studies conducted afterward indicated *An. funestus s.l* was dominating the systems. From 2000 to 2010, 58% of the studied sites had An. gambiae s.l with higher sporozoite infection than *An. funestus s.l.* Also, *An. gambiae s.l* contributed most (>50%) to EIR in 65% of the studied sites. On the other hand, from 2011 to 2022, *An. funestus s.l* was dominant in most sites: 57% of the sites had higher proportions of infected *An. funestus s.l* than other vectors and in 75% of the sites *An. funestus s.l* contributed most (>50%) to EIR. Different vectors' contribution to malaria transmission has changed significantly over the past 20 years. As the role of *An. gambiae s.l* has declined, *An. funestus s.l* now appears to be dominating most settings in East and Southern Africa. Other secondary vector species may be playing minor roles in specific localities. To achieve greater improvements in malaria control in these areas, vector control should be .

Keywords: Entomological trends, Malaria transmission, Proportional contribution, Anopheles, East and Southern Africa

Parallel Scientific Session 4: Larval source management and integrated vector management, New and re-emerging vectors, NTDS, precision public health, other

ABS-123

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

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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. 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. 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. 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, malaria, transmission, Yaoundé, Cameroon

ABS-244

Evaluation of the biological and residual activity of larvicide formulations (SumiLarvTM 2MR, SumiLarvTM 0.5G & Abate® 1SG) against invasive mosquito *Anopheles stephensi* in Ethiopia.

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The efficacy and residual activity of SumiLarv 2MR, SumiLarv 0.5G and Abate 1SG (positive control) against exotic invasive vector Anopheles stephensi larvae was evaluated in Awash Subath Kilo, Afar Regional State, Ethiopia. One disc of SumiLarv 2MR (2g in weight) containing 40 mg pyriproxyfen per disc was applied into plastic containers each containing 100L, 250L and additional 250L containers with a half dose rate to equate to 1 disc/500L of drinking water (tap water). Four replicates were conducted per treatment. The water was conditioned for 7 days before use. Plastic containers with 100L, 250L and 500L (equivalent) of water without a SumiLarv 2MR disc with two replicates per treatment acted as controls. Emergence inhibition rates of released larvae were observed up to eight months. After the completion of the trial, the residual content of pyriproxyfen left in each SumiLarv 2MR disc was analyzed using HPLC. The results of this trial revealed that the high residual efficacy of SumiLarv 2MR against *An. stephensi* larvae was confirmed during the study period of eight months. However, the residual efficacy of SumiLarv 0.5G and Abate 1SG performed for seven and five weeks, respectively. Eight-month-old SumiLarv 2MR discs were left with almost 50% residual content of pyriproxyfen showing the potential of SumiLarv 2MR residual efficacy to continue. Therefore, SumiLarv 2MR appeared to be an effective larvicide with longer residual efficacy to control container breeding *An. stephensi* in Ethiopia.

Keywords: *Anopheles stephensi*, larviciding, SumiLarv 2MR, Ethiopia

ABS-343

Modelling the impacts of gene drive releases on the burden of malaria in West Africa

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Gene drives are genetic elements that bias their own inheritance, causing them to spread in populations where they are introduced. Gene drives can be engineered to either suppress or modify vector populations, giving them great promise as a new technology for combating malaria. Here we model the entomological and epidemiological impacts of a gene drive that reduces the fertility of female mosquitoes, such that its spread will suppress vector populations. We consider releases in sixteen ~12,000km^2 areas of West Africa which were chosen to represent a wide range of the diverse climatic, demographic, and disease transmission conditions found in the region. Our

results indicate that sustained vector population suppression is achievable in all the areas considered, and the impact is greatest in the most densely inhabited regions. These results are robust to considerable uncertainty in mosquito movement rates and population sizes, though the extent of suppression is predicted to be greater at higher movement rates and in larger populations. Gene drive releases in the local dominant vector species substantially reduce disease prevalence, though this may remain high in the highest transmission settings where there are major gains from also targeting secondary vector species. In addition to gene drives, we use our model to predict the impact of a widespread application of the RTS-s vaccine, and also of a switch from pyrethroid-only to pyrethroid-PBO bednets. Gene drives perform well in reducing clinical cases in comparison to these other interventions, and intervention combinations involving gene drives together with vaccination and switching to pyrethroid-PBO bednets were most beneficial in high transmission settings.

Keywords: Gene drive, vector population suppression, mathematical model, West Africa

ABS-401

Mosquito Abatement Through Empowerment (MATE): improving community public health and economic growth, one tractor at a time.

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Last year we demonstrated how community engagement, sustainable funding, and interagency partnerships are leveraged in California (USA) to limit mosquito abundance and disease transmission. We are now developing a program that will use a donated tractor for community farming and to eliminate standing water where malaria mosquitoes grow that we are calling “Mosquito Abatement Through Empowerment”, or MATE. This effort is in partnership with Yotor, a local nonprofit that has been doing humanitarian work in Ethiopian communities impacted by poverty and mosquito-borne diseases. MATE aims to empower the community initially with a donated farm tractor so they can scale up agriculture productivity and create a surplus that is used for further economic development and mosquito control work. A long-term goal is for the community to build mosquito-proof homes that institutionalizes the value of cooperative economic and mosquito control efforts. Solving community problems with a homegrown effort is key. Working with Dr. Getnet from Debremarkos University Entomology lab, we have identified two farming communities with endemic malaria in Ethiopia to pilot the first MATE project: Baso Liben at Arat Amba and Libo Kemkem at Tibaga villages. A community assessment that will define the scope of MATE for each community is underway and the results will be shared with prospective philanthropic donor organizations. So far in this pilot study, we have met our first goal of assembling mosquito and agricultural expert teams. Funds and research support have been mobilized

from within and abroad to acquire mosquito light traps and larvae dippers that are being used to collect pre-intervention entomological data. Permits for the pilot study have been obtained from the regional governmental offices, and mosquito control concepts and expected tasks have been communicated to the core field teams.

Keywords: Mosquito control community agriculture

ABS-575

Controlling mosquitoes and biting midges under challenging conditions. proof of concept?

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Mosquito population management is a complicated enterprise for which there's no magic bullet, concoction, or formula. Interventions must be designed and implemented based on local parameters and conditions. The presence and continued expansion of an "urban" malaria vector in Africa requires firm and decisive action. Examples of well-designed and implemented integrated vector control program that reduced biting midge populations by over 85% and mosquitoes by about 75% in under five months from a large luxury resort in the Caribbean Basin occupying almost seven square kilometers between 4.8 kilometers of sandy beach, roughly 20 Km2 of mangroves and marshes along the fence line, and is home to a large nature preserve are provided. The project has kept biting midge and mosquito populations low through two rainy seasons while non-target insects like dragon flies, beetles, and butterflies thrived. More significantly, revenues from outdoor activities increased by about 250% and complaints related to "biting" insects anywhere on the property stopped.

Keywords: Mosquito control, IVM, environmental manipulation, larviciding, source reduction, community engagement.

ABS-74

Using transcriptomic data to identify potential markers of transfluthrin insensitivity in *Anopheles gambiae* ss.

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Calavi); Diana Omoke (Kenya Medical Research Institute); Cynthia CAO Odhiambo (Kenya Medical Research Institute); Nsa Dada (School of Life Sciences, Arizona State University); Nicola Mulder (Human, Heredity, and Health in Africa - H3ABionet Network); Gerald Juma (University of Nairobi); Benard Kulohoma (University of Nairobi); John Gimnig (Centers for Disease Control and Prevention); Luc Djogbénou (Regional Institute of Public Health (IRSP)); Audrey Lenhart (Centers for Disease Control and Prevention); Eric O Ochomo (Kenya Medical Research institute).

The emergence of resistance to pyrethroids threatens the efficacy of insecticide-treated nets (ITNs) and necessitates the development of complementary vector control tools. Spatial Repellents (SRs) are a new intervention that reduces human vector contact, breaking transmission by creating vector-free spaces. Although structurally different from insecticides used on ITNs, current SRs such as transfluthrin are pyrethroid insecticides raising the possibility of insensitivity among vector populations with high levels of resistance to pyrethroids. We used a high throughput screening system to determine the spatial activity index (SAI) of three strains of An. gambiae s.s. (Kisumu, susceptible; Bungoma, local resistant; Pimperena, resistant) to transfluthrin-treated surfaces. Based on the response-non-response status of tested mosquitoes, a whole transcriptome analysis approach was used to determine differentially expressed (DE) genes and identify potential markers for transfluthrin insensitivity. The SAI analysis showed a heterogeneous response based on the mosquito population. Bungoma (12.515 µg/ml : SAI - 0.069), Kisumu (0.0025 µg/ml : SAI - 0.117) and Pimperena (125.15 µg/ml : SAI - 0.111). The DE analysis in non-responders relative to responders showed an over-expression of primarily members of the cytochrome P450 monooxygenases family. CYP12F2 was the most overexpressed with a fold change (FC) of 36.64 in Bungoma and 43.80 in Pimperena relative to the responder Kisumu strain. Olfactory-related genes were mostly globally down-expressed in all test populations. The results suggest possible biotransformation of transfluthrin by cytochrome P450 monooxygenases and also support previous observations suggesting that transfluthrin does not elicit olfactory responses. The roles of these genes in transfluthrin insensitivity need to be validated to further substantiate their involvement in behavioral responses to transfluthrin.

Keywords: Transfluthrin, insecticide insensitivity, spatial repellents, malaria.

ABS-77

Identification of insecticide resistance markers in *Anopheles arabiensis* and *Anopheles gambiae* from Kenya and Benin using Weighted Gene Correlation Network Analysis.

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Indoor Residual Spraying (IRS) and Insecticide-Treated Nets (ITN) are the main methods used to control mosquito populations for malaria prevention. Currently, efficacy of these strategies is threatened by insecticide resistance (IR) which may compromise malaria control efforts. Studies of the genetic evolution leading to insecticide resistance could enable identification of molecular markers that can be used for IR surveillance and improve understanding of the molecular mechanisms associated with IR. This study aimed to use a Weighted Gene Co-Expression Network Analysis (WGCNA) algorithm, a systems biology method, to identify genes with similar co-expression patterns and hub genes that can be used as molecular markers for insecticide resistance surveillance in Kenya and Benin. *An. arabiensis* and An. gambiae from Kenya and Benin, respectively, were phenotyped for resistance to alphacypermethrin, permethrin and deltamethrin insecticides. RNA was extracted from mosquito samples followed by Illumina sequencing. WGCNA was conducted on the resulting sequences to evaluate co-expression patterns of genes to identify modules, hub genes and generate a gene co-expression network. A total of 20 and 26 gene co-expression modules (sft:20,18) were identified via average linkage hierarchical clustering from *An. arabiensis* (Kenya) and An. gambiae (Benin), respectively. The top modules based on the number of genes in *An. arabiensis* and An. gambiae were identified to be salmon (n=3197) and blue (n=3839) modules. The genes with the strongest connection (hub genes) were found in all modules. Serine protease, E3 ubiquitin-protein ligase, cuticular protein RR2 and leucine-rich immune protein were identified as hub genes in both species. In conclusion, four biologically relevant hub genes shared between the two species were identified as potential markers for insecticide resistance. Functional validation of these genes as IR markers should be conducted through in vitro and in vivo studies.

Keywords: Hub genes, insecticide resistance markers, *Anopheles gambiae*, *Anopheles arabiensis*, Benin, Kenya.

ABS-570

Landscape overview of *Anopheles stephensi*

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Malaria, a preventable disease, has been a plague to humankind for years. The 2022 World Malaria Report documented an estimated 247 million cases and 619,000 deaths. Progress in the effective control of malaria is challenged by threats from emerging resistance to insecticides, medications, and diagnostics as well as the spread of *Anopheles stephensi* an efficient malaria vector capable of transmitting both malaria parasites, Plasmodium falciparum and Plasmodium vivax, to humans in urban settings. These threats findings point to several urgent needs for innovation, new strategies and ways of thinking collectively about solutions. There are still gaps in knowledge regarding *An. stephensi* behaviour in its new environments, and its impact on malaria transmission in Africa. A landscape review of *An. stephensi* was conducted to describe the landscape of recent and ongoing *An. stephensi* research and investments. The MESA Deep Dive methodology was used to analyse the overview of research projects via a systematic curation of active and recently completed *An. stephensi* projects. The Systematic curation of projects was guided by an eligibility criteria. The selected projects were categorised into different research areas for analysis. As of April 2023, 62 projects were included in the review. These were categorised into 8 research areas and funding quantified. This comprehensive analysis provides a valuable overview of the distribution of funding and projects across different research areas, enabling researchers, policymakers, and stakeholders to identify existing gaps in knowledge and prioritise future research efforts. It highlights the detection and spread of *An. stephensi* in multiple African countries, emphasising the urgent need for effective regional responses to prevent further transmission. It serves as a foundation for informed decision-making and the development of evidence-based interventions against *An. stephensi* in Africa.

Keywords: Malaria, *Anopheles stephensi*

Parallel Scientific Session 5: Social Science, Women in science, NTDs, other

ABS-5

Epidemiology of Rift Valley fever in Mali: case of the regions of Sikasso, Kayes and Segou.

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This retrospective epidemiological survey was conducted during the period August - December 2021 and covered the regions of Sikasso, Kayes and Segou. ELISA made it possible to test 825 serum samples collected during fortnightly missions in sentinel herds of ruminants in these localities. In addition, 40 mosquito samples captured in the study sites were tested at PCR. Following the various analyses, an overall serological prevalence rate of 2.06% immunoglobulin type M (IgM) (17 positive / 825 tested) was obtained. This is evidence of a

recent infection of Rift Valley fever virus. All mosquito samples (40 mosquitoes) submitted for real-time PCR analysis were all negative and belonged to the genera Aedes and Culex. The serological prevalence rate varied according to regions and ruminant species. Thus, the highest prevalence rate was observed in the region of Sikasso with 4.04%, followed by that of Segou (2.53%). In contrast, the lowest rate was found in the Kayes region (1.51%). In addition, the statistical analyses did not show any significant difference in prevalence rates by region ($p = 0.231 > 0.050$). The study also showed that the highest serological prevalence rate was obtained in the bovine species (4.40%), followed by sheep (2.15%). The lowest rate was recorded in goats with 0.40%. Thus, statistical analyses made it possible to establish a significant difference in prevalence rates according to the ruminant species ($p = 0.021 < 0.050$). This study thus confirmed the recent circulation of RVF virus among ruminant populations in the localities visited.

Key words: Rift Valley fever, epidemiology; Mali, control programs and global health

ABS-25

Rice farmers' knowledge and practices towards mosquitoes in irrigation schemes in Côte d'Ivoire: a qualitative study.

Kallista Chan (LSHTM)*

Irrigated rice cultivation in sub-Saharan Africa not only brings more malaria vectors to nearby communities, but also greater malaria risk. To aid the implementation of mosquito control in rice-growing communities, it is necessary to understand how farmers view their responsibility towards mosquito generation and whether they are interested in coordinating to minimize it. Qualitative methods (observation grids, semi-structured in-depth interviews, and focus group discussions) were used to reveal the perceptions of mosquitoes and their control in two irrigated rice farming communities in central Côte d'Ivoire near the M'bé and Lokapli irrigation schemes. All rice farmers viewed mosquitoes as severe nuisances, and most acknowledged that they caused djèkouadjo (malaria) and were less numerous during harmattan (dry season). Many study participants believed that mosquitoes originated from grasses and stagnant water around villages. Only those living closer in proximity (~1 km) to the paddies believed that mosquitoes came from the bas-fonds (irrigated lowlands). However, they did not associate mosquito production with rice cultivation. Some farmers believed that there were more mosquitoes in recent years than historically because of the dam construction but remarked on the importance of the dam (and bas-fonds) for their livelihood. Many farmers were not convinced that mosquito control could occur at farm-level. To enhance accountability amongst rice farmers, there is a need for greater awareness on the rice-mosquito link, and emphasis that the link does not imply a trade-off between food security and health. Training should not only be directed towards farming communities, but also agricultural and health extension

workers. Future riceland mosquito control methods must focus on improving productivity and address collective action problems that may occur.

Keywords: Malaria, rice, farmer, agriculture, anopheles

ABS-180

Exploring activities and behaviors potentially increases school–age children's vulnerability to malaria infections in south-eastern Tanzania.

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Strengthening malaria control activities in Tanzania has dramatically declined human malaria infections. However, there is an increasing epidemiological shift in the burden on school-age children. The underlying causes for such an epidemiological shift remain unknown in this context. This study explored activities and behaviors that could increase the vulnerability of school-age children to transmission risk to provide insight into protection gap with existing interventions and opportunities for supplementary interventions. This cross-sectional study conducted twenty-four focus group discussions (FGDs) in three districts of Rufiji, Kibiti and Kilwa in south-eastern Tanzania. Sixteen FGDs worked with school-age children (13 to 18 years) separating girls and boys and eight FGDs with their parents in mixed-gender groups. A total of 205 community members participated in FGDs across the study area. Of them, 72 participants were parents, while 133 were school-age children (65 boys and 68 girls). Routine domestic activities such as fetching water, washing kitchen utensils, cooking, and recreational activities such as playing and watching television and studying were the reported activities that kept school-age children outdoors early evening to night hours (between 18:00 and 23:00). Likewise, the social and cultural events including initiation ceremonies and livelihood activities also kept this age group outdoors from late evening to early night and sometimes past midnight hours. Parents migrating to farms from December to June, leaving behind school-age children unsupervised affecting their net use behavior plus spending more time outdoors at night, and the behavior of children sprawling legs and hands while sleeping inside treated bednets were identified as potential risks to infectious mosquito bites. The risky activities, behaviors, and social events mostly occurring outdoors might increase school-age children's vulnerability to malaria infections. The findings provide preliminary insight on potential risk factors for persisting transmission. Further studies to quantify the risk behavior and activities are recommended to establish the magnitude and anticipated impact on supplementary control strategies to control infection in school-age children.

Keywords: Malaria, Disease reservoir, Outdoor malaria transmission.

ABS-208

First detection of *Trypanosoma brucei gambiense* in Manoka tse-tse flies in the littoral region of Cameroon: epidemiological implications and perspectives.

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Surveillance of human trypanosomiasis focus is necessary to prepare the response in the event of an epidemic outbreak. The objective of the study was to assess tsetse flies and trypanosomes circulating in the dormant Wouri focus. A descriptive study on the presence of *Trypanosoma brucei gambiense* and its potential vectors was carried out in Youpwe, Yabassi, Sodiko, Manoka island and Cape-Cameroon Island from February to April 2022.Tsetse flies collected from the five selected locations using pyramidal traps, were first classified by species according to their morphology, then by sub-species with Polymerase Chain Reaction Diagnostic (PCR-Diag). Trypanosoma species and sub-species were subsequently identified and genotyped using a Nested PCR. *Glossina palpalis palpalis* was the unique tsetse subspecies recorded across the five locations. The tsetse infection rate by Trypanosoma ssp. varied between 5.35% in Cape-island and 35.71% in Manoka island. Three Trypanosoma species were detected: *T. brucei* s.l. 32/500 (6.4%), *T. congolense* 15/500 (3.0%), and T. vivax 8/500 (1.6%). The sub-species *T. b. gambiense* responsible for HAT was detected in tsetse flies from Manoka (2/150: 1.33%), whereas *T. congolense* consisted of *T. congolense* "forest" and *T. congolense* "savannah" types. The presence of *T. b. gambiense* and *T. congolense* sub-species in Manoka and nearby suggests residual circulation of human and animal trypanosomes in quiescent HAT foci of the littoral region of Cameroon. The implementation of epidemiological surveillance is imperative for an efficient response in the event of an outbreak of the disease.

Keywords: human African trypanosomiasis, *T. brucei gambiense*, *T. congolense*, *G. palpalis*, littoral region of Cameroon

ABS-284

Innovative communication strategies for enhancing effective community participation in mosquito control in Malindi, Kenya.

Lydiah Kibe (KEMRI)*; Charles Mbogo (KEMRI); Joseph Mwangangi (KEMRI); Clifford Mutero (ICIPE)

Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 1 million deaths annually. Invasive *Anopheles stephensi* was detected in Kenya recently and urgent interventions are needed to contain its further spread. Integrated vector

management is a crucial strategy that promotes community empowerment, social mobilization, and inter-sectoral collaboration. A community-based mosquito control was implemented in Malindi along the Kenyan coast. An easy-to-follow curriculum was developed which included components on basic entomological skills and communication skills. Lay persons known as 'mosquito scouts' were trained for 3 weeks, and supportive supervision was provided during fieldwork. Each mosquito scout was assigned an area of 1km2. Their activities included searching for mosquito breeding areas, creating awareness, and communicating mosquito information to residents and community-based groups and stakeholders. A total of 62 mosquito scouts, 11 community groups affiliated with PUMMA (Punguza Mbu Malindi), and 11 primary schools were identified and trained in mosquito control activities. Communication strategies included awareness campaigns such as Annual Mosquito Field Events, neighborhood campaigns, door-to-door campaigns, and school mosquito clubs. The strategies motivated and enabled communities to understand more about mosquitoes and control measures and voluntarily took part in vector management activities. The mosquito scouts gained recognition and honor at the community level and are referred to as "mosquito doctors". This made it easy to disseminate and communicate to the household owners about mosquito breeding areas and actions required to control the larval habitats identified. These approaches are appropriate and applicable in areas with low knowledge of mosquito biology and resource constraints, especially now with the detection of the invasive *Anopheles stephensi* in Kenya.

Keywords: Integrated vector management, community, mosquito scouts, Malindi, Kenya

ABS- 600

Morphological and Molecular Identification of Simulium Vectors of Onchocerciasis in Different Ecological Zones of Ethiopia: Parasite-Vector Study

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Simulium (blackfly) species transmit Onchocerca filariae of human and animal origin. Elimination of Onchocerca volvulus from humans is hindered by the co-transmission of animal filariae and lack of vector species identification; hence, the study is conducted to know the diversity and vectorial roles of anthropophilic blackflies in Ethiopia. Simulium preimaginal and adult stages collected from seasonal and perennial rivers from various bio-climatic zones of Ethiopia. Specimens preserved in absolute alcohol for further studies. Annual Biting Rates (ABRs) calculated for the species caught by human landing catches. At the University of Tübingen, Germany, species identification conducted using morphological and molecular genetic tools (Sanger sequencing of Cox1 and ITS2 genes). Geneious Prime and MEGA 11 software employed for phylogenetic analyses. *Simulium bovis*, *S. dentulosum, S. vorax* and S*. adersi* are identified to be important anthropophilic species following *S. damnosum s.l.* and *S. ethiopiense*. In the Metema sub-focus of Sudan Savannah*, S. damnosum ('S.*

gonderense') had the highest ABR of 24,000 bites/man/year followed by S. bovis (ABR= 8,800). In the southern, the ABR of *S. damnosum* (*S. kaffaense)* reached 170,000. Except S. vorax and S. adersi, the other species exceeded the critical threshold of 1000 ABR for Onchocerca transmission. *S. damnosum* complex caught from Adiyo and Cheriko Rivers were molecularly identified, respectively as *S. kulfoense* and *S. kaffaense. Simulium bovis, S. dentulosum, S. vorax* and *S. adersi* are confirmed as important species and added into the list of potential vectors in the Ethiopian Onchocerciasis Elimination Program. Morphometric pictorial key is developed to distinguish the various species in the study of the transmission of O. volvulus: These, and members of S. damnosum complex might also be involved in the transmission of non-O. volvulus infective larvae which requires further study.

Keywords: onchocerciasis, Simulium, Onchocerca, taxonomy, Africa

ABS-342

Leadership and management capacity building: addressing gaps in NMCPs through an integrated training program to reach elimination targets.

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Effective leadership and management (L&M) are essential for impactful implementation of public health program or interventions. Countries targeting malaria elimination, require national malaria control program (NMCP) managers and decision-makers to have well-developed problem-solving skills, ability to develop and implement effective evidence-based elimination strategies and willingness to adopt new techniques. Acknowledging the importance of these skills, the Elimination 8 (E8) included building L&M capacity in its Acceleration Plan for Malaria Elimination. The University of Pretoria and partners developed a L&M training program targeting E8 NMCPs. The curriculum addressing Africa-specific issues and challenges, was informed by desk-top review and online survey. Training comprises three sequential modules: science of leadership and effective management; evidence-based decision-making; and science of malaria and malaria elimination. The program has a phased approach addressing functional skills and competencies, applied in the practical context of malaria elimination. Each participant also must develop a system strengthening project. Participants from Eswatini, Namibia, South Africa, Zambia, and Zimbabwe were nominated by their countries' ministries of health. Of the 56 enrollees in 2022, 48 (86%) completed the program. Heavy workload and infrastructure challenges, majorly contributed to drop-outs. Female participants made up 48% of the cohort. In 2022, the course was presented virtually in English, but a blended approach and option for Portuguese are currently being trailed with a cohort of 53 enrollees. Additional funding is being sourced and expansion beyond the E8 NMCP participants is being

considered to ensure sustainability beyond the initial 2 years. Building L&M capacity will contribute positively to the malaria elimination agenda and ensure that the region has leaders capable of building and leading effective public health systems. Leadership and

Keywords: Management, Capacity Building, Elimination 8, National Malaria Control Program.

ABS-439

Abstract Title: Exploration of community priorities, challenges, and opportunities for One Health vector control interventions using horizontal participatory approaches – findings from coastal and western Kenya.

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Arthropod-borne diseases of people and livestock are a leading public health problem and a constant threat to the economy. Whilst there is an increasing risk of pathogens transmitted by arthropods there are significant limitations to available resources for control. Integrated vector management and One Health approaches have been proposed. We used a horizontal participatory approach to explore (1) community perceptions of arthropod-borne diseases, and (2) of opportunities for co-production of community-based One Health interventions. Open space events were held with 161 participants in western and 108 in coastal Kenya with a variety of community members, leaders, development, and health stakeholders who were invited using a broadly phrased calling question. Participants set their own agenda for discussion groups. Findings were further explored through semi-structured household questionnaires administered to >500 households per study location. Malaria and tick-borne cattle diseases, followed by ectoparasites (sand fleas and bedbugs), were of major concern for communities. A recurring theme was need for researchers to develop simple, affordable, and efficient interventions addressing human and livestock diseases concurrently. Lack of understanding and misconceptions affect attitudes of the community towards participation in control efforts. There was enthusiasm to participate in co-creation of local solutions for vector control, but it was requested to package training events in such a way that several community challenges can be addressed in a single event to avoid frequent meetings with different interest groups engaging on completely different topics. Inclusion of the community in all steps was a strong recommendation. Target communities suggest interventions that combine improvement of human and cattle health through targeted capacity building and co-production to enhance stakeholder involvement and ownership.

Keywords: One Health, community engagement, vector borne diseases, livestock, mosquitoes, veterinary

ABS-468

Cost-Effective PCR-Based Identification of *Tunga penetrans* (Siphonaptera) Larvae Extracted from Soil Samples Containing PCR Inhibitor-Rich Material.

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Tropical Veterinary Medicine, Freie Universität Berlin)

Tungiasis is a highly neglected parasitic skin-disease caused by *Tunga penetrans* – found in both Africa and Latin America. T. penetrans has on-host and off-host stages therefore, investigation of the flea and intervention strategies must focus on the host and suitable breeding sites for off-host development. In the absence of a morphological key, low-cost molecular based techniques are important to identify off-host stages obtained from the soil in low- and middle-income countries. Six assay combinations based on three DNA preparation protocols – NucleoSpin® Soil DNA Isolation Protocol (S-kit), Ammonium Acetate DNA Protocol (AmAcet), Crude Flea Lysate Protocol (CL) (both developed in the study) – and two DNA polymerases – FIREPol® Taq and Phusion®– were compared for efficacy and cost-effectiveness. PCR assays were conducted using a T. penetrans specific primer pair targeting a 278 bp partial internal transcribed spacer (ITS-2) region and a pan-Siphonaptera primer pair targeting a 730 bp partial cytochrome oxidase II (cox2) gene. Regardless of the polymerase used, the frequency of successful PCR, Cq values and PCR efficacies for developed protocols were superior to the S-kit. Comparison of assay combinations based on the ITS-2 PCR showed no significant difference in the Cq values and PCR efficacies. When comparing assay combinations based on a partial cox2 PCR, significant differences were observed with Phusion polymerase assays showing superiority. Moreover, the AmAcet - FIREPol® Taq assay showed a higher frequency of PCR reactions with a positive amplification than the S-kit and the CL approach. The CL and AmAcet DNA preparation methods coupled with Phusion PCR protocols were the most effective low-cost assays. The study identified low-cost PCR-based approaches to identify flea larvae from soil, and the same approach can presumably be adapted to be used for other arthropods from PCR-inhibitor-rich matrices.

Keywords: Tungiasis, *Tunga penetrans*, molecular entomology, DNA isolation, Phusion® polymerase, FIREpol® Taq polymerase, low-cost PCR

DAY 2

Parallel Scientific Session 6: LLINS, IRS and insecticide resistance management

ABS-325

Evaluation of the systemic insecticidal effects of ivermectin treated cattle on Aedes aegypti, vector of arboviruses

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The burden of Aedes-borne viral pathogens has increased over the past two decades. To control that, insecticide-based vector control tools remain the best way to decrease transmission, but they hampered by the spread of insecticide resistance in Aedes vectors. Thus, the development of complementary vector control tools is needed. Here, we evaluated the systemic insecticidal effects of ivermectin (Ivm) injected to calves on the survival and fertility of Aedes aegypti. A total of 7,005 females of Ae. aegypti from an insecticide susceptible strain “Bora-Bora” and the "Bobo" strain, a recent colony developed from wild larva captured in Bobo-Dioulasso, Burkina Faso was used. Mosquitoes were directly blood fed on cattle injected with Ivm at 1 and 0.8 mg/kg of body weight. Survival and reproductive parameters were compared between strains, the dose of Ivm and the delay after injection (DAI) at which blood feeding occurred. Our data show that all parameters but hatching rate were significantly decreased in Bora Bora fed on treated calves, with different magnitude in function of the Ivermectin dose and the DAI: survival decreased by at least 50% until 14-21 days post treatment, mean number of females that laid eggs decreased by 45-50%, while the number of eggs laid by the females that remained alive decreased by 65-85% until 21 DAI. For the Bobo strain, survival decreased by 15% until 7 DAI for the 1mg/kg dose only, and hatching rate was the only reproduction parameter significantly impacted, with 20 to 40% eggs that were laid that didn’t hatch. These differences in Ivm toxicity between Bora Bora and Bobo call for ivm differential susceptibility between strains. However, in both populations, the impacted parameters have all great importance in determining vectorial capacity. Hence, Ivermectin could contribute to significantly reduce *Ae. aegypti* populations densities if the toxic effect is sustained over time, notably through the use of Long Acting Ivm Formulations.

Keywords: *Aedes aegypti*; Ivermectin; Survival; Fertility; Arboviruses

ABS-332

Considerations for more accurate bio efficacy testing of insecticide treated nets (ITNs) and indoor residual spraying (IRS) for metabolic resistant mosquitoes

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Alternative insecticide classes for indoor residual spray (IRS) and insecticide treated nets (ITNs) include pro-insecticides like Chlorfenapyr, synergists like piperonyl butoxide (PBO) & neonicotinoids like clothianidin that require modified bioassays to accurately measure their efficacy while capturing their mode of action. Evaluations were conducted in the laboratory using cone test, tunnel test and Ifakara ambient chamber test with pyrethroid susceptible and pyrethroid resistant strains with metabolic resistance mechanisms. Aim: to demonstrate the effect of holding time, environmental conditions and mosquito daily heterogeneity on test outcomes. Experiment one: cone tests of pyrethroid PBO nets during the daytime and at night time. Experiment two: evaluation of chlorfenapyr and clothianidin IRS with different holding times and at different temperature. Experiment 3: ITN regeneration time and wash resistance testing all ITN preparations on a single day versus over multiple days. Evaluating pyrethroid ITNs and PBO ITNs during the day significantly increased the odds of mortality among metabolic resistant strains: deltamethrin 4.33 (1.56-12.01); deltamethrin-PBO 2.33 (1.23–4.41). Increasing holding time significantly increased IRS induced mortality by 30%. Low temperature (<27ºC) significantly reduced 72-hour mortality of chlorfenapyr ITNs by 20%. Preparing ITN samples in advance and evaluating them all in series significantly reduces daily heterogeneity to give confidence intervals <5% compared to >10% if experiments are done according to WHO guidance. Poor assay conduct can under-estimate the efficacy of non-pyrethroid vector control tools and increase uncertainty in results obtained. Longer holding times, conduct of assays at times when mosquitoes are actively foraging and conduct of series of ITN preparations on the same day are critical to more accurately estimate the performance on new modes of action insecticides.

Keywords: insecticide treated nets, indoor residual spray, bio efficacy, bioassay, ITN, IRS, anopheles, malaria, control

ABS- 376

Identifying optimal mass distribution campaign intervals to improve malaria control

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While insecticide-treated nets (ITNs) are distributed through numerous channels, mass distribution campaigns (MDCs) form a key pillar in the effort to ensure effective coverage across countries at risk of malaria. MDCs are typically conducted at three-year intervals, though there are notable uncertainties around ITN retention rates following an MDC. It is unclear whether shorter distribution intervals of two years would yield more cost-effective control across different national and sub-national scales. We inferred MDC timings at a monthly resolution by fitting local polynomial regression curves to time-series of campaign-sourced ITNs from Demographic and Health Surveys (DHS). Logistic regression models were then conducted to identify national and sub-national disparities in usage and access to ITNs following an MDC from DHS data. These analyses informed the parameterization of stochastic individual-based transmission dynamics models to generate projections of cases averted for different MDC distribution intervals. We initially applied our approach to Senegal due to the extensive number of DHS surveys conducted, before expanding it to other sub-Saharan national and sub-national settings. There are notable heterogeneities in ITN usage and access following MDCs across both national and sub-national scales. Models indicate that the number of cases averted for different administrative-one regions vary substantially under two- and three-year MDC distribution intervals for pyrethroid-only, pyrethroid-piperonyl butoxide and pyrethroid-pyrrole ITNs. In some locations increasing the frequency of MDCs could be substantially more cost-effective than other antimalarial interventions. Mass distribution campaigns are the cornerstone of malaria control in Africa though maintaining high coverage is essential. National Malaria Control Programmes and funders may wish to switch from three to two-year intervals campaigns in some locations.

Keywords: ITNs, LLINs, mass distribution campaigns, malaria control, vector control, cost-effectiveness

ABS-236

Assessment of efficacy of Pirimiphos-methyl on sprayed surfaces in The Gambia

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In The Gambia, the use of insecticides for indoor residual spraying has significantly reduced malaria cases. This efficacy, however, is jeopardized by several factors like application method, insecticide type, and spray surface nature. We investigated how different wall surfaces found in The Gambia affect insecticide efficacy in this study. Spraying efficacy is evaluated after a month. Different sprayed walls were randomly chosen from Gambisara village in Upper River Region. Trained Regional Vector Control officers and field biologists collected mosquito larvae from natural breeding sites. The larvae and pupae were separated. The anopheles pupae were reared into adults, Female anopheles mosquitos aged 2-5 days were exposed to sprayed walls for 30 minutes and the mortality rate was monitored after 24 hours. A total of 2,400 female anopheles mosquitoes were exposed to different levels on sprayed walls. Dead after 24 hours exposure was, 321 (89%) mud walls, 314 (87%) mud walls plastered, 311 (86%) mud walls plastered and painted, 310 (86%) cement

walls, 280 (78%) cement walls plastered 265 (74%) cement walls plastered and painted. Overall, 1801 dead mosquitoes were recorded with a mortality rate of 79%. In the controls, 120 mosquitoes were exposed, 20 for each wall type. At the end of the test, 10 dead mosquitoes were recorded in the controls representing 3% mortality rate. This survey indicated that insecticide efficacy last longer on mud walls compared to other types. However, since factors like mode of spraying, volume of water and sprayed surfaces affect insecticide efficacy on sprayed walls, make it difficult to conclude. Walls tested were sprayed by different people who may have different mode of application speed making it difficult to draw line on these findings.

Keywords: Efficacy, insecticide, mosquito, pupae, larvae.

ABS-420

The real entomological impact of IRS when considering implementation practices, human behavior and vector bionomics

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Indoor residual spraying (IRS) has been and remains an important malaria control intervention. IRS campaigns are commonly evaluated by quantifying their operational coverage and -less frequently- the product's residual efficacy, but these indicators do not provide a complete picture of the potential entomological effectiveness of an IRS campaign. We estimate the 'realized district-level IRS impact' by overlaying different data sets that have been collected in southern Mozambique over the past decade. Data include IRS coverage, IRS pace of spraying, residual efficacy of the IRS products on different wall types, human attitude and practices towards IRS, mosquito biting and resting behaviors, as well as mosquito vector competence. The weekly decay of this impact after an IRS campaign has been implemented is reported. Data is analyzed using R statistical software version 4.3.0. We will present the outcome of our analysis and propose novel IRS metric(s), which will allow us to better estimate the entomological impact of an IRS campaign and better compare the impact of IRS with different products, across different settings and between campaigns. Our aim is to discuss the relative importance and feasibility (in terms of data collection) of these new IRS metrics, and their importance for quantifying the impact of an IRS campaign, with PAMCA's attendees. This is work is currently in progress, and will be completed before the PAMCA annual conference.

Keywords: IRS, efficacy, impact, human behavior, mosquito behavior, implementation

ABS-631

The Rise of Mortality of Pyrethroid-Resistant *Anopheles gambiae sensu lato* from Chad Republic after synergist bioassays with piperonyl butoxide is suggesting evident support of deployment of PBO-Insecticide Treated Nets

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High pyrethroid resistance in the major malaria vector *Anopheles gambiae sensu lato* poses serious threat to malaria control using pyrethroid based treated-nets in Chad Republic, hindering effective management strategies. Here, resistance intensity and synergist bioassays were assessed in populations of *Anopheles gambiae sensu lato* mosquitoes from southern Chad. Field caught *Anopheles gambiae sensu lato* were collected at larval stages from sampling sites located in southern Chad and reared to adult to assess insecticides resistance profile. Resistance intensity assays were performed with 5X and 10X of the discriminating concentrations of pyrethroids. Synergist bioassays with PBO were performed. WHO bioassays revealed high resistance in *Anopheles gambiae sensu lato* to deltamethrin, permethrin and alpha-cypermethrin in all sites tested. Resistance intensity was reflected in moderate mortalities [(64.34% to 85.39% at 5X and 91.59% to 94.32% at 10X) and (89.16% to 85.39% at 5X and 91.59% to 94.32% at 10X)] at higher concentration of deltamethrin and permethrin, respectively. Intense resistance was also observed with alpha-cypermethrin either high and moderate mortalities (35.33% to 66.95% at 5X and 64.47% to 69.67% at 10X) at higher concentration of alpha-cypermethrin. High DDT resistance (9.33% to 43.18% mortality), moderate bendiocarb and malathion resistance at 94.20% and 89.98%, respectively were also observed in one site and full susceptible to carbamates and organophosphates were observed in one other site. Synergist bioassays with piperonyl butoxide recovered pyrethroid susceptibilities in all sites, implicating P450s. This finding of high pyrethroid and DDT resistance in *Anopheles gambiae s.l* from Chad highlight challenges associated with deployment of bed nets. The PBO-Insecticide Treated Nets and organophosphate-based IRS may be alternatives for malaria control in this region.

Keywords: *Anopheles gambiae s.l*, Malaria, Insecticide Resistance, PBO, Chad

ABS-460

Comparing the epidemiological impact of dual active ingredient nets in pilot implementation programmes and cluster randomised control trials

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Infectious disease control in low-income settings is severely under financed so it is vitally important that funds are spent on interventions that are efficacious. Cluster randomised control trials (RCTs) are the gold standard for assessing the efficacy of novel vector control tools against malaria. The efficacy of novel insecticide treated nets (ITNs) varies depending on the epidemiology and ecology of the local setting. It has been argued that RCTs are expensive to conduct, can delay the time between the development of a novel ITN and it's widespread implementation, and results are not always generalizable to other settings. A complementary approach is the use of pilot implementation programmes, where novel interventions are introduced at scale and monitored concurrently. These studies generate a different kind of evidence, and lower standardisation and lack of a randomisation of clusters to different interventions are key differences compared to randomized trials. The effect of these limitations on the interpretability or generalizability of results has not been formally explored. Previous work has demonstrated that parameterising entomological parameters, such as mosquito mortality and blood feeding, from experimental hut trials, within a mechanistic model of malaria transmission can reliably predict the epidemiological impact of an intervention in different RCTs. Here we extend this method to compare the ability of models and local entomological data to predict the changes in malaria prevalence observed during pilot studies for (1) pyrethroid-pyrrole, (2) pyrethroid-PBO and (3) pyrethroid-pyriproxyfen ITNs across a wide range of settings in Burkina Faso, Mozambique, Nigeria and Rwanda. The accuracy of model projections from RCTs and pilots are compared. The benefits of a small number of high-quality datasets compared to lower quality information from a wider number of sites is discussed.

Keywords: malaria transmission model, predictive accuracy, experimental hut trial

ABS-245

Determination of the Residual Efficacy of Broflanilide (VECTRONTM T500) Insecticide for Indoor Residual Spraying

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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. The rate of decay of the biological efficacy of insecticides used for indoor residual spraying is an important factor when making decisions on insecticide choice and use for national programs. Previous tests of propoxur, bendiocarb and pirimiphos-methyl have indicated that residual activity is strongly affected by the wall surface. In particular, bendiocarb showed poor residual life on dung and mud walls, the most commonly used in areas where IRS is conducted. A key part of an IRS program is insecticide resistance monitoring. If resistance is detected to most of existing insecticide classes for IRS (DDT, organophosphates and carbamates), the logical next choice could be broflanilide, as pyrethroids are used on nets. VECTRONTM T500 (active ingredient broflanilide) had positive results in some phase II experimental hut trials however, little is known on its persistence in different setting. This study was conducted to confirm the efficacy of VECTRONTM T500 against *Anopheles arabiensis* by spraying the insecticide formulation on different wall surfaces (mud, dung, paint & cement) & determine its decay rates over time in Ethiopia. The results of this trial revealed that the residual efficacy of VECTRONTM T500 extends up to nine months in all treated wall surface types. ECTRONTM T500 is ideal to be considered as a potential candidate insecticide formulation in malaria endemic countries such as Ethiopia.

Keyword: VECTRONTM T500, *Anopheles arabiensis* , IRS, Ethiopia

ABS-647

Phenotypic insecticide resistance status and molecular detection of resistance mutations in Anopheles gambiae sensu lato in The Gambia.

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The use of long-lasting insecticide treated bed nets (LLINs) and Indoor Residual Spraying (IRS) in high burden areas has played a major role in the reduction of malaria cases and deaths in The Gambia. Widespread resistance of *Anopheles gambiae sensu lato* to pyrethroids, scale-back of IRS, high costs and suboptimal compliance to vector control interventions threaten these gains and has led to the adoption of the WHO insecticide rotation plan by the NMCP. This study aimed to describe phenotypic and molecular resistance of *An. gambiae s.l.* to pyrethroids to guide the National Malaria Control Program's (NMCP) selection of insecticide for IRS in The Gambia. From July-October 2021, *An. gambiae s.l*. larvae were collected from 7 sentinel sites and reared to adults. Using WHO tube bioassay, a total of 3,237 *An. gambiae s.l.* were exposed to Deltamethrin 0.05%, Deltamethrin 0.25% and Pirimiphos-methyl 0.25%. 195 mosquitoes were genotyped at 7 loci for 11 SNP mutations associated with insecticide resistance. Resistance to Deltamethrin 0.05% was confirmed in all sites, with mortality ranging from 30% in Bakau to 73% in Janjanbureh. Moderate to high resistance to Deltamethrin 0.25% was observed in 6 sites (81%-97% mortality) and low resistance in one site (Janjanbureh; 99% mortality). An. *gambiae s.l.* in The Gambia are susceptible to

Pirimiphos-methyl 0.25%, resistant to Deltamethrin 0.25%, and moderate to high resistance to Deltamethrin 0.05%. One to 6 SNPs per mosquito were identified with over 80% with 1-3 SNPs. The lowest and highest frequencies were observed for Cyp6jS and Coeae1d, respectively. Since no resistance was confirmed for Pirimiphos-methyl 0.25%, the NMCP can continue using this insecticide for IRS in The Gambia, while adhering to the insecticide rotation plan to delay expansion of resistance.

Parallel Scientific Session 7: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health

ABS-176

A digital question-based entomological surveillance planning tool increases knowledge acquisition and self-efficacy in users

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Stalled progress in malaria control across Africa underscores the need to focus on gaps in protection so that programs can tailor vector control to local drivers of transmission. A paper-based Entomological Surveillance Planning Tool (ESPT) was developed in 2018 to distil normative guidance into an operational decision-support tool to enable cost effective, locally tailored, and evidence-based vector control. Currently, an electronic version of the ESPT (known as eSPT) is being developed to improve access, uptake and use of the paper-based ESPT. To inform its further development, the eSPT's contribution towards question-based entomological surveillance planning was evaluated through exploring knowledge acquisition and retention, and technology acceptability. Evaluation workshops were conducted with target users in Ethiopia and Malawi, with further evaluations currently underway in Mozambique. These users included entomologists and decision-makers from government, and partner institutions in vector-borne disease control. A mixed-methods, uncontrolled, before and after study investigated the impact of the eSPT on knowledge, attitudes, and work practices related to entomological surveillance planning. The evaluation workshops in Ethiopia and Malawi showed that the eSPT significantly increased participants' entomological knowledge acquisition ($p = 0.044$), and self-efficacy to develop entomological surveillance plans ($p = 0.001$). These results reveal that the eSPT improves users' entomological knowledge acquisition and self-efficacy to develop entomological surveillance plans.

Keywords: Malaria, Entomological surveillance

ABS-545

Effect of parasite density on the extrinsic incubation period (EIP) of Plasmodium falciparum for *Anopheles gambiae*

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In the fight against malaria, transmission blocking interventions (TBIs) such as transmission blocking vaccines or drugs, are promising approaches to complement conventional tools. They aim to prevent the infection of vectors and thereby reduce the subsequent exposure of a human population to infectious mosquitoes. The effectiveness of these approaches has been shown to depend on the initial intensity of infection in mosquitoes, often measured as the mean number of oocysts resulting from an infectious blood meal prior to intervention. In mosquitoes exposed to a high intensity of infection, current TBI candidates are expected to be ineffective at completely blocking infection but will decrease parasite load and therefore, potentially also affect key parameters of vector transmission. The present study investigated the consequences of changes in oocyst intensity on subsequent parasite development and mosquito survival. To address this, we experimentally produced different intensities of infection for *Anopheles gambiae* females from Burkina Faso by diluting gametocytes from three natural *Plasmodium falciparum* local isolates and used a newly developed non-destructive method based on the exploitation of mosquito sugar feeding to track parasite and mosquito life history traits throughout sporogonic development. Our results indicate the extrinsic incubation period (EIP) of *P. falciparum* and mosquito survival did not vary with parasite density but differed significantly between parasite isolates with median EIP of 16, 14 and 12 days and median longevity of 25, 15 and 18 days for the three isolates respectively. Our results here do not identify unintended consequences of the decrease of parasite loads in mosquitoes on the parasite incubation period or on mosquito survival, two key parameters of vectorial capacity, and hence support the use of transmission blocking strategies to control malaria.

Keywords: *Plasmodium falciparum*, malaria, transmission blocking interventions, extrinsic incubation period, mosquito survival

ABS-183

Implementation Of a New Vector Surveillance System To Anticipate The Impact Assessment Of The Novel Genetic Technologies In Burkina Faso

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New approaches based on the release of sterile male mosquitoes to control natural populations are proposed as the most promising strategies for malaria control. To effectively assess the impact of these interventions, vector surveillance systems that address practical issues of malaria control must be established. However, in most sub-Saharan African countries vector surveillance is generally not, or under-funded and limited resources are allocated to support the development and enhancement of adequate capacities for effective entomological surveillance within national malaria control programmes (NMCPs). Thus, vector surveillance systems remain weak, fragmented between research institutes, universities, and the national programmes, and lack appropriate coordination, although such systems are urgently needed. In Burkina Faso, we have brought together all relevant stakeholders from the Ministry of Health, the NMCP, research centres, universities to develop a better approach to establishing sustainable system with increased local participation and integration of vector control implementation, surveillance, and operational research for malaria elimination. Here we present the impact of the training in malaria vector surveillance and monitoring of vector control interventions to anticipate the envisaged use of gene drive technology to supress vector populations in Burkina Faso setting. Newly trained entomologists, including 70 health promotion officers deployed in the peripheral health districts, 13 others in the intermediate level of the health regions and 9 in the central level of decision making in the NMCP, were assessed on practical techniques and methods for collecting adult mosquitoes and larvae in the field. The results show that our approach is quick, inexpensive and accurate, with a high mosquito and larval sampling performance, which makes it a promising system for very large-scale vector surveillance to assess the impact of implementations for vector control.

Keywords: Assessment of impact ; Health district entomologist ; Vector surveillance

ABS-184

Development, piloting, and evaluation of an Entomological Adaptive Sampling Framework (EASF) in Mozambique and Ghana

Mercy Opiyo (UCSF MEI/CISM)*

Routine entomological surveillance is important for monitoring and evaluating vector control interventions, however there is no operational guidance for optimizing entomological sampling in programmatic settings. An adaptive sampling framework responds to existing data and can adjust the sampling strategy to maximize representativeness and accuracy of the data across time and space. Applied as part of a malaria control program, this may be able to better capture changes in disease transmission dynamics to produce better data

that can guide programmatic and strategic decisions. A spatiotemporal EASF model was developed for Mozambique and Ghana and used to inform adaptive entomological sampling designs across space and time for detecting changes in the three priority indicators: 1) vector species compositions, 2) vector behaviour, and 3) insecticide resistance (IR). The optimal sampling approach suggested by the spatiotemporal model is running in parallel with each country's routine surveillance framework. The EASF will be compared with routine surveillance in terms of the primary outcomes of representativeness, cost-effectiveness, and acceptability. In Mozambique the EASF will run for 2 years while Ghana 1 year. We will present the year one preliminary results from Mozambique and Ghana pilots. The EASF may help programs establish a cost-effective adaptive entomological surveillance strategy that is responsive to changing transmission dynamics and optimizes the use of available resources by obtaining more robust and informative data.

Keywords: adaptive surveillance, vector control, National Malaria Control Programmes

ABS-204

Influence of landscape heterogeneity on entomological and parasitological indices of malaria in Kisumu, Western

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Identification and characterization of larval habitats, documentation of Anopheles spp. composition and abundance, and *Plasmodium spp*. infection burden, are critical components of integrated vector management. The present study aimed to investigate the effect of landscape heterogeneity on entomological and parasitological indices of malaria in western Kenya. A cross-sectional entomological and parasitological survey was conducted along an altitudinal transect in three eco-epidemiological zones during the wet and dry seasons in 2020 in Kisumu County, Kenya. Larval habitats for Anopheles mosquitoes were identified and characterized. Adult mosquitoes were sampled using Pyrethrum Spray Catches (PSC). Finger prick blood samples were taken from residents and examined for malaria parasites by real time-PCR (RT-PCR). Increased risk of Plasmodium falciparum infection was associated with residency in the lakeshore zone, school-going age children, rainy season, and no ITNs ($p<0.0001$. Similarly, lakeshore zone and the rainy season significantly increased Anopheles spp. abundance ($p< 0.0001$). *An. funestus* (41.8%) and *An. arabiensis* (29.1%) were the most abundant vectors in all zones. Sporozoite prevalence was 5.6% and 3.2% in the two species respectively. The lakeshore zone had the highest sporozoite prevalence (4.4%, 7/160) and inoculation rates (135.2 infective bites/person/year). High larval densities were significantly associated with lakeshore zone and hillside zones animal hoof prints and tire truck larval habitats, wetland and pasture land, and the wet season. The empirical evidence on the impact of landscape heterogeneity and seasonality on vector densities, parasite transmission, and Plasmodium infections in humans emphasizes the importance of tailoring specific adaptive environmental management interventions to specific landscape attributes to have a significant impact on transmission reduction.

Keywords: *Anopheles* density, *Plasmodium* infection prevalence, landscape, risk factors

ABS-234

Evaluation of the trophic behaviour of *Aedes aegypti* in the city of cotonou in southern Benin

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The city of Cotonou, like the major cities of Africa, has undergone profound changes in terms of both demographics and infrastructure, marked by rapid urbanisation. This galloping urbanisation and high rainfall have favoured the emergence of several vector-borne diseases in several cities in Benin. These different factors expose Cotonou to major urban epidemics such as dengue fever transmitted by *Aedes aegypti*. Consequently, the fight against this mosquito is essential. It is within this framework that the present study was initiated in order to obtain data related to the evaluation of the trophic behaviour coupled with the aggressive density and the type of blood meal of *Aedes aegypti.* In the city of Cotonou, southern Benin, a cross-sectional study was conducted in urban and periurban neighborhoods from April 2018 to August 2019 to collect Ae. Aegypti populations. 3,892 Aedes caught by different methods showed that Ae. Aegypti and Ae. circumluteolus are more abundant in urban than peri-urban areas ($p<0.05$). The aggressive density of Ae. aegypti populations was significantly higher in urban areas (157.43 bites per man per hour) than in peri-urban areas (32.43 bites per man per hour) ($p<0.05$). Also, out of 250 females' blood-fed *Ae. Aegypti* tested by ELISA (Enzyme Linked Immunosorbent Assay) technique for blood meal identification, 86.80% took their blood meal on humans compared to 4.4% which took their blood meal on sheeps. These findings showed that the city of Cotonou in southern Benin, offered good condition for the development of *Ae. aegypti* population. The anthropology and endophagy behavior of this mosquito observed through the results of this study is a very favorable clue to vector control strategies based on the use of long-lasting impregnated mosquito nets and insecticide residual sprays adopted in Benin.

Keywords: *Aedes aegypti*, behaviour, catch; Cotonou, Benin

ABS-335

Understanding the role of understudied female Anophelines in a low trasmission setting, Southern Zambia.

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Matoba (Macha Research Trust); Philip E. Thuma (Macha Research Trust); Jennifer Stevenson (Macha Research Trust); Edgar Simulundu (Macha Research Trust); Monicah M. Mburu (Macha Research Trust); Mary E. Gebhard (Department of Molecular Microbiology and Immunology, Johns Hopkins Malaria Research Institute, Johns Hopkins Bloomberg School of Public Health); Douglas E. Norris (Department of Molecular Microbiology and Immunology, Johns Hopkins Malaria Research Institute, Johns Hopkins Bloomberg School of Public Health)

Despite rapid reductions in malaria in Macha, prevalence by RDT has remained near 2% for almost a decade. Current control tools such as insecticide treated nets or indoor residual sprays that target mosquitoes indoors, seem ineffective in eliminating the last of the malaria in the region.The purpose of this study was to understand how understudied female anophelines may contribute to residual malaria transmission in Macha area. Twenty-six clusters of 12 households were surveyed along a transect from Mutama river to Kariba Dam in Southern Province Zambia from May 2018 to September 2018. The household clusters were located 5 kilometers apart. CDC light traps were set both indoors near humans sleeping under bednets and outdoors near animal enclosure to collect adult mosquitoes. Of the 5,690 female Anopheles mosquitoes collected, outdoor collections accounted for 94% with *An. rufipes* and *An. pretoriensis* being the dominant species and 6% were from indoor collections with An. arabiensis dominating. One sample confirmed as *An. rufipes* was positive for *P. falciparum* sporozoites. 401 samples were run on blood meal PCR,where 13% (n=55) were found with human blood, 2% (n=8) had both human and animal blood while 56% (n =225) had animal blood only. 29% (n=113) had no fragment. *Anopheles rufipes* an understudied female anopheline was found with *P. falciparum* sporozoites. 59 understudied anophelines were found with human blood. This provide evidence that understudied female anopheline may be contributing to malaria transmission during dry season in the study region. The finding supports previous work where at least 3 Anopheles species in Macha area have been reported positive for *P. falciparum*: *An. pretoriensis*, *An. Squamosus* and *An. coustani*. The findings underscore the necessity for further evaluation of understudied anophelines, their behaviour and control tools that might be effective to both the primary and these understudied vectors.

Keywords: Prevalence, Understudied, Anopheline, Residual malaria transmission

ABS-258

The effect of temperature on aging rates in *Anopheles gambiae s.l.*: Improving model generalization for infrared spectroscopy-based surveillance

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The age of vector populations is the most important factor that determines disease transmission. However, there is a lack of effective methods to measure age structure in mosquitoes. Infrared spectroscopy (IRS) with machine learning (ML) models has shown promising results as all-in-one solution to determining age and species in malaria vectors. Nevertheless, models trained on lab-reared samples do not generalize well enough to be used on field samples. This might be caused by the different temperatures to which lab and field mosquitoes are exposed, affecting their aging rates. Therefore, we aim to characterize how temperature affects aging rates in mosquitoes and how these changes are reflected in spectra to produce models that can predict the biological age of mosquitoes regardless of the setting where they live. Methods: The effect that temperature has on biological age was tested using two different temperatures: 24 and 27 degrees, with two different ranges: 3 and 6 degrees, using environmental chambers. Temperature and light fluctuations were set to match fluctuations seen on the field. *Anopheles coluzzii* and *Anopheles gambiae* were reared from larvae into adults for 31 days. Mid-infrared and near-infrared spectra of mosquitoes at different time points were obtained and survival analyzed to determine biological age. Results: Here we will present the survival analysis under different temperatures and the relationship between biological age, chronological age, and temperature using generalized linear models (GLM). Additionally, we will show the accuracy of the ML models trained on IRS data to predict biological age. Combining GLM and ML, we will predict chronological age based on IRS spectra and temperatures. Conclusions: These results will be a step forward in the development of IRS-ML models that can be deployed and implemented in routine vector surveillance without current limitations.
Keywords: malaria, infrared spectroscopy, age, surveillance

ABS-259

Residual bio-efficacy of attractive targeted sugar bait stations targeting malaria vectors during seasonal deployment in western province, Zambia.

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The primary vector control interventions in Zambia are long-lasting insecticide-treated nets and indoor residual spraying. Challenges with these interventions include insecticide resistance and the outdoor biting and resting behaviors of many *Anopheles* mosquitoes. Therefore, new vector control tools targeting additional mosquito behaviors are needed to interrupt transmission. Attractive Targeted Sugar Bait (ATSB) stations, which exploit sugar feeding behaviors of mosquitoes may help in this role. This study was conducted to evaluate residual laboratory bio-efficacy of Westham prototype ATSBs deployed in communities throughout a 8-month deployment in Western Province, Zambia during first year of a large cluster randomized phase-III trial (Clinical Trials.gov Identifier: NCT04800055).

One undamaged bait station that had been installed on outside walls of households was collected on a monthly (one per cluster per month) basis from each of twelve selected intervention clusters among the 35 trial interventions clusters. Bioassays utilized mosquitoes from a laboratory reared colony of *An. gambiae*s.s.s, male and female mosquitoes, from November 2021 to June 2022. The study utilized 71 field deployed ATSB stations plus 12 new ATSB stations for comparability purposes. Field deployed ATSB stations had significant lower bio-efficacy than ATSBs which had never been deployed in the field, but the field-deployed stations retained high levels of bio-efficacy mortality of over 80% after more than six months in the field. Duration of deployment was not associated with lower bio-efficacy. There was relatively little variation in mortality between month rounds for ATSBs which had been deployed to the field. Westham prototype ATSB stations can still retain bio-efficacy even after deployment in the field for 8 months, provided they do not meet predetermined criteria for replacement.

Keywords: Attractive Targeted Sugar Bait (ATSB) Stations, Prototype, Residual Bio-efficacy, Sugar feeding behaviour

ABS-214

Prevalence of pfdhfr and pfdhps mutations in Plasmodium falciparum associated with drug resistance among pregnant women receiving IPTp-SP at Msambweni County Referral Hospital, Kwale County, Kenya

Kevin Thiongo (KEMRI)*; Stella Gikunju (KEMRI); Eric Lelo (KEMRI)

Prevention and treatment of malaria during pregnancy is crucial in dealing with maternal mortality and adverse fetal outcomes. The World Health Organization recommendation to treat all pregnant women with sulfadox- ine-pyrimethamine (SP) through antenatal care structures was implemented in Kenya in the year 1998, but concerns about its effectiveness in preventing malaria in pregnancy has arisen due to the spread of SP resistant parasites. This study aimed to determine the prevalence of SP resistance markers in Plasmodium

falciparum parasites isolated from pregnant women seeking antenatal care at Msambweni County Referral Hospital, located in coastal Kenya, between the year 2013 and 2015. This hospital-based study included 106 malaria positive whole blood samples for analysis of SP resistance markers within the Pfdhfr gene (codons 51, 59 and 108) and Pfdhps gene (codons 437 and 540). Archived red blood cells were processed for molecular characterization of SP resistance markers within the Pfdhfr and Pfdhps genes using real time PCR platform and Sanger sequencing. All samples had at least one mutation in the genes associated with drug resistance; polymorphism prevalence of Pfdhfr51I, 59R and 108N was at 88.7%, 78.3% and 93.4%, respectively, while Pfdhps polymorphism accounted for 94.3% and 91.5% at 437G and 540E, respectively. Quintuple mutations (at all the five codons) conferring total SP resistance had the highest prevalence of 85.8%. Quadruple mutations were observed at a frequency of 10.4%, and 24.5% had a mixed outcome of both wildtype and mutant genotypes in the genes of interest. The data suggest a high prevalence of P. falciparum genetic variations conferring resistance to SP among pregnant women, which may explain reduced efficacy of IPTp treatment in Kenya. There is need for extensive SP resistance profiling in Kenya to inform IPTp drug choices for successful malaria prevention during pregnancy.

Keywords: IPTp, malaria, resistance, mutant, wildtype

Parallel Scientific Session 8: Precision public health and innovations for VBD elimination: artificial intelligence, entomological databases, genomic surveillance, new and re-emerging disease vectors, climate change, One health

ABS-32

Identification of yellow-g in *Anopheles gambiae* and design of molecular strategy to study its function, in view to genetically control malaria vectors

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Genetic control of mosquito vectors could be a promising approach to enhance existing malaria vector control methods. Finding new gene which can be target in genetic control could enhance effectiveness of this strategy. This study aimed to design a model for studying function of the gene yellow-g in *An. gambiae*, in view to evaluate its suitability as a target in gene drive approach. This gene is involved in *D. melanogaster* eggshell formation. We used online tools such as BLAST, CD-Search coupled with gene expression databases such as FlyAtlas2 and MozAtlas to search for yellow-g orthologue in *An. gambiae*. We designed experimental approaches for gene knockdown (by RNAi) using E-RNAi v3.2 and knockout (by CRISPR-mediated genome editing) using CHOPCHOP v3 for design of CRISPR guide RNA. We

then designed a template plasmid for homologous recombination using the Benchling. We found the orthologue of the yellow-g gene in *An. gambiae* is AGAP005958. The corresponding protein sequences similarity is 48% with D. melanogaster yellow-g protein. For knockdown, the results showed that the effective RNAi sequence targets gene exon1 on Chr2L: 24051080..24051235 with an e-value = 2e-84. The guide RNA designed for the knockout targets exon 3 position 2L:24050465 (e-value = 3e-6). Homology arms of 1Kbp on either side of the CRISPR-Cas9 target site were cloned into a recombination plasmid around the eGFP. These designs will allow to refined study in vivo for determining the real function of AGAP005958 in *An. gambiae*, and assess its suitability as a target in a genetic control approach. In addition this study will allow us to better understand the process of egg development in the mosquito, which could be useful in other approaches.

Keywords: gene drive, yellow-g, orthology, knockdown, knockout.

ABS-33

In silico analysis and design of a molecular construct to target the beta tubulin2 gene in *Anopheles gambiae*

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The increasing expansion of vector resistance to insecticides requires finding alternative control methods to achieve malaria elimination. Genetic control is one of the promising approaches to control malaria vectors. In the context of genetic control of malaria vectors, genes involved in reproduction are of crucial importance to replace or suppress a vector population. The search for male-specific transcripts and proteins could lead to a better understanding of testicular specificity signals, whether at the promoter level, at splicing, or during translation. The regulatory sequences of these genes can also be used in genetic control strategies to engineer gene drive systems to disseminate desired traits including pathogen resistance or sex distortion. Beta tubulin2, is one of the genes involved in gamete formation which could be further exploited to optimize the efficiency of genetic control methods under development. Here, we developed in silico, a molecular construct to target beta tubulin2 gene in *Anopheles gambiae* to interfere with mosquito fertility, basing on Drosophila beta tubulin2 gene which has three putative orthologs in *Anopheles gambiae* (AGAP010929, AGAP008622 and AGAP008623). Specifically, this is to identify the ortholog of the beta tubulin2 gene in Anopheles gambiae, and to design knockdown and knockout strategies of the beta tubulin2 gene with RNA interference and CRISPR Cas9 technology respectively. A double-stranded RNA of 154 nucleotides was generated for the knockdown and a guide RNA was designed to knockout AGAP008622 gene via the CRISPR/Cas9 strategy. All these designs will be introduced into the mosquito for an in vivo experimental study to characterize the beta tubulin2 gene function in *Anopheles gambiae* towards the development of genetic control methods against malaria vectors.

Key-words: in silico analysis, Anopheles gambiae, beta tubuline2, genetic control, malaria

ABS-34

Identification of odorant co-receptor gene in *Anopheles gambiae* and in silico design of strategies to study its function in a vector control perspective

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The most effective strategies to control malaria aimed to prevent the mosquito from biting. The African malaria mosquito shows an incredible preference for humans over other sources of blood, a behaviour that is driven by olfaction and could be exploited for vector control. The odorant receptor co-receptor (ORCO) gene is an essential component in the insect olfactory system and may help drive human-specific odour preferences. To investigate the role of ORCO in host seeking behaviour, we carried out an in silico study with the objective to design strategies to study the function of gene coding for the olfactory co-receptor involved in *Anopheles gambiae* reception of smell. FlayBase database was used to identify the ortholog of orco gene in *Anopheles gambiae*. NCBI/BLAST, NCBI/CD-Search and FlayAtlas/MozAtlas databases were used respectively for sequences alignment, conserved domain search and genes expression profile search in order to confirm the orthology. To study the function of the gene, E-RNAi database was used to design an RNA interfering system and CHOPCHOP and Benchling databases were used to design a CRISPR/Cas9 strategy. Our study finds strong evidence to suggest that the ortholog of orco in Anopheles gambiae is Agam/or7, also known as AGAP002560. We designed two experimental approaches to further investigate the function of AGAP002560 based on RNAi knockdown or CRISPR/Cas9 knock-out using custom double string RNA or guide RNAs, respectively. To facilitate the experimental investigation of AGAP002560 knockout, we designed a donor plasmid for homology-directed repair to allow integration of a GFP expression cassette into the AGAP002560 gene. These results constitute an important step for in situ study of the function of Agam\or7 gene and may yield new approaches for mosquito population control.

Keywords: in silico, *An. gambiae* s.s, olfaction, ortholog

ABS-113

Prevalence of Microsporidia MB, a symbiotic microbiome of *Anopheles gambiae* sl. in rice production areas in Benin

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Microsporidia MB, is an endosymbiont shown to completely impair the transmission of Plasmodium without affecting mosquito survival and therefore constitute a promising tool for malaria control. However, little is known about its ecology, conditions of development, mode of action and transmission. This study screened the presence and prevalence of Microsporidia MB in rice fields in Benin in dry and rainy season. Mosquito larvae and adults were collected in rice fields and houses around rice fields in 4 locations (2 in southern and 2 in the Center Benin). Collections were performed during dry and rainy season. Adults and larvae were molecularly identified at species level and screened for the presence of Microsporidia MB using PCR as described by Scott et al. (1993); Santolamazza et al. (2008) and Herren et al. (2020) respectively. Species identification revealed that *An. coluzzii* was the main specie in the southern Benin while *An. gambiae* ss was predominant in the Center of Benin. Microsporidia MB prevalence rate of 3.09% (n=1554) was recorded in adult field-collected mosquito followed by larvae samples with 2.93% (n=682) and adults emerged from field-collected larvae with 1.11% (n=1167). High prevalence of Microsporidia MB was observed in dry season with 4.69% (n=1410) while in rainy season, a very low infection rate of 0.65 (n=1993) was recorded. The difference in the infection rate observed between the two seasons could be explained by the disruption of the ecological niches of Microsporidia MB, especially in the rainy season. This study revealed the presence of Microsporidia MB in Benin with high prevalence in dry season. However, variations in Microsporidia MB prevalence observed in this study could be due to the differences in the feeding histories of mosquito at their different stage of development.

Keywords: Microsporidia MB, Anopheles gambiae sl., rice field, dry/rainy season, Benin

ABS-243

Microsporidia MB: Evaluating the impact of symbiont-based malaria vector control via EMOD, an agent-based model of vector genetics and malaria transmission

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Vector control has been a key component in the fight against malaria for decades, and chemical insecticides are critical to the success of vector control programs worldwide. However, increasing resistance to insecticides threatens to undermine these efforts. The use of vector biocontrol such as microsporidia MB offers a new modality for malaria control that is not reliant on insecticides. Microsporidia MB are microbes that are non-virulent, vertically and horizontally transmitted, and can impair Plasmodium transmission. Here, we present a multi-locus, agent-based model of vector genetics that accounts for mutations and a many-to-many mapping cardinality of genotypes to phenotypes to investigate spread of microsporidia MB within a vector population. This model is embedded within a large-scale individual-based model of malaria transmission that has been calibrated to population-level measures of malaria transmission as well as clinical malaria incidence in a variety of transmission settings. We investigate the drivers of microsporidia prevalence in vector populations including seasonality, horizontal and vertical transmission, and fitness costs. We then explore the target product profiles for microsporidia MB when they are deployed by themselves or in concert with existing vector control tools such as ITNs in a range of seasonality and transmission archetypes. We show that microsporidia MB can be a valuable tool in the fight against malaria transmission, and can greatly reduce burden in sub-Saharan Africa even with limited deployment.

Keywords: Microsporidia MB, mathematical modeling

ABS-282

Anopheles gambiae population replacement for malaria elimination in Africa using gene drive

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Gene drives hold promise for the genetic control of malaria vectors. The development of vector population replacement or modification strategies depends on the availability of effector mechanisms impeding parasite development in transgenic mosquitoes. Transmission Zero is a global malaria research programme that strives to develop and test suitable effector and gene drive systems, which could assist the efforts for malaria elimination in Africa. We augmented a midgut gene in the malaria mosquito *Anopheles gambiae* by introducing small genetic modifications to produce antimicrobial peptides with known antimalarial activities. We also generated helper stains that allowed us, following crosses, to further edit the effector transgenes, including one that expresses both the Cre recombinase and Cas9 endonuclease, that can excise specific fragments of the DNA in a precise manner and create precise genomic DNA cuts and edits, respectively. Finally, we established state-of-the-art facilities for mosquito transgenesis and infection in Tanzania, which would allow us to transfer and test these technologies in Africa. A transgenic effector strain called MMCP is shown to be capable of efficient nonautonomous gene drive and interfering with malaria transmission. MMCP delays *Plasmodium falciparum* oocyst development and the release of infectious sporozoites, while it simultaneously reduces the mosquito life span. Modelling the spread of this modification using a large-scale agent-based model of malaria epidemiology reveals that it can break the cycle of disease transmission across a range of

transmission intensities. We have successfully generated the first two transgenic mosquito strain ever to be made in Africa. Efforts to generate these lines in Africa and test them for interfering with the transmission of parasites circulating among people will be presented.

Keywords: Gene-drive, population replacement, transmission blocking, generation of transgenic mosquito, Africa

ABS-637

Accelerating malaria prevention through model-informed product selection and design: insights from vaccines, monoclonal antibodies, and chemoprevention drugs

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Malaria remains a critical global health challenge, with a looming threat of both drug and insecticide resistance. We urgently need new interventions to bring malaria burden back on track and, yet, product development remains slow and costly. Our integrated disease-modelling framework is addressing this challenge to accelerate the development of new malaria therapeutics: malaria vaccines, monoclonal antibodies, and chemoprevention drugs. For these interventions, the interplay between a product's mechanism-of-action, pharmacokinetic/pharmacodynamic properties, and deployment will strongly influence impact on individual- and population-level outcomes. To best use R&D, we must understand the influence of these product characteristics early in clinical development. We are using individual-based models that incorporate detailed vector, human and intervention dynamics, spanning large parameter spaces, to link product characteristics to public health impact, enabling funders, regulators, and product developers to focus resources on the candidates most likely to have a marked impact on malaria prevention. We consider varied malaria endemicities and transmission seasons. We present applications of this individual-based modelling framework to small molecule chemoprevention drugs, next-generation vaccines, and monoclonal antibodies. For small molecule drugs, results show that selecting candidates based on their duration of protection and ease of administration, rather than on treatment efficacy, can maximize malaria burden reduction in children. For vaccines, we identified a potential for improved first-generation products to provide protection cross multiple malaria seasons. For all three malaria prevention tools, our work underscores the importance of understanding of the standard-of-care and generating early clinical evidence on product mechanism of action, pharmacokinetics, and pharmacodynamics for accurate predictions of impact.

Keywords: Malaria, modelling, next-generation, product profiles, development

ABS-425

Mapping the current and potential future distribution of *Anopheles stephensi* in Africa

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Detection of the urban malaria vector *Anopheles stephensi* in the Horn of Africa and recently in West Africa suggest a significant threat to malaria control across the continent. Despite recent surveillance efforts, there remains uncertainty about the species' current distribution in Africa and where it may establish. There remains the possibility that the species may already be well-established in the continent, and that many recent detections are the result of increased surveillance effort, rather than recent importation. To understand and mitigate the threat posed by the species we need to understand where the species is currently established and where it might establish in the future. We developed a spatial model that simultaneously accounts for the species' environmental requirements, rates of spatial spread (e.g. via trade and traffic networks), and variability between countries and over time in the probability that the species would have been detected. We used this model to map both the likely current distribution and potential future distribution across Africa. This incorporates the most recent occurrence data, estimates of microclimatic conditions relevant to the species (e.g. temperature and humidity inside water tanks) and structural differences between urban and rural areas (e.g. distinguishing planned and informal settlements). Though the species has yet to be detected in Central Africa, our analysis suggests microclimatic conditions in this region would be suitable for persistence. The probability of detecting *An. stephensi* is estimated to be very low across most of the continent. We identify places where targeted surveillance would be most beneficial to understanding the species' current distribution in Africa. We discuss how these maps can be routinely updated as information grows on An. stephensi distributions and surveillance effort and disseminated to mosquito control experts through the Vector Atlas.

Keywords: stephensi modelling distribution climate surveillance

ABS-536

MINT, an online tool to support decisions on vector control against malaria

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There is no one-size-fits-all policy for malaria control and the best set of interventions to use in a region will depend on local epidemiology, entomology, budgets, and goals. Insecticide treated nets (ITNs) remain at the forefront of disease control, and there is an increasing choice of products that vary substantially in price. Here we introduce https://mint.dide.ic.ac.uk/Here we introduce https://mint.dide.ic.ac.uk/ and outline how it can be used to support decisions on optimal ITN allocation within and between regions. A repository of over 2.5 million simulations from a validated transmission dynamics model of *falciparum* malaria in Africa is used to explore how malaria cases vary depending on the deployment of pyrethroid-only, pyrethroid-piperonyl butoxide, and pyrethroid-pyrrole ITNs, as well as indoor residual spraying. User-defined costs are included to allow the most cost-effective intervention to be identified. New functionality allows the efficient allocation of resources across diverse settings to be explored. At a price of $2.75 per ITN, novel pyrethroid-pyrrole ITNs appear to be the most cost-effective vector control tool across a range of settings in Africa. For example, switching from pyrethroid-only to pyrethroid-pyrrole ITNs in an area with moderate to high pyrethroid resistance could theoretically reduce cases by between 10 to 35% depending on the local epidemiology and history of vector control. Frameworks like this can be combined with local data to support decision-makers in choosing the most appropriate mix of vector control tools for a region and push for increased investment in malaria control.

Keywords: Malaria, vector control, modelling, online tool

ABS-58

Development of endectocide pipeline for screening novel compounds

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Malaria elimination might be an ambitious goal, but it has resulted in the stimulation of research avenues to expand existing control tools. One of these avenues includes the development of new anti-malarial target candidates and product profiles. The identification of target candidate profiles (TCPs) is characterised by their ability to kill the parasite at different stages of its lifecycle. Although most of these have anti-plasmodial activity, the TCP-6 profile drugs have endectocidal properties impacting the vector survival or its reproductive fitness. Ivermectin is currently being used as one of the TCP-6 candidates, however, the identification of additional candidates is needed. This study aimed to develop an endectocidal screening cascade which was evaluated by using the Medicines for Malaria Venture (MMV) Pandemic Response Box (PRB). A screening cascade was developed by implementing pre-identified criteria for each step of the assay. The gold-standard endectocide, Ivermectin, was selected as the positive/killer control. A total of four hundred compounds with known antiviral, antibacterial or antifungal function were evaluated at 5µM concentration using an endectocide membrane-feeding assay (EMFA) against a laboratory strain of Anopheles coluzzii. The mortality of females was recorded over a time period of 72 hours and those compounds identified with >90% mortality were evaluated downstream. A screening cascade detailing the criteria for hit identification and hit validation was developed. Eight PRB-compounds were identified during the hit-identification phase and were subsequently analysed through the hit-validation procedure. The MMV-PRB provided an ideal source framework for evaluating compounds with endectocidal activity.

Keywords: Screening platform, *Anopheles coluzzii*, endectocide membrane feeding assay

Parallel Scientific Session 9: Vector bionomics: vector biology, ecology, taxonomy and population genetics

ABS-405

Impact of herbal and synthetic antimalarial medications on mosquito gut microbiota and enzyme activities.

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The mosquito gut microbiota plays a vital role in preventing or promoting the transmission of malaria by mosquitoes. This study investigated the impact of supplementing sugar meals with either herbal or synthetic antimalarial medications on the microbiota of

Anopheles mosquitoes. *Anopheles* larvae were collected from the Odeda Local Government, Ogun State, Nigeria, and transported to the insectary at the Department of Pure and Applied Zoology, Federal University of Agriculture, Abeokuta, Nigeria. Then, 250 female mosquitoes were divided into five groups and starved for 48 h prior to feeding for 1 h on sugar meal in combination with different group supplements *Morinda lucida*, artemther/lutefantrine, morinda lucida + artemther/lutefantrine, amoxicillin (positive control), and distilled water (negative control). After 24, 48, and 72 h, we performed spectrophotometric tests of gut enzyme activity (including amylase, α-glucosidase, lipase, and proteinase) and pour-plate analyses of the gut microbial composition. Following this, mosquito survival was measured daily. This is an ongoing project. This study determined whether the gut amylase, α-glucosidase, lipase, and proteinase levels and gut microbial composition of the treated group after 24, 48, and 72 h differed from those of the control groups. This study provides insights into gut enzyme activities and microbial activities when mosquitoes are treated with sugar, supplemented with either herbal or synthetic antimalarial drugs, or their combination.

Keywords: Mosquito gut microbiota, Antimalarial medications, Gut enzyme activity, Gut microbial composition, *Anopheles* mosquitoes

ABS-416

Evaluating interactions between larval predators and genetically engineered *Anopheles coluzzii*.

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One concern with the release of genetically engineered mosquitoes (GEMs) is that they may have a negative environmental impacts. We conducted experiments to evaluate interactions between larval GEMs and their predators. Our experiments utilized vertebrate (*Gambusia affinis*) and invertebrate (Toxorhynchites rutilus) predators. We examined two traits related to predation: (i) the effect of GEM ingestion on predator health and (ii) the ability of GEM versus wild type to avoid predation. To test impacts of larval diet on predators, the fish, G. affinis and predaceous mosquito, T. *rutilus* were fed ad libitum to either wildtype or GEM larvae. Daily growth rate of G. affinis fry was monitored for a period of 35 days and T. rutilus developmental time from 1st instar to pupa was recorded and adult wing-lengths measured. Predator avoidance was assessed by exposing mosquito larvae in an aquarium to either one G. affinis, or one *T. rutilus* 3rd stage larva for one hour. The number of remaining larvae were counted.Predator ingestion. We observed no difference in growth rate for wild type versus GEM fed G. affinis. Likewise growth rate and adult size were not significantly different for the GEM versus wild type fed *T. rutilus*. Predator avoidance. We found no difference in the numbers of GEM versus wild type *A. coluzzii* consumed per hour by either G. affinis or T. rutulis. We are using the numbers of larvae consumed per hour as a proxy for predator avoidance, assuming those individuals with a higher capacity to avoid predation will result in a lower number consumed per hour. We conclude that ingestion of GEM A. coluzzii

does not have a negative impact on the growth rate of vertebrate or invertebrate predators and that predator avoidance as one factor influencing fitness is not impaired in GEM.

Keywords: genetically engineered mosquitoes, *Gambusia affinis*, Toxorhynchites rutilus, predators, versus, wild type, larvae.

ABS-454

Assessment of outdoor biting patterns of *Anopheles* mosquitoes sampled from animal shelters in Umkhanyakude and Zululand Districts: implications to current malaria elimination strategies

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Residual malaria remains a concern in South Africa even as the country moves towards eliminating malaria within its borders. Thus it is imperative to study anopheles mosquito behavior especially with increasing evidence of opportunistic outdoor feeding behavior of *Anopheles gambiae* complex vector mosquitoes. This aims to ultimately understand the outdoor biting host-seeking behavior of malaria vectors and enable information-based programmatic decision making consistent with biting behavior of exophilic vectors. To this end anopheles mosquitoes were sampled from animal shelters during the 2022/23 malaria season in uMkhanyakude and Zululand districts. The samples were collected from animal shelters using sucking tubes at different time intervals from 19:00 up to midnight. All Anopheline samples were identified morphologically using the microscope and vector species-specific using PCR. The laboratory results confirmed the presence of both primary (An. arabiensis) and secondary (*An. merus*, *An. vaneedeni*, *An rivulorum*, *An. parensis*) malaria vectors. *Anopheles arabiensis* showed a peak biting time between 21:00 and 22: 00 in Zululand and Umkhanyakude districts. Furthermore, this time interval coincides with the increase in abundance and diversity of *Anopheles* mosquito found. In conclusion, the malaria vector biting peak times were consistent across the districts. Insights into the biting behavior of malaria vectors are discussed with implications to the current malaria elimination strategies.

Keywords: Vector, Malaria, Bionomics, *An. gambiae*, *An. funestus*, *Anopheles*, Mosquitoes

ABS-411

Introgression with reproductive isolation between *An. coluzzii* and *An. gambiae* populations in central and south-eastern Senegal.

Oumou kalsom Gueye (University Cheikh Anta Diop)*; El H A Niang (University Cheikh Anta Diop); Frederic Tripet (Swiss Tropical and Public Health Institute)

An. coluzzii and *An. gambiae*, the major malaria vectors in sub-Saharan Africa, were long time considered as 'M and S' molecular forms before being elevated to full species status. Over the last decade, they have been intensively studied to better disentangle their sympatric ecological diversification process and have been used as study model to study interspecific gene flow. In this study, species specific SNPs

were used to study the genetic structure of natural populations of *An. coluzzii* and An. gambiae from different regions of Senegal to determine and characterize a potential introgression between the two species. Samples collections of Indoor-resting populations and swarms were conducted in the south and central Senegal during the 2018 raining season. Species belonging the Gambiae complex were identified by PCR. Then, those identified as *An. coluzzii*, *An. gambiae* and their hybrids were genotyped. A total, 10 *An. coluzzii* and *An. gambiae* specific SNPs located in the speciation islands of the X, 2L and 3L chromosome were chosen to determine the types of hybrids found in the different study areas and potential gene introgression between the two species. Results showed the presence of recombinant individuals with introgression mainly in the 2L and 3L chromosome. however, introgressions at the X chromosome have been noted only in areas where hybrids were relatively high. But these recombinant individuals were all backcross hybrids since no first-generation hybrids were identified. This study revealed reproductive isolation between *An. coluzzii* and *An. gambiae*. However, the rate of recombinant hybrids suggests a recent hybridization event has occurred and that there is an adaptive introgression of the 2L island containing the insecticide resistance gene in *An. coluzzii*.

Keywords: Malaria, *An. coluzzii, An. gambiae*, Introgression, SNPs

ABS-466

Microsporidia MB and Anopheles gambiae interaction dynamics and its relevance in developing a symbiont-based strategy to control malaria

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Malaria is a major health problem across sub-Saharan Africa. Despite the large-scale implementation of malaria control programmes, high numbers of malaria cases and deaths are still being reported. This suggests that the current malaria control strategies are limited and therefore a need for novel approaches to fight malaria. Microsporidia MB, a native symbiont of Anopheles mosquitoes, has been shown to block *Plasmodium falciparum* transmission. This makes it a good candidate for developing a complementary symbiont-based strategy to control malaria. However, the mechanisms through which it maintains itself in mosquito populations are not yet known. We used FISH microscopy to establish how the symbiont is vertically and horizontally transmitted in Anopheles mosquitoes. Our results show that Microsporidia MB infects the female mosquitoes' germline stem cells very early and is subsequently transferred into the developing eggs following germline cell division and differentiation. In the early stages of egg development, Microsporidia MB is randomly present in the oocyte and the nurse cells as large multinucleated cells which later divide and migrate into the oocyte in the late stages of egg development. Additionally, the symbiont infects the male reproductive organs and is transferred to the females during mating before establishing itself in the next generation by infecting eggs. These results reveal an intimate and long-term symbiotic relationship between *Anopheles*

arabiensis mosquitoes and the symbiont. The stability of the vector-symbiont relationship is critical in developing an effective symbiont-based malaria control strategy. Also, the paternal transmission route allows the use of males to disseminate the symbiont into target mosquito populations. This is important because, unlike females, male mosquitoes do not bite humans and therefore releasing males will be easily acceptable by local communities in release sites.

Keywords: Malaria Symbiont Microsporidia

ABS-499

Study of the behavior and entomological parameters of *Anopheles* in two health zones in the province of north-ubangi, democratic Republic of Congo in 2021

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The objective of this work was to identify the behavior of female Anopheles and entomological parameters in the two health zones (Karawa and Gbado-Lite) in the province of Nord-Ubangi in the Democratic Republic of Congo. Two mosquito sampling techniques were used, pyrethrum capture and human bait capture in homes. This study was carried out from March 31 to April 14, 2021. This Province is located in the north of the Democratic Republic of Congo, in a forest area. A total of 784 *Anopheles* samples were captured, i.e. 575 by CAH (236 inside dwellings and 339 outside) and 209 by PC. The Anopheles captured in these two environments belong to the following 3 species: *Anopheles gambiae* s.l, (98%) Anopheles funestus s.l (1%), *Anopheles paludis* (1%). The study of its behavior reveals that Anopheles gambiae s.l is more exophagic than endophagic and the peak inside starts a little later between 11 p.m. and 2 a.m. while outside it starts a little earlier at 19 hours. The density of *Anopheles gambiae* s.l is 98% compared to all the *Anopheles* mosquitoes collected. The determination of the sporozoite index by the ELISA method gives us 58% of the infested Anopheles. Because the *gambiae* species feeds on the outside (more exophagic), it would be better to add complementary vector control methods, because the method currently used for control with LLINs is not sufficient all the more that the vectors begin to change its feeding behavior.

Keywords: *Anopheles*, *Anopheles gambiae* s.l, aggressiveness, infestation, density, Gbado-lite, Karawa, DRC

ABS-503

Parallel evolution in mosquito vectors: A novel locus confers resistance to Pirimiphos-methyl in *Anopheles gambiae* s.l

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Emerging resistance to insecticides used in vector control is of major concern to malaria control programmes. The organophosphate, pirimiphos-methyl, is widely used in indoor residual spray programmes and is of vital importance as a complementary tool to LLINs for the control of the Anopheles gambiae. Using public data from phase 3 of the *Anopheles* 1000 genomes project and an additional 974 whole-genome sequenced mosquitoes phenotyped for resistance to insecticides, we use a population genomic approach to examine novel mechanisms of resistance to pirimiphos-methyl. In multiple regions and vector species across sub-Saharan Africa, we find large signals of selection at a novel locus containing a cluster of detoxification enzymes. Within this cluster lie two carboxylesterases whose orthologs are known to confer resistance to organophosphates in Culex pipiens. Close examination reveals a complex and diverse pattern of haplotypes under selection in An. gambiae, *An. coluzzii* and *An. arabiensis*. We use haplotype and phylogenetic approaches to examine whether these signals arise from parallel evolution or adaptive introgression. As in Cx. pipiens, copy number variation plays a role in the evolution of insecticide resistance at this locus. Finally, using whole-genome sequenced phenotyped samples, we find that multiple haplotypes under selection confer resistance to pirimiphos-methyl. Overall, we demonstrate a striking example of contemporary parallel evolution which has important implications for malaria control programmes.
Keywords: resistance anopheles genomics bioinformatics transcriptomics

ABS-615

Potential geographical spread of yellow fever vectors (Aedes spp) in relation to human population density in Lagos State, Nigeria: a maximum entropy (MaxEnt) modeling approach

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Controlling mosquito vectors is made more difficult due to various micro-climatic and human-related factors. In order to understand how *Aedes* species, which are major disease-carrying mosquitoes in Nigeria, are influenced by these factors, we studied their distribution in Lagos and their connection to climate and human factors. *Aedes* larvae and adults were collected from 8 Local Government Areas (LGAs) in Lagos State, resulting in 98 occurrence points. Using 23 environmental variables, we modeled the geographic distribution of Aedes spp. under current climatic conditions. Human population density was overlaid to estimate the risk of arboviral diseases in Lagos State. Mosquitoes were present in all the 8 LGAs (4 urban and 4 rural) in different proportions. However, species distribution varied considerably. Both *Aedes aegypti* and *Aedes albopictus* were found across the LGAs with evidence of species partitioning (Both species were predominant in 4 LGAs each). Virtually all the LGAs in Lagos State were predicted to be highly suitable for Aedes mosquitoes. Only two LGAs have some areas which are moderately suitable for *Aedes* mosquitoes. The study suggests that adjoining LGAs in Ogun State (Larger parts of Ipokia, Ado-odo-ota, and small parts of other 10 LGAs) are highly suitable (70-99% probability) for *Aedes* mosquitoes. Urban areas with extensive tire usage create more breeding sites. These highly suitable areas had dense populations in both states. The main contributing variables to Aedes distribution were precipitation and temperature in the coldest quarter. The presence of *Aedes aegypti* and *Aedes albopictus* in Lagos is influenced by human use of tires in urban areas, while climatic factors like cold quarter temperature and precipitation affect their adaptability. Understanding this is crucial for controlling Aedes vector infections in the state.
Keywords: Aedes, Climate, Population Density, Yellow fever, Nigeria

ABS-562

Anopheles mosquitoes bred without blood for malaria research and control

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Stopping malaria transmission depends on effective vector control, implying the use and development of new strategies to interrupt transmission, making insectaries and mass production of mosquitoes central to malaria elimination strategies. Raising mosquitoes requires the use of blood, making large-scale production of mosquitoes challenging due to ethical and financial constraints. To overcome these limitations, we have developed an artificial blood-free diet for *Anopheles* mosquitoes rearing that mimic standard vertebrate blood diet, inducing oogenesis, egg, larvae and pupae as well as fit adult mosquitoes. The artificial diet was tested on various Anopheles species among different African insectary contexts, namely Burkina Faso, Tanzania and Mozambique. The diet is being tested on *An. coluzzii*, *An. gambiae*, *An. funestus* and *An. arabiensis*. Multiple feedings using membrane feeding assays were performed. Feeding rates, no. of oviposited eggs, female mortality, and *Plasmodium berghei* and *P. falciparum* infectivity to the vector were compared between artificial diet and fresh blood fed groups. Long term use of the diet is being evaluated using standard colony assessment indicators at different generations. The initial testing of the diet showed that all Anopheles species from the different endemic regions fed well on the diet and were able to lay eggs. The number of eggs laid decreased with multiple feedings and female mortality tends to increase in the same fashion. The infection rate to Plasmodium was higher on groups previously fed on the diet when compared to mosquitoes previously fed on blood. The implementation of long-term usage of the diet is at different stages in the different insectaries, varying from 2 to 13 generations. We have established our artificial diet in a network of insectaries, proving that implementing an artificial alternative to blood is feasible, and may constitute a breakthrough on Anopheles rearing.

Keywords: Malaria, Anopheles, mosquito rearing, blood-substitute-diet, insectary

ABS-99

Anopheles larval habitats seasonality and environmental factors affecting larval abundance and distribution in Arjo-Didessa sugar cane plantation, Ethiopia

Arega Tsegaye (Jimma University)*

The intensive utilization of current adult vector control tools, results in insecticide resistance among the main vectors. It could compromise the effectiveness of the current adult vector control strategies. Thus, it is important to look for new or alternative vector control interventions for immatures to complement adult control by focusing on different larval habitats and their seasonal availability. Thus, this study investigated larval habitat seasonality and seasonal larval abundance and distribution in irrigated sugar cane plantation settings in Ethiopia. *Anopheles* mosquito breeding habitats were surveyed and visited twice a month for 14 months, beginning in Sep, 2020 and ending in Oct, 2021. Larval habitat diversity, as well as larval abundance and distribution, were determined across seasons. Environmental parameters, which include habitats physicochemical characteristics, were assessed. The study revealed that *Anopheles gambiae s.l.* was the most predominant 4197 (57%) species, followed by An. coustani complex 2388 (32.8%). Molecular analysis of sub-samples of *An. gambiae s.l*. resulted in *An. arabiensis* (77.9%) and *An. amharicus* (21.5%). Larval breeding habitat types and their productivity were variable across seasons. Physico-chemical parameters such as temperature ($t = 2.22$, $p = 0.028$), conductivity ($t = 3.21$, $p = 0.002$), dissolved oxygen ($t = 7.96$, $p = 0.001$), nitrate ions ($t=2.51$, $p=0.013$), and ammonium ions ($t = 2.26$, $p = 0.025$) showed significant association with mosquito larval abundance. The study revealed that different larval habitats have different productivity in different seasons and physicochemical characteristics like ammonium, nitrate and distance from larval habitats to household are associated with larval productivity. Therefore, vector control should consider Anopheles larval habitat seasonality, as well as the impact of agrochemical application on larval source management (LSM)

Keywords: larval, physico-chemical, Breeding, Habitat, Seasonality

ABS-24

Suppressing the breeding of malaria vectors in African rice fields: the effects of rice cultivation practices on rice yield, water productivity and greenhouse gas emissions in lowland irrigation schemes

Kallista Chan (LSHTM)*

Rice is a rapidly expanding and intensifying crop in sub-Saharan Africa. However, rice fields consume a lot of water, emit a large proportion of the world's methane, and, in Africa, produce many malaria vectors. Therefore, rice intensification strategies that optimize both climate change and health co-benefits are urgently needed. To determine the effect of different rice cultivation practices on malaria vector density, rice yield, water productivity, and greenhouse gas emissions, seven experimental field trials were conducted in Côte d'Ivoire and Tanzania. Each trial assessed the effect of different growing techniques, including the method of crop establishment, timing of fertilizer application, and water management technique (e.g., alternate wetting and drying irrigation – AWD). Over four cropping seasons (04/2019-12/2021), rice plots were arranged in a randomized complete block design with three replicates for each treatment. Mosquito larvae were sampled at the borders of each rice plot twice every week from land preparation to two weeks after harvesting. Compared to continuously flooded (CF) fields, fields under AWD were not effective in reducing malaria vectors in Côte d'Ivoire but did not cause any yield penalties, consistently reduced water use by 41-71% and reduced global warming potential by 41%. On the other hand, compared to fields under CF, fields under AWD were successful in reducing malaria vectors by 63.8% (95% CI -74.3%, -49.1%, $p<0.0001$) in Tanzania. This study suggested that there are rice-growing techniques that can minimize mosquito and methane production, whilst reducing water use and sustaining yields. Some techniques need to be adjusted and repeated across more trials (and more seasons and locations) to demonstrate its efficacy. Nonetheless, regular rice research looking to improve yield should prioritize methods that can provide climate and health co-benefits.

Keywords: Anopheles, larvae, rice, agriculture, climate.

ABS-104

Predators of *An. gambiae* sensu lato larvae exhibit adaptive patterns of predation and mobility in a semi-field experiment

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Species of the Anopheles gambiae complex are major malaria vectors. The larvae of these species inhabit diverse aquatic habitats and are often preyed upon by aquatic macroinvertebrate predators. Understanding the impact of predators on malaria vector larval population is important for designing community-based mosquito control programs. Predation efficacy and foraging strategy of adult diving beetles, backswimmers, and dragonfly nymphs, the common An. gambiae s.l. predators were experimentally evaluated in a semi-field. Small and large basins were randomly planted in the semi-field and filled with well water. Field collected beetles were marked with white oil paints while backswimmer and dragonfly nymphs were not marked. The predators were randomly placed in the habitats and mosquito larvae added in half of the habitats. Number of eaten mosquito larvae, survival, and movements of predators were recorded at 24, 48 and 72 hr. Presence of mosquito larvae in habitats significantly affected the survival of backswimmer and dragonfly nymphs. Beetles flew from small habitats without prey to nearby large habitats with prey which enhanced their survival. The predator larval predation rates were stable overtime at a mean of 3.2, 7.0 and 9.6 larvae consumed each night. Aquatic macro invertebrate predators exhibit adaptable foraging behaviour in response to prey presence and habitat size and they have the capacity to reduce mosquito larval numbers, indicating their potential for use as biocontrol agents.

Keywords: Semi-field, Aquatic macro invertebrate predators, Anopheles gambiae s.l. mosquitoes, biocontrol

ABS-125

Experimental evaluation of the residual efficacy of two insects' growth regulators for a potential use as complementary lsm strategies to control malaria vectors in Senegal

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The use of chemical and microbial larvicides as one of the key components of the Larval Source Management (LSM) has been proven very effective against African malaria vectors. However, the adoption of these interventions has been hampered by the need for frequent application of their currently available formulations and their negative impact on the environment. Therefore, there is a need to explore more efficient. This study aims to evaluate the residual efficacy of two insects-growth-regulators for a potential complementary LSM against malaria vectors in Senegal. Laboratory and the experimental station tests were conducted using larvae of two insectary colonies of *An. coluzzii* and *An. arabiensis* to determine the optimal treatment doses (multiples of EI 90%). Wild populations of *An. arabiensis* from several sites were also tested beside the *An. coluzzii* insectary colony to assess the residual efficacy of the two products. For the insectary colony of *An. coluzzii*, the average EI90% for the novaluron was 0.26ug/l (CI 95% 0.09-0.44ug/l); but 0.28ug/l (CI 95% 0.26-0.3) for *An. arabiensis*. With pyriproxyfen, it was 0.6ug/l (CI 95% 0.33-1.11ug/l) for *An. coluzzii.* To monitor the residual efficacy of the two regulators ,

the concentrations of 1 and 10u/l were used. At 10 ug/l, Novaluron inhibited totally the emergence of *An. arabiensis* and *An. coluzzii* up to 18 and 23 days, respectively, but only during 9 and 11 days at 1ug/l. The Pyriproxyfen (10 ug/l) inhibited the emergence of An. arabiensis and An. coluzzii respectively for 35 and 42 days, but during 8 and 17 days at 1ug/l dose. These preliminary data revealed a good residual efficacy with low application doses for the two products. More studies, including field testing under operational conditions are required to determine their cost for a suitable inclusion in the malaria-vector-control-tools.

Keywords: LSM, Insect's growth regulators, malaria vector, Senegal

ABS-24

Suppressing the breeding of malaria vectors in African rice fields: the effects of rice cultivation practices on rice yield, water productivity and greenhouse gas emissions in lowland irrigation schemes

Kallista Chan (LSHTM)*

Rice is a rapidly expanding and intensifying crop in sub-Saharan Africa. However, rice fields consume a lot of water, emit a large proportion of the world's methane, and, in Africa, produce many malaria vectors. Therefore, rice intensification strategies that optimize both climate change and health co-benefits are urgently needed. To determine the effect of different rice cultivation practices on malaria vector density, rice yield, water productivity, and greenhouse gas emissions, seven experimental field trials were conducted in Côte d'Ivoire and Tanzania. Each trial assessed the effect of different growing techniques, including the method of crop establishment, timing of fertilizer application, and water management technique (e.g., alternate wetting and drying irrigation – AWD). Over four cropping seasons (04/2019-12/2021), rice plots were arranged in a randomized complete block design with three replicates for each treatment. Mosquito larvae were sampled at the borders of each rice plot twice every week from land preparation to two weeks after harvesting. Compared to continuously flooded (CF) fields, fields under AWD were not effective in reducing malaria vectors in Côte d'Ivoire but did not cause any yield penalties, consistently reduced water use by 41-71% and reduced global warming potential by 41%. On the other hand, compared to fields under CF, fields under AWD were successful in reducing malaria vectors by 63.8% (95% CI -74.3%, -49.1%, $p<0.0001$) in Tanzania. This study suggested that there are rice-growing techniques that can minimize mosquito and methane production, whilst reducing water use and sustaining yields. Some techniques need to be adjusted and repeated across more trials (and more seasons and locations) to demonstrate its efficacy. Nonetheless, regular rice research looking to improve yield should prioritize methods that can provide climate and health co-benefits.

Keywords: Anopheles, larvae, rice, agriculture, climate.

ABS-218

Larvicidal activity of *momordica foetida* (cucurbitaceae), *gnidia glauca* (thymelaeaceae) and *vepris soyauxii* (rutaceae) extracts on *anopheles gambiae* s.l. (culicidae) and acute oral toxicity

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Anopheles mosquitoes transmit malaria which is a life-threatening disease in Cameroon and in Africa. As an alternative strategy to control mosquitoes, we assessed the larvicidal activity of *Momordica foetida*, *Gnidia* glauca and *Vepris soyauxii*, extracts on *Anopheles gambiae* s.l., and evaluated their acute oral toxicity. The whole plant except the fruits of M. foetida, fresh leaves of *G. glauca*, and stem barks of *V. soyauxii* crude extracts were obtained by solvent extraction and then bio-assayed against third-instar larvae of *Anopheles gambiae* s.l. with concentrations ranging from 100 to 450 ppm for 24h and 48h respectively. Wistar rats were used to evaluate the acute oral toxicity of the plant's methanolic extracts. Methanolic extracts had higher larvicidal activity as compared to aqueous extracts where *V. soyauxii* methanolic extract showed the highest larvicidal activity of LC50 and LC90 values of 203.92 and 241.459 ppm respectively followed by *G. glauca* and finally *M. foetida* methanolic extracts on *An. gambiae* ss. Similarly, in *An. coluzzii*, *V. soyauxii* still had the highest larvicidal activity with values of LC50 being 215.007 and 270.866 ppm for LC90, M. foetida followed and finally *G. glauca*, methanolic extracts. As for the toxicity, the highest concentration of 2260.7 mg/kg did not show any symptoms of toxicity or death on the Wistar rats. *V. soyauxii, G. glauca* and *M. foetida* methanolic extracts showed promising biological responses against malaria vector species, *Anopheles gambiae* and *Anopheles coluzzii*, and may serve as a potential alternative and eco-friendly tool for larval control in African endemic countries. The investigated plant extracts are promising as larvicides against An. gambiae s.l. mosquitoes and are useful leads in the search for new biodegradable larvicides.

Keywords: *Anopheles gambiae s.l.*, Larvicide, Toxicity, *Momordica foetida*, *Gnidia glauca*, *Vepris soyauxii*

ABS-219

Contribution of larviciding with biological compounds to the management of pyrethroid resistance in a population of *Anopheles gambiae* s.l. expressing high resistance intensity.

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Laviciding with biological insecticide is considered appropriate for targetting outdoor biting mosquitoes and for managing insecticide resistance. However, the influence of larviciding in managing pyrethroid resistance remains unexplored. We investigated whether larviciding using the microbial-based larvicide VectoMax G is contributing to increase the susceptibility of Anopheles coluzzii populations to pyrethroids. The susceptibility status of *An. coluzzii* field population was evaluated at different time points, before and during

larviciding treatments. Simultaneously, *An. coluzzii* larvae were collected and divided into four groups, each subjected to 21 generations of selection, asfollows;(i):deltamethrin0.05%_only,(ii):VectoMax_only,(iii):VectoMax+deltamethrin0.05%,(iv):VectoMax+deltamethrin0.05%+susceptible. Life-traits parameters were measured in the progeny. Kdr frequency, then expression profile of detoxification and oxidative genes was checked using qPCR. Phenotypic and genotypic parameters were compared between the first and the last generation of each laboratory colony and between field samples collected before and during larviciding, with "Ngousso" strain as control. First findings shown a decrease in resistance intensity to deltamethrin from high to low in field populations. A significant decrease in the overexpression profile of Gste2 was detected in field population after larviciding implementation. Other genes showing a similar pattern though not significant were Cyp6z1, Cyp6p1 and Cyp6g16. The colony vectomax+deltametrin+susceptible displayed a fitness profile similar to the susceptible colony, with high fecundity, high hatching rate, short larval development time and long adult survival rate. Overall, this study suggests that reversal could occur under larviciding, but may take longer to achieve in a highly resistant population and under continuous insecticide selection pressure.

Keywords: microbial larvicide, resistance reversal, *Anopheles coluzzii*.

ABS-220

Contribution of vectomax®g, a larvicide for the control of mosquito densities and malaria transmission in some districts in the city of Yaoundé

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Malaria remains a major public health problem in Cameroon. In the frame of a larviciding trial, a study was conducted to assess the efficacy of larviciding with vectomax®g for the control of mosquito population, composition and malaria transmission dynamic in the city of Yaoundé, Cameroon.Clusters were grouped into treated sites, which received larviciding with vectomax®g (*Bacillus thuringiensis* and *Bacillus sphaericus*); and into control sites. Adult mosquitoes were collected indoors and outdoors in both control and treated sites using centers for disease control and prevention light traps and human landing catches during the months of July, September, and November 2019 in eight districts of Yaoundé. Mosquitoes were sorted by genus using the morphological characteristics and identified to the species level using polymerase chain reaction (PCR). The enzyme linked immunosorbent assay method was used to determine mosquito infection status to *Plasmodium*. Amongst the 915 mosquitoes collected, culex species were predominant (66.34%) followed by *An. gambiae sensu lato (s.l.)* (30.27%). The proportion of mosquito species collected in control sites was high compared to treated sites. The difference was significant in Anophelinae collected ($\chi 2$= 98.69; P<0.0001) with a reduction rate of 85.52% noted in *An. gambiae s.l*. Out of 122 *An. gambiae*

s.l. analyzed, 77.05% (n = 94) were An. coluzzii and 22.95% (n=28) *An. gambiae sensu stricto (ss.)*. The infection rate of *An. gambiae s.l.* by *Plasmodium falciparum* was 1.9% in control sites (5/260) and none in treated sites. The entomological inoculation rate varied from 0 to 3.83 infective bites/man/month in control sites therefore, a risk of malaria transmission in control sites. Our findings suggest that larviciding with vectomax®g can be highly effective for reducing mosquito density and malaria transmission in the city of Yaoundé Cameroon.

Keywords: Vectomax®g, Larviciding, Malaria, Anopheles, transmission, Yaoundé, Cameroon.

ABS-582

Semi-field efficacy of PermaNet Dual® (a new deltamethrin-chlorfenapyr net) against pyrethroid-resistant *Anopheles gambiae* populations from Côte d'Ivoire

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There is a pressing need for developing and testing new vector control tools to manage insecticide resistance. We evaluated the efficacy of PermaNet Dual® (a novel deltamethrin-chlorfenapyr-coated net), in comparison with PermaNet® 3.0 and PermaNet® 2.0, against pyrethroid-resistant *Anopheles gambiae* mosquitoes in experimental huts in Tiassalé, Côte d'Ivoire. We tested PermaNet Dual®, PermNet® 3.0 and PermaNet® 2.0, unwashed and washed 20 times, against free-flying pyrethroid-resistant *Anopheles gambiae s.l.* in Tiassalé experimental huts in Côte d'Ivoire. We conducted complementary laboratory cone and tunnel bioassays to predict PermaNet Dual® efficacy in the huts. The experimental hut trial data showed that the mortality and blood-feeding inhibition in the wild pyrethroid-resistant An. gambiae s.l. were overall significantly higher with PermaNet® Dual compared with PermaNet® 3.0 and PermaNet® 2.0, for both unwashed and washed samples. The mortality with unwashed and washed samples were 93.6% and 83.2% for PermaNet® Dual, 37.5% and 14.4% for PermaNet® 3.0, and 7.4% and 11.7% for PermaNet® 2.0, respectively. Moreover, unwashed and washed samples produced the respective percentage blood-feeding inhibition of 41.4% and 43.7% with PermaNet® Dual, 51.0% and 9.8% with PermaNet® 3.0, and 12.8% and -13.0% with PermaNet® 2.0. Tunnel tests predicted PermaNet® Dual efficacy observed in the current experimental hut trial. The deltamethrin-chlorfenapyr coated PermaNet Dual® induced a high efficacy and performed better than PermaNet® 3.0 and PermaNet® 2.0 against the pyrethroid-resistant *An. gambiae*, testing both unwashed and washed samples. The presence of deltamethrin and chlorfenapyr in PermaNet Dual® greatly improved protection and control of pyrethroid-resistant *An.*

gambiae populations. Thus, PermaNet Dual® represents a promising tool in the fight against pyrethroid-resistant *Anopheles* vectors for an effective malaria control.

Keyword: Malaria, *Anopheles gambiae*, Insecticide resistance, PermaNet® Dual, Experimental hut trial, Tiassalé, Côte d'Ivoire

ABS-588

Efficacy of In2Care® EaveTubes against wild populations of malaria vectors in a small-scale field study at Kagera Sugar Ltd, Misenyi, Tanzania

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A small-scale efficacy study with the new malaria vector control product the In2Care® EaveTubes was carried out at Kagera Sugar Ltd, Missenyi, Tanzania between October 2019 and July 2020. Its main aim was to gather proof of impact against wild populations of *anopheline* mosquitoes (malaria vectors) in Tanzanian field settings. In total, 350 Eave Tubes were installed in 100 iron sheet barrack rooms and 35 mud houses in a selected camp where workers of Kagera Sugar Ltd resided. Two similar camps did not receive any malaria interventions and served as control sites to monitor baseline mosquito densities. During the 9-month intervention, the quality and durability of the insecticide used in the EaveTubes were tested. Furthermore, malaria disease cases were monitored to provide an indication of potential epidemiological impacts. Entomological data showed that EaveTubes significantly reduced indoor *anopheline* vector densities with 58% overall and with 75% during the peak mosquito season. Quality control results showed there was no degradation of insecticide content or mosquitocidal efficacy of EaveTube netting samples used for 6 months under field conditions. The deltamethrin-treated product was effective against wild mosquitoes, reared insecticide-susceptible mosquitoes, and reared pyrethroid-resistant mosquitoes. Malaria incidence results showed a decline in disease cases in the EaveTubes-treated camp and the control camps, compared to the baseline. The highest malaria case incidence reduction was in the EaveTube intervention camp (25.6%). These findings indicate the high efficacy and durability of EaveTubes against wild malaria mosquito populations and nuisance mosquitoes in Tanzania. EaveTubes can thus complement malaria vector control in areas where insecticide resistance has compromised existing vector control tools.

Keyword: mosquito, malaria, mortality, efficience

ABS-645

Non-inferiority experimental hut and community (Phase III) cluster randomized indoor residual spraying evaluation trials of VECTRONTM T500 against malaria vectors in Tanzania.

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The efficacy and effect of VECTRON™ T500 against malaria vectors were evaluated in experimental hut and community randomized trials respectively. The experimental hut trial conducted in Moshi Tanzania showed that VECTRONTM T500 was non-inferior to Actellic® 300CS in terms of mortality (OR:> 1.37, P < 0.001) of wild free-flying Anopheles arabiensis. In the community randomized trial conducted in Muheza Tanzania, VECTRONTM T500 was non-inferior to Fludora® Fusion in terms of its ability to reduce vector density (density ratio 0.92, 95% CI 0.35 - 2.35, P = 0.858). The number of infective bites per year post-intervention in the community trial was 11 for Fludora® Fusion and 5 for VECTRON™ T500. Cone bioassays showed that VECTRONTM T500 remained efficacious on mud and concrete walls 12 months post spraying against insecticide susceptible and resistant *An. gambiae* sensu stricto. The long-lasting residual efficacy of VECTRONTM T500 presents an important development to this intervention class.

Keyword: IRS

ABS-660

Large-scale village field trials: Residual efficacy of Ficam® VC (WP-SB) and Fludora® Fusion (WP-SB) in indoor residual spraying against pyrethroid resistant *Anopheles gambiae s.l.* in Mali

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Insecticide resistance threatens to disrupt progress in malaria vector control in Mali unless novel insecticides are introduced. The aim of this study was to evaluate the residual efficacy and impact of the insecticides Fludora® Fusion and Ficam® VC against pyrethroid-resistant strains of *Anopheles gambiae s.l.* on typical surfaces encountered in Mali. This study was conducted in the Selingue health district, Southern Mali, from September 2021 to December 2022 in a randomized-cluster cross-sectional study with a Fludora® Fusion (clothianidin 500 g/kg and Deltamethrin 62.5 g/kg), a Ficam® VC (bendiocarb 800g/kg), and a Reference Arm, (pirimiphos-methyl CS 300, 300mg/l). Each study arm comprised five villages. Mosquito capture for entomological parameter impact assessment was achieved with prokopack aspirators during the day, and human landing catches (HLC) at night. Bottle assays were used to evaluate population susceptibility while residual efficacy against insecticide-susceptible *An. coluzzii Ngousso* and pyrethroid-resistant *An. gambiae VK-PER* strains was assessed with WHO cone bioassays. Resistance to permethrin and deltamethrin was observed in the captured *An. gambiae s.l.*, while showing susceptibility to pirimiphos-methyl, bendiocarb and the clothianidin + deltamethrin combination. At twelve months post-IRS, the mean density of *An. gambiae s.l.* in pirimiphos-methyl treated rooms was four times higher than the Fludora® Fusion Arm, and three times higher in biting rate. Ficam® VC and pirimiphos-methyl achieved 6 and 7 months respectively on both mud and cement surfaces against the susceptible *An. coluzzii Ngousso* strain, while Fludora® Fusion achieved 12 months residual efficacy on all surfaces against susceptible and resistant strains. Ficam® VC and Fludora® Fusion are both effective in the control of pyrethroid-resistant strains *An. gambiae s.l*. with residual efficacy for Ficam® VC and Fludora® Fusion of 5 - 6 months and 12 months respectively.

Keyword: Malaria vector control, Pyrethroid resistance, Indoor residual spraying, Residual efficacy

ABS-670

Towards Management of Insecticide Resistance in Nigeria: Village scale Evaluation of VECTRON T500 against Populations of *Anopheles coluzzii* resistant to pyrethroids but susceptible to organophosphate

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Insecticide resistance is increasingly becoming a major challenge in the management of malaria vector populations in Nigeria. Resistance to pyrethroid is now widespread with increasing resistance to organophosphates, used for various interventions. Hence, the country considers new insecticides capable of killing populations of these resistant mosquitoes. We therefore evaluate the bio-efficacy of Vectron T500 against Kisumu strains and resistant populations of *An. coluzzii* (NAC) in Lagos, Nigeria. In Oreta, Lagos State, a quasi-experimental study was done, using stratified random sampling to assess indoor residual spray effects on concrete and mud walls. Three arms were created of 30 houses each: VT500, standard Indoor Residual Spray (IRS) insecticide, and a control. For each arm, 15 houses were concrete while 15 were mud. Monthly bio-assays were conducted on each house for 6 months, accompanied by pre/post surveys and focus group discussions to gauge individual perceptions of the intervention. Statistical analysis was conducted at $P<0.05$. Bio-assay studies revealed that VT500 killed KISUMU and NAC populations above 80% cut off mark except for the standard IRS insecticide that had a 73.3% and 70.2% mortality at 5th and 6th month respectively. For all the arms, efficacy did not significantly differ ($p<0.05$) between VT500 and the standard IRS insecticide on concrete and mud walls. Pre-intervention surveys indicated 71.7% prior knowledge of IRS, while post-intervention discussions revealed limited understanding of slow-acting IRS products. With the rapid development of resistance to the four classes of insecticides, VT500 holds promise for insecticide resistance management in Nigeria due to its efficacy.

Keywords: Anopheles coluzzii, Indoor Residual Spray, Vectron T500, Insecticide resistance, Nigeria

ABS-675

Impact of new insecticide-treated nets and indoor residual spraying on entomological indicators of malaria transmission in Rwanda

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Insecticide-treated nets (ITNs) and indoor residual spraying (IRS) are the core malaria control interventions in Rwanda. However, the resistance to insecticides has been threatening the effectiveness of these interventions. As part of its insecticide resistance management strategy, Rwanda introduced the use of pirimiphos-methyl (organophosphate) in 2017 for IRS and new nets in 2020, based upon data on the endemicity of malaria and insecticide resistance. The MOPDD with support from the PMI-VectorLink implemented IRS with Actellic-300CS in Ngoma district in 2019, and in 2020 Karongi and Kicukiro district received IG2 nets and PBO ITNs respectively. Entomological indicators of malaria transmission that included sporozoite infection rate (SIR), entomological inoculation rate (EIR) and vector composition were monitored, one year before and two years after the deployment of these interventions. : The SIR before and after the

deployment of the vector control interventions was 0.2% vs 0% in Ngoma district (IRS), 1.2% vs 0.7% in Karongi district (IG2 nets), 1.05% vs 0.1% in Kicukiro (PBO nets), respectively. The EIR per person per year before and after the deployment of the interventions was 5.47 vs 0 in Ngoma, 3.94 vs 2.04 in Karongi and 19.16 vs 1.97 in Kicukiro district , respectively. Prior to the interventions the predominant species was *An. gambiae s.s.*, making up to 75.4%, 90.4%, and 94.8% of the *An. gambiae* complex, in Ngoma, Karongi and Kicukiro districts, respectively. After the interventions, the proportion of *An. gambiae s.s.* dropped drastically to 3.9%, 56.9%, and 58.8% in Ngoma, Karongi and Kicukiro, respectively. The deployment of IRS and new nets had an impact in reducing the main entomological indicators of malaria transmission. These changes were also accompanied by a shift in vector species composition from dominance by *An. gambiae s.s.* to *An. arabiensis*, with the highest shift occurring in Ngoma (IRS).

Keywords: New insecticide-treated nets, indoor residual spraying, entomological indicators of malaria transmission, Rwanda

ABS-398

Screening male mosquitoes resistance to insecticides in perspective to release sterile/transgenic males in Burkina Faso

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Mosquitoes transmit diseases such as malaria, dengue fever, and Zika virus. However, controlling mosquitoes has become increasingly challenging due to their resistance to insecticides. Implementing the sterile insect technique and related techniques based on the release of high number of sterile males begins by the identification of a target vector and the knowledge of their behaviour. While many studies focused on male mosquitoes biology including its mating competitiveness in the field. It is critical to ensure that released males have at least the same resistance status compared to their wild counterparts and the impact of their size on resistance status. Phenotypic resistance was evaluated using 2 to 5 days old adult male and female of *Aedes Aegypti* (Bora Bora and Bobo) and *Anopheles coluzzii* according to WHO susceptibility test. Mosquito were maintained in IRSS insectary under standard conditions. Deltamethrin 0.05% impregnated paper were used. 1-hour of exposure and 24 hours mortality as outcomes. Mosquitoes size were determined by measuring the wings of live and dead mosquitoes of both strains. WHO susceptibility tests showed that *Aedes Aegypti* Bobo males and females induced 25% and 16.59% of mortality respectively. *Aedes Aegypti* Bora Bora is fully susceptible 100% both sex. *Anopheles coluzzii* males and females showed 19.05% and 25% mortality respectively. Comparison in term of mortality between sex revealed no significant different in *An. coluzzii* ($P=0.1437>0.05$) but little different was observe in Aedes Aegypti Bobo ($P=0.04136<0.05$). No significant different ($P>0.05$)

in term of size between dead and live intra sex of both species but in general, females mosquitoes had high size than male in the both strain (P<0.05). *Anopheles coluzzii* males are resistance as females and the size has no impact on their mortality. While, *Aedes Aegypti* Bobo males are also resistance but females showed high resistance than males.

Keywords*:Anopheles coluzzii*, *Aedes Aegypti*, male, female, insecticide

ABS-406

Efficacy of dual insecticide (chlorfenapyr+ deltamethrin) partially treated nets against *Anopheles arabiensis*: roof vs sides vs whole treated nets.

Njelembo J Mbewe (London School of Hygiene and Tropical Medicine)*

Restricted application of dual insecticides to panels of a bed can lead to development of more cost-effective nets. Here, the efficacies of bed nets with restricted treatment of dual insecticides chlorfenapyr (CFP) and deltamethrin (DLT) to either roof or side panels were compared to whole CFP + DLT, whole DLT and untreated nets against wild free flying *Anopheles arabiensis* in terms of mortality, blood feeding, exophily and deterrence. An experimental hut trial was conducted in Harusi, Lower Moshi Tanzania. Proportions of mosquito mortality, blood feeding and exiting of huts were analysed using multiple logistic regression. There was no significant difference in the likelihood of mortality between all the nets with insecticide regardless of whether they were whole or partially insecticide treated on roof or side panels (P>0.05). However, the CFP + DLT roof only treated nets killed the most mosquitoes per unit area of net treated with insecticides (28.2% /m2) compared to other insecticide treated nets. Additionally, blood feeding, mosquito hut entry and exiting was significantly higher in all trial arms with insecticide treated nets compared to untreated net arm (P>0.05). In conclusion, the dual insecticide CFP + DLT restricted to either the roof or side panels of nets was as efficacious as whole CFP + DLT and whole DLT treated nets; therefore could be more cost effective.

Keyword: chlorfenapyr, deltamethrin, restricted insecticide treatment, Anopheles arabiensis, cost effectiveness

ABS-640

Genetic approaches to constrain gene drives in Anopheles mosquitoes

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Gene drives based on CRISPR-Cas nucleases have been successfully engineered for mosquitoes and are being explored as a powerful potential approach for effective control of disease vector populations. The CRISPR-Cas9-based gene drive that targets the doublesex gene has been shown to be highly suppressive and to rapidly collapse populations of *Anopheles gambiae* in both small laboratory cages and in enclosures with more complex ecological conditions. Despite the fast-pacing development of gene drives, options to counter or revert the activity of gene drives and their dissemination in a mosquito population remain limited. We have recently developed an anti-drive genetic system relying on the inhibition of Cas9 activity by the AcrIIA4 protein. The anti-drive was demonstrated to be effective at countering the *An. gambiae* doublesex-targeting gene drive in both small and large-sized cages. Currently, we are undertaking the effort to further improve the available AcrIIA4-based anti-drive system and develop novel genetic strategies to robustly control and counter gene drive activity in mosquitoes, providing new capabilities compared to those that currently exist. We are also aiming to present the potential applications of these strategies via mathematical models. These activities may be important for the prospects of future gene drive field releases; providing and demonstrating gene-drive reversibility, if necessary, could help to establish risk mitigation plans and address potential concerns regarding the use and release of gene drives.

Keywords: anti-drive, gene drive inhibitor

ABS-657

Environmental and climatic drivers of the abundance of *Anopheles gambiae s.l.*, *An. coustani* and *An. squamosus/cydippis* in five provinces of Madagascar.

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Although *An. gambiae s.s., An. arabiensis, An. merus, An. funestus* and *An. mascarensis* are considered as the main Plasmodium vectors and have been well studied in Madagascar, *An. coustani* and *An. squamosus/cydippis* have been neglected. This study sought to identify the environmental and climatic factors driving the spatio-temporal distribution the Anopheles abundance for improving vector control strategies. Bimonthly mosquito collections were performed in 25 collection sites, in seven bioclimatic zones, and five provinces during 2019. In each site, mosquitoes were collected using CDC light (LTs), human-baited net (NTs), indoor pyrethrum spray (IPSCs) and Muirhead-Thomson (MTPTs) traps. Generalized linear models were used to identify the climatic and environmental factors driving Anopheles abundance. 48,094 *Anopheles* belonging to 14 species were collected, of which 38,173 (79%) were collected from LTs, 8,152 (17%) from MTPTs, 1,023 (2%) from IPSCs and 746 (2%) from NTs. *Anopheles squamosus/cydippis* (38%), *An. gambiae s.l.* (26%) and *An. coustani* (19%) were the three most abundant species. They were found in at least 24 sampled sites and showed highest density at the end of the rainy season (April). NDVI was positively associated with the abundance of An. coustani (IRR = 15.19), An. gambiae s.l. (IRR = 19.16) and *An. squamosus/cydippis* (IRR=6.22) and NDWI with those of *An. gambiae s.l.* (IRR=7.15). Precipitation impacted the abundance of *An. squamosus/cydippis* (IRR=1.00). The equatorial zone was negatively associated with *An. squamosus* (IRR=0.11) and *An. coustani* (IRR=0.33), the subdesert with those of An. coustani (IRR=0.03) and *An. gambiae s.l*. (IRR=0.01). *Anopheles gambiae s.l., An. coustani* and *An. squamosus/cydippis* have heterogeneous spatio-temporal which should reflect the epidemiological variation of malaria transmission. The environmental and climatic factors identified as drivers of these variation should lead to better choices for targeted vector control.

Keywords: Plasmodium vectors; vector abundance, climatic and environmental drivers; bioclimatic domaines; Madagascar

ABS-667

Gene drive and anti-drive genetic control tools for *Anopheles gambiae*: a lesson from large cage studies

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Genetic approaches carry a great potential for sustainable, environmentally-friendly control of mosquito-borne diseases. The development of robust CRISPR-Cas9-based gene drives and anti-drive constructs in *Anopheles gambiae* holds a particular promise of a maturing genetic technology that, in the near future, could be tested in the field for the management of malaria vectors. "The WHO guidance for testing genetically modified mosquitoes" recommends a phased approach, in which strains planned for release are initially assessed in small-scale efficacy/safety studies, followed by testing in larger population cages, which better simulate natural conditions and evoke more complex feeding and reproductive behaviors. The Laboratory of Ecology & Genetics, Polo GGB (Terni, Italy) has been involved in large cage tests of transgenic strains developed within the framework of the Target Malaria initiative. Recently, we performed long-term studies of two *An. gambiae* transgenic lines: one with a gene drive construct targeting the doublesex gene, and the other carrying an anti-drive construct with the Cas9 inhibitory properties. The studies confirmed earlier findings from small-cage experiments that the gene drive strain is able to drive a population to extinction, and that the anti-drive strain is able to efficiently contain spread of the gene drive. In addition, we found that more complex ecological settings of the large cages can uncover transgene-associated fitness effects not observable in small cage tests. These results highlight the benefits of evaluating transgenic lines in large cages for efficacy and safety assessment prior to local field releases.

Keyword: *Anopheles gambiae*, Genetic control tools, gene drive, anti-drive, CRISPR-Cas9, large cages

ABS-9

Succession Mechanisms of the Major *Anopheles gambiae s.l* Complex Malaria Vectors in Sub-Saharan Africa: A Narrative Review

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The source of malaria vector populations that re-establish at the beginning of the rainy season is still unclear yet knowledge of mosquito behavior is required to effectively institute control measures. Alternative hypotheses like aestivation, local refugia, migration between neighbouring sites, and Long-Distance Migration (LDM) are stipulated to support mosquito succession. We assessed the malaria vector succession dynamics and examined various studies done on vector survival by aestivation, local refugia, and local or long-distance migration across sub-Saharan Africa, exploring a range of methods used, ecological parameters and highlighting the knowledge trends and gaps. The results on which particular succession mechanisms support the re-establishment of *An. gambiae, An. coluzzii* or *An. arabiensis* in sub-Saharan Africa were not conclusive and therefore call for further investigations emphasizing the use of ecological, experiments under controlled conditions in the laboratory or semi-field, and genetic approaches, as they are known to complement each

other. This review therefore unveils and assesses the uncertainties that influence the different malaria vector succession mechanisms and provides recommendations for future studies

Keyword: *Anopheles*, succession mechanisms, dry season survival, malaria

ABS-240

Prevalence of Microsporidia mb among field collected *Anopheles* mosquitoes may be associated with geographical factors of breeding niches across Ghana.

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Microsporidia MB is a symbiotic microbe that inhibits the development of malaria-causing Plasmodium parasites in Anopheles mosquitoes. However, its distribution in different Anopheles species and habitats is not fully understood. Understanding the ecological factors that influence its distribution is crucial for determining its potential as a tool for symbiont-based disease control. A better understanding of its ecological distribution is necessary to determine its potential for controlling malaria transmission. This study aimed to determine the prevalence of Microsporidia MB in Anopheles mosquitoes in selected sites across Ghana and measure the physicochemical parameters of breeding sites to determine associated micro-ecological factors. A total of 4195 immature Anopheles mosquitoes were collected from selected sites across Ghana between August and October of 2021 and 2022. DNA was extracted from the abdomen to detect the prevalence of Microsporidia MB using qPCR and molecular identification of mosquito species using SINE and RFLP methods. R software was used for statistical analysis. The overall prevalence of Microsporidia MB was 1.9% (78/4195), with similar prevalence among *An. gambiae* (41.0%; 78/4195) and *An. coluzzii*, (30.8%; 24/78) (χ2, P= 0.28), reiterating previous findings from archived samples and only one case in *An. arabiensis* (1.3%; 1/78) was observed. Male mosquitoes showed a higher prevalence of infection than females, (χ2, P= 0.001). Sites in the Savannah ecological zone compared to other zones without associations with rice fields, had the highest prevalence of Microsporidia MB (55.1%; 43/78), (χ2, P= 0.0009). The study indicates that Microsporidia MB is widely distributed

among predominant malaria vectors in a given geographic region, and its sustainability during the aquatic stages of the host may be affected by micro-ecological factors..

Keyword: Microsporidia MB, Anopheles mosquitoes, mosquito-microbiota, Ghana

ABS-549

Modelling the use of genetically engineered underdominance in management of insecticide resistance and control of insect vector/pest densities

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The most widely mandated and effective approach for minimizing insecticide resistance is the refuge strategy. In this strategy, “refuge” areas with no insecticide treatment are created nearby to treated areas. These non-toxic areas then provide a source of susceptible pests that mate with rare resistant individuals surviving in insecticide areas, and thus dilute and delay the spread of resistance. Recessive inheritance of resistance and/or high toxin doses limit survival of heterozygotes in insecticide areas and greatly lower the refuge size needed for successful resistance management. Transgenic insects have been developed to supplement existing pest management strategies. One strategy that has been designed exploits genetic underdominance, which arises when heterozygotes are less fit than homozygotes. The selective pressure works to fix one of the homozygotes, depending on its frequency in the population. Because this frequency is usually high, the effects of engineered underdominance could be localized, which can be advantageous. The aim of this project was to investigate the release of engineered insects displaying genetic underdominance to manage insecticide resistance and pest densities. The genetic technology is compared to the release of insects carrying a dominant lethal, which has been well studied in the context of insecticide resistance management. Simulations based on a simple population genetics and dynamics framework are used to investigate the ability of underdominant genetic systems to reduce emerging resistance or reverse it from pervasive levels.

Keywords: underdominance, insecticide resistance, population genetics and dynamics, modelling, gene drive, transgenic, replacement

ABS-286

Models to inform monitoring to detect impacts of gene drive releases on malaria vector suppression in African field trials

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Gene drive technologies are a promising means of malaria vector control with the potential to cause widespread and sustained vector population suppression. Here we consider gene drives that have been engineered in Anopheles vector species to target female fertility, suppressing the vector population as the gene drive spreads. Large cage experiments have shown that these gene drives can crash mosquito populations within a year, although their performance in wild populations remains untested. In preparation for the first field trials of these gene drives, field trial design needs to consider the efficacy of a new release in suppressing wild Anopheles, and the ability of monitoring to detect this effect. Measurements of mosquito abundance in field populations are highly variable, and are affected by environmental processes such as rainfall, climate and habitat variability, as well as measurement error and biases in mosquito collection methods. Here we develop a mathematical model to investigate how natural variability and measurement error in mosquito population sizes influence statistical power to detect population suppression effects caused by gene drive releases. Our models are informed by data from pesticide spray catches in four villages in western Burkina Faso, covering a 60 month period with a monthly temporal resolution. Our results compare monitoring strategies with differing numbers of control and release sites, as well as varying spatial trap arrangements and temporal trapping frequency. We estimate detection power over time against the cost of the different strategies. Our results can inform the development of field trial protocols for these novel interventions.

Keywords: Gene drive, mathematical model, vector control, vector suppression, vector abundance, spatial spread, population dynamics

ABS-477

Profiling insecticide resistance of *Anopheles gambiae (s.l.)* for prioritization and deployment of ITNs in Senegal

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In Senegal, insecticide treated nets (ITNs) are distributed nationwide through routine and mass distributions. The rapid and widespread increase of pyrethroid resistance presents a major threat for malaria vector control in sub-Saharan Africa. To determine appropriate ITNs in Senegal, 2018-2021 insecticide resistance monitoring data, susceptibility status, resistance intensity, and PBO synergism data were used. Using the WHO susceptibility test kits, three pyrethroids (deltamethrin 0.05%, permethrin 0.75% and alpha-cypermethrin 0.05%) were tested to assess the susceptibility status of *An. gambiae s.l.* adult populations, reared from larvae, across 11 out of 14 regions in the country. When resistance was confirmed, intensity (high, moderate, and low) was tested at 5x and 10x (nine regions). Synergist assays with PBO 4% were conducted in ten regions to determine the involvement of P450s metabolic enzymes in resistance. Mortality varied between 25% and 78% for deltamethrin, 0% and 72% for permethrin and 5% and 74% for alpha-cypermethrin. Deltamethrin resistance was high in five regions, moderate in two, low in one, and insufficient sample size in one. Permethrin resistance was high in four regions, moderate in three and low in two. Alpha-cypermethrin resistance was high and moderate in four regions each. Pre-exposure to PBO restored susceptibility to at least one of the pyrethroids in seven of the ten regions. Alpha-cypermethrin susceptibility was restored in five regions, deltamethrin and permethrin susceptibility were restored in three and two regions respectively. Pyrethroid resistance was detected in all regions and was high and moderate in all nine regions for which intensity testing was possible and PBO was shown to restore susceptibility to pyrethroids in seven regions. These findings can guide the National Malaria Control Program's plan for ITN distribution and operationalization of the national insecticide resistance management plan

Keyword: ITN distribution, Insecticide Resistance, *An. gambiae s.l.*

ABS-541

Population structure and signals of selection in *Anopheles funestus* mosquitoes across Sub-Saharan Africa

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An. funestus is one of four major vector species of human malaria in sub-Saharan Africa, but it does not yet have population genomic data available across its range. To address this gap and to position vector control experts to understand the response and adaptation of *An funestus* to control, the MalariaGEN *Anopheles funestus* Genomic Surveillance consortium has begun to generate whole genome sequence data to study genomic variation in natural populations. Approximately 700 samples from 13 African countries were sequenced and aligned to a high quality *An. funestus* reference genome and variants were called. Samples were classified into cohorts based on PCA clustering using genotype data from the 2L chromosome, which harbours fewer inversions than other arms. Using the genotype and haplotype data for these samples we determined regions that showed signals of selection. We discovered 80 million SNPs across the sequenced individuals. PCA grouped the samples into 8 distinct cohorts, mostly concordant with geographic structure. We found signals of selection across the genome, and explored several of the strongest signals, many of which had been reported in previous studies. One selected region was identified in all cohorts – this is the resistance to permethrin I locus (rp1). Other strongly selected loci occurred only in a subset of cohorts, but often contained known or suspected insecticide resistance loci. Similar to *An. gambiae* and *An. coluzzii*, *An. funestus* has huge amounts of genetic variation and analyses across the continent reveal the geographic structure of the species. Additionally, we showcase the genes that are likely to be the targets of strong selection, many of which are similar to those found to be under selection in the *gambiae* complex vectors. The work presented here was made possible by several partners across Africa and the UK.

Keyword: Population structure, Selection, *funestus* complex, vector control, mosquitoes

ABS-327

Effectiveness of indoor residual spray on malaria control; a review of the malaria cases among children under five years in Rachuonyo North Sub-County, Homa Bay County, Kenya.

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Indoor residual spraying (IRS) is one of the key interventions recommended by World Health Organization in preventing malaria infection. Rachuonyo North is one of the Sub counties of Homa Bay County where IRS has been implemented from 2018 to 2022.The objective of this study was to assess the effect of IRS on malaria cases among children under 5 years pre and post IRS. IRS was done in the month of February every year, we abstracted retrospective malaria data from KHIS MOH 706 Rev 2022 for the year 2021 and 2022 and tallied monthly aggregates of total tests done and the positivity rates among children less than 5 years in Rachuonyo North Sub County. We performed descriptive analysis and estimated the effect of the interventions and temporal changes of malaria positivity rate before and after IRS and nine months post IRS. We also compared the effect of the insecticide used during the IRS activity on malaria cases. Total malaria test were 8239 and 7502 in 2021 and 2022 respectively. Fludora fusion insecticide was used in 2021 IRS whereas Fumi shield was used in 2022. Average positivity rate was 20% (1582/8239) in 2021 and 29% (2192/7502) in 2022. Malaria cases reduced from 24%(94/390) in January to 10%(55/567) in February after IRS with Fludora fusion in 2021. However, in 2022 there was increase in cases from 26%(181/705) in January to 30%(107/352) in February after spray with Fumi shield. Follow up nine months later, malaria positivity rate was at 23%(204/872) from 10%with Fludora fusion whereas Fumi shield recorded a slight increase to 32%(275/857) from 30%. IRS has demonstrated reduction in malaria cases and effectiveness in malaria control however the efficacy seem to be short lived, if the frequency of spraying is enhanced can yield better results.

Keyword: IRS, Effectiveness, Malaria, Control

ABS-339

Increase in the malaria entomological inoculation rate following indoor residual spraying (irs) withdrawal in Atacora, Benin

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The National Malaria Control Program withdrew IRS from the Atacora department in Northern Benin after six consecutive years (2011 to 2016) of implementation in the region. This was done with the expectation that past IRS campaigns significantly suppressed the seasonal malaria transmission in Atacora. This study assessed the entomological inoculation rate (EIR) after the IRS withdrawal. Monthly mosquito collections by human landing captures (HLCs) were done in two Atacora districts (Natitingou and Toukountouna). Entomological monitoring occurred during the last IRS campaign year (2016) and two years after the IRS withdrawal (2018), both times from January to December. Technical constraints prevented entomological assessment in 2017. Malaria vectors were tested for the presence of Plasmodium falciparum sporozoites by ELISA. Two years after IRS withdrawal, the average EIR increased in the two survey districts. In 2016, the cumulative EIR ranged from 17.2 infected bites/year in Natitingou to 24.8 infected bites/year in Toukountouna. In 2018, the EIR range significantly increased ($p<0.0001$) to 94.9 infected bites/year in Natitingou to 129.2 infected bites/year in Toukountouna. While the EIR increased significantly after IRS withdrawal, it's not clear if mitigation measures were insufficient in this seasonal malaria transmission setting or other factors, such as rainfall, accounted for the increase EIR. Additional analysis or investigation should be done establish if IRS withdrawal led to increased EIR. Nonetheless, robust epidemiological and entomological monitoring is needed before IRS is withdrawn, and appropriate mitigation efforts should be in place to maintain the gains by IRS and monitor transmission trends to avoid any rebound of transmission.

Keyword: IRS; disruption; malaria; Benin

ABS-375

Comparative efficacy of two new light traps for consideration of use in surveillance of malaria-vectors

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Mosquito surveillance is an important component of national disease control and research programs. The Centre for Disease Control (CDC) miniature trap is considered a standard light trap for vector surveillance. The cost as well as logistics involved in the acquisition of this trap can be a challenge for programs in Africa. Recently, several new light traps became available from alternative suppliers. We tested the efficacy of two new traps namely BG-Pro (Biogents AG, Regensburg, Germany) and Silver Bullet (SB) (Lumin8, Gauteng, South Africa) in comparison to the standard CDC light trap in trapping *Anopheles gambiae sensu lato*. Semi-field and field test were conducted to evaluate the efficacy of the traps under comparable conditions following a Latin square design. Semi-field tests were conducted where insectary reared *An. gambiae s.l.* mosquitoes were released in 3 different screen houses containing either BG-pro, SB or CDC light trap, and their recapture rates measured. Field efficacy evaluation involved set up of traps, both indoors and outdoors, in selected study homes. Specimen captured were morphologically differentiated and quantified. The wavelengths and absolute spectral irradiance of traps were additionally measured using spectrometry. In a competing semi-field assay, the odds of recapturing mosquitoes when using SB was three times (OR 3.2, 95% CI 2.6-4.0) higher than the CDC light trap while the odds of recapturing released *Anopheles gambiae s.l.* in a non-competing semi-field assay using BG-Pro was four times (OR 4.0, 95% CI 2.7-5.8) higher than those recaptured by the CDC light trap. In the field, the mean indoor and outdoor catches of *Anopheles gambiae s.l.* in the SB, BG-Pro and CDC traps were comparable. BG-Pro and Silver Bullet traps are a good addition to the current mosquito surveillance tools and can be used to efficiently quantify the primary vector of malaria.

Keyword: Mosquito surveillance, Light Traps, CDC, BG-pro, Silver Bullet

ABS-400

Plasmodium malariae contributes to high levels of malaria transmission in a forest-savannah transition area in Cameroon

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Malaria control efforts are highly skewed towards *Plasmodium falciparum* while overlooking other Plasmodium species such as *P. malariae*. A better understanding of the role of Plasmodium species other than *P. falciparum* is needed to strengthen malaria elimination initiatives. The aim of the present study was to elucidate the contribution of *P. malariae* to malaria transmission in Cameroon. The study was conducted in the Ngatti Health District, a forest–savannah transition area in the Adamawa Region, Cameroon. A total of 497 individuals aged from 1 to 85 years were diagnosed with malaria in November 2020 using a rapid diagnostic test (RDT) and microscopy. Dried blood spots were collected from 156 participants with the aim to detect different Plasmodium species by nested PCR. The overall Plasmodium prevalence was 50.3%, 51.8% and 64.7%, as detected by microscopy, the RDT and PCR, respectively. Based on the PCR results, *P. falciparum* was the most prevalent species (43%); followed by co-infections *P. falciparum/P. malariae* (17%), P. falciparum/P. ovale (1.3%), *P. falciparum/P. ovale/P. malariae* (1.3%); and then by *P. malariae* mono-infection (2.5%). The same trend was observed using microscopy, with 35% of participants infected with P. falciparum, 11% co-infected with P. falciparum/P. malariae and 4% infected with P. malariae. The prevalence and parasite density of malaria infection varied significantly with age group ($P < 0.05$), and the density of Plasmodium infection increased significantly in children aged < 5 years compared to the other age groups ($P = 10−3$). The results of this study reveal the significant contribution of *P. malariae*, in addition to *P. falciparum*, to the high malaria transmission rate in this region highlighting the need to deploy initiatives to also tackle this Plasmodium species to eliminate malaria in the region.

Keyword: Malaria, *P. falciparum, P. malariae, P.ovale*

ABS-403

Molecular surveillance leads to the first detection of *Anopheles stephensi* in Kenya

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Anopheles stephensi, an invasive malaria vector, is native to south Asia and the Arabian Peninsula and has recently been reported in the Horn of Africa countries including Djibouti, Ethiopia, Sudan, Somalia, and Nigeria. It is characterized by a high degree of behavioral plasticity and making it a potential propagator of malaria transmission in rapidly urbanizing settings with poor drainage. The World Health Organization (WHO) has called on all countries to scale up surveillance efforts to report invasion by this vector and institute appropriate and effective control mechanisms. In Kenya, the Division for National Malaria Program (DNMP) and its partners have been conducting entomological surveillance in coastal and northern counties that are suspected to be at risk of An. stephensi invasion as well as counties at risk of malaria. These efforts were supported by molecular surveillance of *Anopheles* mosquitoes by the Kenya Medical Research Institute (KEMRI) to try and identify *An. stephensi*. Mosquitoes were collected in December 2022 and February 2023. Polymerase Chain Reaction (PCR) was used as the primary method of identification in addition to morphological identification with further confirmation of results by amplicon sequencing of the ITS2 region. 566 samples were analyzed by PCR, out of these, 44 were confirmed to be An. stephensi from three sub-counties of Marsabit County. Sequencing of the ITS2 region was performed on 4 samples, 3 of which clustered closely with isolates from India, Yemen, Iraq, and Nigeria based on phylogenetic analysis. The vector's detection in Kenya necessitates immediate reexamination and expansion of vector surveillance and control. This is likely to heighten transmission in Northern Kenya and beyond. Additional investigations may involve collecting more *An. stephensi* to identify genetic markers and analyzing genetic relationships and migration patterns through population genetic analyses.

Keywoed: *An. stephensi* in Marsabit County, Kenya.

ABS-438

Understanding the entomological drivers of malaria transmission in high-burden villages in Vhembe District, Limpopo Province, South Africa.

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Despite control efforts, the Vhembe District, Limpopo Province, South Africa (SA), continues to experience the highest autochthonous malaria case incidence per population ratio in SA. Malaria cases occur perniciously across five villages and one wildlife ranch, which requires focused investigation into the entomological drivers and other contributing factors. Investigations were conducted to identify primary, secondary

and unknown mosquito vectors in the District from 2020 to 2023. Adult mosquitoes were collected using CO2-baited traps and larvae were collected from all breeding site types. Species identification was performed morphologically and, when appropriate, molecularly. Plasmodium circumsporozoite protein detection by enzyme-linked immunosorbent assay was performed on trapped female adults towards vector incrimination. Relationships to climate and environmental data obtained from the South African Weather Services and National Aeronautics and Space Administration, were assessed to identify further factors determining transmission. A total of 8223 (68.1%) anophelines were collected, while larval infested water bodies were detected in 5/6 sites. Of the 25 Anopheles species collected, only one *An. arabiensis* and two *An. merus*, significant malaria vectors in SA, were collected. *Anopheles vaneedeni*, a recently incriminated SA malaria vector, was collected in higher numbers (14). Other species such as *An. rivulorum, An. leesoni, An. coustani, An. demeilloni, An. rufipes,* implicated in malaria transmission in other countries, were also collected in high numbers (>156). Unfortunately, *Plasmodium falciparum* sporozoites were not detected. The almost complete absence of primary vector species in the Vhembe District suggests other Anopheles species are largely responsible for ongoing transmission. Further investigations and surveillance are required to determine the contribution of these species to malaria transmission to inform future targeted and effective control.

Keywords: Malaria vector, Anopheles, Vector surveillance, Ecology

ABS-442

Quantifying predictors of human-to-mosquito malaria parasite transmission in southern Malawi

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A better understanding of human-to-mosquito transmission dynamics and human infectious reservoirs of *Plasmodium* in Malawi will improve the design and evaluation of interventions to reduce transmission. We aim to quantify the predictors of infectiousness among participants in a longitudinal cohort in southern Malawi using membrane-feeding assays. Participants of all ages (n=147) in 25 households in 4 clusters are screened by qPCR (18S rRNA gene) fortnightly (Nov 2022-July 2023). Venipuncture samples for membrane feeding are

obtained 7-10 days after screening from asymptomatic participants with at least 1 parasite/µl. Whole blood is fed to *Anopheles gambiae* Kisumu strain mosquitoes. Oocysts are detected and quantified by microscopy 10 days after feeding. Predictors and outcomes will be assessed. 69 feeds have been conducted, we anticipate presenting the results from 200 feeds. On the feeding day, the mean parasitemia by microscopy was 8648parasites/ul (median=0, IQR=0 to 420) and 8.7 gametocytes/ul (median=0, IQR=0 to 0). Among 69 feeds, 8 (12%) resulted in at least one infected mosquito. Among infectious feeds, 1.5%-8% of mosquitos were infected with a mean oocyst density of 1.7 (range 1-4). Feeds that resulted in mosquito infection were more likely to contain microscopically-detected gametocytes: 75% (6/8) of infectious feeds contained gametocytes, while 3% (2/61) of non-infectious feeds contained gametocytes (p=0.001). The proportion of feeds resulting in at least one infected mosquito increased with participant age but was not statistically significant: 0% (0/3) for participants less than five years old, 8.7% (4/46) for participants 5-15 years old, and 20% (4/20) for participants over the age of fifteen (p=0.144). The difference in infectious feeds between females (14.3%, 7/49) and males (5.0%, 1/20) was not statistically significant. We anticipate overall data to contribute to quantifying the predictors for human-to-mosquito malaria parasite transmission.

Keyword: Malaria transmission, *Anopheles gambie*, oocysts

ABS-481

Arboviral disease outbreaks in Kenya: a historical perspective, current trends and the role of vector surveillance in early detection

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Arboviruses are transmitted by arthropods: mosquitoes, ticks, sand-flies, culicoides, often resulting in outbreaks. In Kenya, the first outbreak (1912), involved Rift Valley Fever Virus (RVFV). Previously linked to prolonged heavy rainfall, recent trends have involved minimal rains in central and western regions. Subsequent arboviral outbreaks involved dengue and chikungunya, which first emerged in Kenya in coastal region in 1982 and 2004 respectively. From 2011-2018, dengue and chikungunya outbreaks occurred in Mombasa, Lamu, Mandera, Wajir, Garissa, and West Pokot. The first Yellow fever (YF) outbreak occurred in 1992-1993 in Kerio Valley in the Rift Valley.

Entomologic investigations using standard tools was conducted to determine vector prevalence in outbreak sires, and their role in transmission. The 2006-2007 RVF outbreak in northeastern and Rift Valley involved *Aedes mcintoshi*, *Ae. ochraceus* and *Ae. tricholabis*; and other species in the genera: *Mansonia, Culex* and *Anopheles*. From 2018-2022, dengue and chikungunya outbreaks repeatedly occurred in coastal region. The principle vector, *Ae. aegypti*, was collected in large numbers after *Cx. quinquefasciatus*. Dengue and chikungunya viruses were isolated from *Ae. aegypti* while chikungunya was also isolated from *Cx. quinquefasciatus*. YF also re-emerged in Isiolo (2022-2023). Entomologic investigations showed the presence of sylvatic cycle vectors including *Ae. simpsoni*, *Ae. chauseri*, *Ae. furcifer*, and urban cycle vectors, *Ae. aegypti.* Outbreaks continue to expand their geographic spread. It is unknown when, where and the magnitude of the next outbreak, and the virus that will be involved. For humanity to be safe from arboviral diseases, deliberate efforts must be made to fund surveillance activities in Africa, which is the origin of most arboviruses, because: "If we don't go out looking for these viruses, they will come out looking for us".

Keywords: Arboviruses, vectors, surveillance, outbreaks

ABS-487

So near but so far away: Indoor versus outdoor malaria transmission in an area targeted for malaria elimination

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In-depth knowledge of malaria vectors and their bionomics in low transmission settings is critical for malaria elimination strategies. South Africa's goal is to eliminate malaria by 2030. However, the failure to address the ongoing residual malaria transmission is of grave concern. Literature suggests that malaria residual transmission is mainly driven by outdoor biting vectors. Against this background South Africa KZN-MCP, has strengthened its entomological malaria surveillance focusing on outdoor-mosquito collection methods. This work presents surveillance in malaria- prone and malaria-free zones 2020-2022. Larvae and adult *Anopheles* were sampled in UMkhanyakude, Zululand, and King Cetstwayo districts of KZN. Adults were collected by HLC, clay pots, tyres, PSC catches, C02 TT, animal shelters, and drums. *Anopheles* were identified morphologically. *Anopheles gambiae* complex and *An. funestus s.l*. were further PCR. 2,506 Anopheles were collected. Of these, 1027; 224 and 69 were morphologically identified as *Anopheles gambiae* complex, *An. funestus s.l.* and *An. coustani*, respectively. Most mosquitoes were sampled outdoor with only 3 collected inside houses using PSC. Overall, clay pots collected 19.55%, animal shelters 15.56%, and tyres 12.3%. *Anopheles gambiae* complex were mainly from tyres 77.92%, clay pots 75.05% and animal shelters 24.10%. *Anopheles funestus s.l.* was from animal shelters 22.56%, clay pots 17.70%, and tyres 13.0%. 566 *An. gambiae* complex

and 140 *An. funestus s.l*. specimens were PCR of which 39.4 % *An. arabiensis* and no *An. funestus ss*. found. Entomological surveillance should be enhanced including monitoring other entomological indicators to confirm the role of malaria outdoor transmission. This will provide comprehensive information to include supplementary vector control tools to combat outdoor malaria-biting mosquitoes as part of the KwaZulu-Natal's malaria elimination agenda.

Keyword: Malaria elimination, An. arabiensis, Outdoor transmission,

ABS-513

Contrasting effects of the alkaloid ricinine on the capacity of *Anopheles gambiae* and *Anopheles coluzzii* to transmit *Plasmodium falciparum*

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Besides feeding on blood, females of the malaria vector *Anopheles gambiae* sensu lato readily feed on natural sources of plant sugars. The impact of toxic secondary phytochemicals contained in plant-derived sugars on mosquito physiology and the development of *Plasmodium* parasites remain elusive. The focus of this study was to explore the influence of the alkaloid ricinine, found in the nectar of the castor bean Ricinus communis, on the ability of mosquitoes to transmit *Plasmodium falciparum*. Females of *Anopheles gambiae* and its sibling species in *Anopheles coluzzii* were exposed to ricinine through sugar feeding assays to assess the effect of this phytochemical on mosquito survival, level of *P. falciparum* infection and growth rate of the parasite. Ricinine reduced mosquito median survival by 3.5 days of both *Anopheles* species. Ricinine caused acceleration in the parasite growth rate with an earlier invasion of the salivary glands in both species than in control (LRT X2 =4.36, df= 1, P = 0.037). At a concentration of 0.04 g l-1 in *An. coluzzii*, ricinine had no effect on mosquito infection, while 0.08 g l-1 ricinine-5% glucose solution induced a 14% increase in *An. gambiae* infection rate (LRT X2 = 4.5, df = 1, P = 0.03). Overall, our

fndings reveal that consumption of certain nectar phytochemicals can have unexpected and contrasting effects on key phenotypic traits that govern the intensity of malaria transmission. Further studies will be required before concluding on the putative role of ricinine as a novel control agent, including the development of ricinine-based toxic and transmission-blocking sugar baits. Testing other secondary phytochemicals in plant nectar will provide a broader understanding of the impact which plants can have on the transmission of vector-borne diseases.

Keywords: *Plasmodium falciparum, Anopheles coluzzii, Anopheles gambiae*, Ricinine, Malaria transmission

Parallel Scientific Session 14: LLINS, IRS and insecticide resistance management (Student track – Student Competition)

ABS-12

First report of V1016I, F1534C and V410L kdr mutations associated to pyrethroid resistance among *Aedes aegypti* from Niamey, Niger

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Ae aegypti is the vector of important arbovirus including Dengue, Zika, Chikungunya and Yellow fever. Though this vector was not specifically targeted by insecticide-based control programs in West Africa, it has been reported to become resistant in countries of this region. We investigated *Aedes aegypti* insecticide resistance status and mechanisms involved in Niamey, the capital of Niger, in order to provide baseline data required for arbovirus outbreak prevention and preparedness in the country. Ovitraps were used to collect *Ae aegypti* eggs that are thereafter hatched in the laboratory for bioassay tests. Larvae reared to adults stage of 3-5 days old mosquitoes were used for WHO tubes and CDC bottles bioassays with synergist tests. F1534C, V1016I and V410L kdr mutations were genotyped using AS-PCR methods. Population of Ae aegypti from Niamey was found highly resistant to pyrethroids but susceptible to organophosphates and carbamates. F1534C, V1016I and V410L Kdr mutations were detected and were associated to permethrin resistance, whereas only

F1534C has been associated to deltamethrin resistance. Oxidases and esterases enzymes have been found involved in the mechanism of resistance to pyrethroids. This study reports for the first-time the resistance of *Aedes aegypti* populations to pyrethroid insecticides in Niamey, supported by both target site mutations and metabolic enzymes. These results could support evidence-based decision-making for *Aedes aegypti* control in Niger.

Keyword: *Aedes aegypti*, kdr mutations, pyrethroids, insecticide resistance, Niger

ABS-47

Assessing the preferred resting sites of *Anopheles* mosquitoes inside houses in Chikwawa district, Malawi

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Malaria vector control relies on long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) in Malawi. IRS targets mosquitoes that rest on the inside walls of dwelling structures. However, there is lack of information regarding mosquito resting behaviours inside houses. The study assessed the resting behaviours and identified the preferred resting surfaces of mosquitoes inside three common house types in Chikwawa district. Mosquito collection was done inside 80 houses across four villages (20 thatch roofed with mud walls, 20 thatch roofed with un-plastered brick walls, and 20 iron sheet roofed with un-plastered brick walls) between August and November 2020. In each house, resting mosquitoes were sampled from multiple surfaces (roofs, walls above 1m, and walls below 1m, floors, furniture, and clothing) from 6–8 AM using Prokopack aspirators. 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, <10% of Anopheles were found resting on non-sprayable surfaces (hanging clothes, furniture and floors). 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.

Keywords: *Anopheles funestus*, *Anopheles gambiae s.l.*, malaria transmission, indoor resting behavior

ABS-139

Insecticide Resistance and Whole Transcriptome Profiles of *Anopheles funestus* Population in western Kenya

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Anopheles funestus is an efficient vector of human malaria in Africa. The resurgence of *An. funestus* in western Kenya was partly attributed to insecticide resistance. However, evidence on the molecular basis of pyrethroid resistance in western Kenya is limited. *An. funestus* mosquitoes were sampled by aspiration in Bungoma, Teso, Siaya, Port Victoria and Kombewa in western Kenya. The F1 progenies were exposed to deltamethrin (0.05%), permethrin (0.75%), DDT (4%) and pirimiphos-methyl (0.25%) following WHO tests guidelines. A synergist assay using PBO (4%) was conducted to determine cytochrome P450s' role in pyrethroid resistance. RNA-seq was performed on a pool of specimens which were Resistant, susceptible and unexposed to unveil the molecular mechanisms of pyrethroid resistance. Pyrethroid resistance was observed in all the sites with an average mortality rate (MR) of 57.6%. Port Victoria had the highest level of resistance to permethrin (MR=53%) and deltamethrin (MR=11%) pyrethroids. Teso had the lowest level of resistance to permethrin (MR=70%) and deltamethrin (MR=87%). Resistance to DDT was observed only in Kombewa (MR=89%) and Port Victoria (MR=85%). A full susceptibility to P-methyl (0.25%) was observed in all the sites. PBO synergist assay revealed high susceptibility (>98%) to the pyrethroids in all the sites except for Port Victoria (MR=96%). Whole transcriptomic analysis revealed that the main enzyme families associated with pyrethroid resistance are cytochrome P450s, GSTs, COEs, cuticular proteins and salivary gland proteins. The highly upregulated genes include P450s (CYP4H18, CYP4H17, CYP9J3, CYP4G16, CYP6Y1, CYP18A1, CYP4D17 and CYP4C25), GSTs (GSTE2, GSTE1, GSTE5, GSTU2, GSTU3 and GSTD6), and others (AFUN002514, AFUN010203, AFUN016508, AFUN000373 and AFUN001273). This study highlights the phenotypic resistance and genes involved in the pyrethroid resistance of *An. funestus* in western Kenya.

Keywords: *Anopheles funestus*, insecticide resistance, western Kenya, RNA-seq, pyrethroid, DDT, PBO

ABS-155

Phenotypic and molecular insecticide resistance monitoring of *Anopheles funestus* mosquitoes to guide malaria control efforts in Tanzania.

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Insecticide-based vector control approaches remain the mainstay of malaria control in Africa. The effectiveness of these tools is however threatened by the increasing vector resistance to the insecticides. In Tanzania, *Anopheles funestus* is an increasingly important malaria vector mediating most of the transmission in some settings compared to other vectors. Consequently, its routine resistance monitoring is crucial to ensure the continued efficacy of control tools against it. We assessed the resistance status of *An. funestus* to pre-determined doses of insecticides in nine regions of Tanzania representative of geographical variations and malaria transmission intensity. We further genotype the mosquitoes to monitor allele frequencies of three metabolic resistance genes - CYP6P9a, L114F-Gste2, and CYP6P9b; additionally, we analyzed the association between surviving the standard insecticide dose (phenotypic resistance) and these resistant alleles (genotypic resistance) using generalized linear models. We found high resistance to deltamethrin and permethrin across the country (mortality range 24-55%); however, susceptibility was fully restored following mosquito pre-exposure to PBO. Resistance to bendiocarb was mostly observed in the South (Mtwara, Lindi, & Ruvuma) and North (Kagera) of the country (mortality range 57-77%) with full susceptibility to DDT and pirimiphos-methyl. Moderate resistance intensity to deltamethrin was observed in coastal regions (Mtwara, Lindi, & Pwani). Similarly, we observed moderate intensity for permethrin in Katavi and Mtwara. We observed a positive association between CYP6P9b and L114F-Gste2-resistant alleles and phenotypic resistance. However, CYP6P9a-resistant alleles did not increase the chances of insecticide survival. These findings provide a basis for implementing resistance management strategies to limit the further exacerbation of resistance and its impact on malaria control.

Keywords: *Anopheles funestus*, insecticide resistance, malaria

ABS-158

A 2-year temporal investigation of insecticide resistance in *Anopheles funestus* from Uganda reveals an escalation with no association to known molecular markers

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Insecticide resistance escalation is a major threat to sustaining the success of malaria vector control. In this study, we monitored the temporal patterns of insecticide resistance and associated mechanisms from 2021 to 2022 in *An. funestus.* Mosquitoes (F0) were collected in October 2021, March 2022 and November 2022 from eastern Uganda and used to rear progeny (F1). Resistance phenotyping to all classes of insecticides was conducted with F1s with synergistic assays and dose-response assessed for pyrethroids. Resistance markers were genotyped in F0s and gene expression profile of six significant key genes assessed in F1s exposed to pyrethroids. Intense resistance was observed to pyrethroids in October 2021 and November 2022 but not March 2022. At higher diagnostic doses, greater mortality was observed with permethrin compared to alpha-cypermethrin and deltamethrin. Similar observations were made with bednets except for Permanet 3.0 where mortality was 100%. Resistance was observed to organochlorines and carbamates but mosquitoes were susceptible to organophosphates, neonicotinoids and pyrroles. Synergistic assays revealed cytochrome P450s as the major drivers with limited role played by glutathione-s-transferases and carboxyl esterases. Known resistance markers were either at very low frequencies, lower than 5% (N485I-Ace1, A296S-RDL, Gste2-119F, Cyp6P9a, Cyp6P9b,), fixed (4.3kb-SV, G454A-Cyp9K1) or absent entirely (6.5kb-SV) hence, no significant association with resistance was observed. CYP9K1 gene was the most overexpressed while GSTE2 was the least overexpressed. This study suggests that novel genetic elements (markers) are associated with the resistance in *An. funestus* in Uganda but CYP9K1 gene seems to be a major driver of pyrethroid resistance. Carbamate resistance is possibly being driven by cross-resistance with pyrethroids. Genomic approaches will be used to unravel mechanisms responsible for the resistance.

Keywords: Insecticide resistance, *Anopheles funestus*, resistance escalation, molecular markers, temporal, Uganda

ABS-194

Association between g119s mutation (ace-1) and detoxification genes with bendiocarb and malathion resistance in two major malaria vector populations in 207urrent207.

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The spread of pyrethroid resistance in malaria vectors is a major threat affecting the performance of 207urrentt control measures. However, there is still not enough information on the resistance profile of mosquitoes to carbamates and organophosphates which could be used as alternatives. The present study assessed the resistance profile of *Anopheles gambiae s.l.* to bendiocarb and malathion, at the phenotypic and molecular levels, in different eco-epidemiological settings in Cameroon. *Anopheles gambiae s.l*. mosquitoes were collected from four eco-epidemiological settings across the country and their susceptibility level to bendiocarb and malathion was determined using WHO tubes bioassays. The ace-1 target site G119S mutation was screened by PCR. Reverse Transcription quantitative PCR 3-plex TaqMan assays were used to quantify the level of expression of eight genes associated with metabolic resistance. Resistance to malathion and/or bendiocarb was recorded in all study sites except in mosquitoes collected in Kaélé and Njombé. The Ace-1 (G119S) mutation was detected in high frequencies (>40%) in Kékem and Santchou. Both *An. gambiae* and *An. coluzzii* were detected carrying this mutation. The cytochrome P450s gene Cyp6p3 associated with carbamate resistance and the glutathione S-transferase gene Gste2 associated with organophosphate resistance were found to be overexpressed. Genes associated with pyrethroid (Cyp6m2, Cyp9k1, Cyp6p3) and organochlorine (Gste2, Cyp6z1, Cyp6m2) and cuticle resistance (Cyp4g16) were also overexpressed. The rapid spread of resistance to organophosphates and carbamates could seriously compromise future control strategies based on IRS. It is therefore becoming important to assess the magnitude of bendiocarb and malathion resistance countrywide.

An. gambiae, An. coluzzii, carbamates, organophosphate, resistance, ace-1 (G119S) mutation, overexpression, Cameroon

ABS-217

Reorienting Vector Surveillance and Management in the Context of Emerging Threats: Report on the mosquito larvae spraying exercise held on march 15, 2022 at Kigoma / Ujiji Municipal Council

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Mosquito larvae spraying is an effective method of controlling the population of malaria vectors by targeting the larvae of mosquitoes in their breeding sites. Malaria remains a significant public health concern in many parts of the world,To reduce the burden of malaria, it is crucial to prioritize mosquito larvae spraying as a preventive measure against the disease. However, there are several challenges to implementing this method effectively. Kigoma/Ujiji Municipality is implementing various measures to fight against malaria, including mosquito larvae spraying. The municipality has 10 mosquito breeding sites. On March 11, 2022, another round of spraying was carried out, treating over 70% of all breeding sites in the municipality. However, there are still several challenges that need to be addressed to improve the effectiveness of the mosquito larvae spraying exercise. The limited funds and low treatment coverage have rendered the process less effective. The shortage of insecticides has led to partial treatment, potentially causing long-term effects such as resistance to the chemicals. Poor community participation, a lack of skilled personnel, and a lack of follow-up mechanisms are also significant challenges. To address these challenges, recommendations have been made, including mobilizing resources to facilitate larvicidal activities, procuring enough insecticides to cover all breeding sites, conducting community mobilization and sensitization, training healthcare workers and community volunteers, establishing a follow-up mechanism, and coordinating interventions during spraying time. Reorienting vector surveillance and management in the context of emerging threats could help address these challenges and achieve the project's objectives. By implementing the recommendations and addressing the challenges, the mosquito larvae spraying exercise can be more effective in preventing malaria transmission in Kigoma/Ujiji Municipality and globally. The article discusses the importance of mosquito larvae spraying as an effective method of controlling the population of mala

Keywords: Breeding sites, Vector

ABS-525

The exigent threat of the alien invasive *Anopheles stephensi* in Africa

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The invasion and spread of *Anopheles stephensi*, a new malaria vector species, present an exigent threat to health systems across Africa, particularly in urban settings where the vector is known to thrive. Outside of the native range in South Asia and the Arabian Peninsula, *An. stephensi* was first reported in Djibouti and has since spread across the Horn of Africa. Although attempts have been made to establish its potential distribution, quantified areas of absolute change in time and space have not been defined. We fitted a mathematical model to *An. stephensi* occurrence data in its native and invasive range to assess the risk of transmission of malaria considering urbanization, vector bionomics and climate change scenarios. The basic reproduction number (R0) for transmission of malaria by *An. stephensi* was estimated using an agent-based compartmental model (ABM) where observed host-vector populations were divided into susceptible-exposed-infectious-recovered (SEIR) compartments under the assumption that vectors remain infectious until death. R0 was spatially projected onto country-specific geographical coordinates using a temperature-dependent mathematical expression of R0 that incorporates age-stratified vector mortality rates. Our ABM highlighted shifts in the distribution of *An. stephensi* in space and time based on R0. The spatial distribution map defined the range of malaria transmission by the invasive malaria vector using R0 estimated from SEIR compartmental model. Understanding spatial distribution of this alien invasive vector is imperative to improving control strategies and informing public health policy interventions.

Keywords: *Anopheles stephensi*, urban centers, agent-based model, basic reproduction number, malaria.

ABS-543

Entomological surveillance of malaria vectors in Turkana County, an arid and Semi-arid region in Kenya

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Turkana County is arid and semi-arid region in Kenya which is sparsely populated with predominantly semi-nomadic population, hardly reached with convectional malaria control. Recently, there have been reports of malaria outbreaks in Kenya with emerging new foci including Turkana County. There is the need to survey malaria vectors and its associated risk factors to inform control strategies. In this study, we sought to determine prevalence, parasite infection rates and blood feeding preference on malaria vectors in Turkana County. Mosquito collections were done in 2017 and 2020 in 6 villages in Turkana County. Adult mosquitoes were sampled using CDC light traps while scoopers were used for larvae collection. Taxonomical keys by Gillies and De Meillon, (1968) and Gillies M.T. and Coetzee M. (1987) were used for mosquito morphological identification. *Anopheles gambiae* and *An. funestus* complex mosquitoes were further analyzed for sub-species identification following DNA extraction by Collins et al., (1987) and PCR by Scott et al., (1993) and Koekemoer et al., (2002) protocols. Sporozoite and blood meal analysis was done using ELISA technique described by Wirtz et al., (1987). A total of 484 were collected. For 2017, 86.5% were *An. arabiensis* 13.5% did not amplify. In 2020, 54.2% were identified as *An. arabiensis* 6.2% *An. gambiae s.s* while 39.6% did not amplify. 42.9% fed on human and 1.5% were positive of *Plasmodium falciparum*. *Anopheles arabiensis* is the dominant vector in Turkana County. 40% of *anophelines* were not identified as *An. gambiae* or *An. funestus* complexes, the dominant malaria vectors in Kenya indicating possibility of new species in the county requiring further investigation. The mosquitoes were infected with Plasmodium falciparum and feeding on human indicating local transmission, therefore, malaria control strategies need to be implemented in the County.

Keyword: *Anopheles gambiae*, *Plasmodium falciparum*, Malaria

ABS-550

Towards Community Based Vector Surveillance through VectorCam, a novel artificial intelligence –based tool for mosquito identification

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Vector surveillance is the key strategy for Integrated vector management of Malaria, however, with the global shortfall of the expert taxonomist, there is a need to deskill the task of vector surveillance to the non-skilled village health team (VHT). VectorCam is a computer vision-aided handheld tool for morphological identification of mosquito species, sex, and abdominal status that can be operated without the need for an expert entomologist. We plan to field test VectorCam in Uganda through a pilot study to compare the accuracy, timeliness, and completeness of VectorCam's vector surveillance data being captured through the hands of the Village health team. Randomized case-control study is proposed for 1 year in two districts of Uganda for the pilot implementation of VectorCam. The study arm will have VectorCam being used by VHTs and the control arm will continue to have routine vector surveillance. An equal number of houses will be used from the same sentinel sites in both arms of the study for mosquito collection with the same methods of mosquito collection (PSC and CDC light traps). Vector surveillance data being captured will be reported to DHIS2 and will be compared for accuracy, timeliness, completeness, and cost-effectiveness of both arms in a phased manner. The core algorithm was tested against wild-caught specimens in Uganda- and achieved accuracy as follows: Species- *Anopheles funestus s.l*. (96%), *An. gambiae s.l.* (94%), other *Anophelines* (91%), *Culex sp.* (97%), and other genera (97%). Sex (95%) and abdominal status (86%), respectively. The pilot study will evaluate the effectiveness of this as a field tool for community-based vector surveillance. VectorCam offers the promise of using artificial intelligence, to deskill the process of mosquito identification and enable a community-based surveillance strategy. This proposed study will generate the evidence needed to support such an approach.

Keyword: Community Based Vector Surveillance, artificial intelligence –based tool for mosquito identification

ABS-558

ANOSPP: amplicon sequencing for high throughput *Anopheles* mosquito species identification and *Plasmodium* presence status

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Anopheles is a diverse genus of mosquitoes and malaria vectorial capacity varies widely among its species. Conventional morphological and PCR-based diagnostics are not always conclusive. Secondary malaria vector species are gaining attention but remain understudied. ANOSPP is designed to overcome these challenges and because it requires very small amounts of DNA that can be non-destructively extracted, mosquito morphology remains accessible for later examination after sequencing results reveal the species. ANOSPP is a multiplex amplicon sequencing approach that generates 10,000 base pairs of sequence data from 62 loci distributed across the generic nuclear Anopheles genome and 2 loci in the Plasmodium mitochondrial genome. A single Illumina MiSeq run generates data for 768 individuals. K-mer based alignment free sequence data analysis ensures accurate species prediction across the entire Anopheles genus. ANOSPP can differentiate closely related species and this information is complemented by parasite detection and identification. We have processed tens of thousands of samples through ANOSPP, with partners' research interests varying from species diversity surveys to ecological differentiation studies and intervention efficacy tracking. We have discovered unexpected species in some locations and mosquitoes carrying a variety of different Plasmodium species. We hope to have half a million individual mosquitoes sequenced in the next few years. Importantly, we are seeking to expand our reference index and are looking to acquire samples of every described species (see https://www.sanger.ac.uk/collaboration/the-anospp-project/) and we are developing simplified workflows from sample to analysis that can be used locally by vector biologists in malaria endemic regions. We hope ANOSPP will become a useful tool for malaria control efforts across the globe, but especially in Africa.

Keyword: Taxonomy, sequence analysis, pipeline, genomic surveillance

ABS-437

Characterizing human reservoirs of *P. falciparum* transmission

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In the life cycle of malaria parasites, humans play an important role by transmitting parasites to mosquitoes. Previous studies suggest that asymptomatic individuals carrying microscopically detected gametocytes are most likely to transmit P. falciparum to mosquitos. We aimed to determine the factors that predict microscopically detectable gametocyte carriage among participants in an intensive cohort study in southern Malawi. Individuals of all ages (n=146) in 4 clusters (5-7 households per cluster) were screened for infection by microscopy every 2 weeks from December 2021-July 2022. In this study, 2,092 blood smears were evaluated for gametocytes and 227/2092 (10.9 %) were positive for asexual parasites. Preliminary results show that gametocytes were detected in 28 participants (1.3%) with median gametocyte density of 32 parasites/ul [IQR: 16-72]. The mean age of participants with gametocytes was 14.9 years [sd=14.7, range 0-79], which was not different than the mean age of the sampled population [17.0, sd=17.3, p=0.5]. Eleven percent (16/146) of participants had gametocytes detected on at least one visit. Some participants, 13/146 (8.9%) had repeated gametocyte carriage with 1-4 months between gametocyte-positive samples. Males were overrepresented among gametocyte carriers (50 %) compared to their contribution to the sampled population (38%) but this was not statistically significant (p=0.2). Further analysis including duration of infection preceding gametocytemia will be presented. In our setting the gametocyte carriage rates were not influenced by age or gender.

Keywords: malaria, asymptomatic, gametocytemia, gametocyte carriage

ABS-622

The subtle art of herding cats: Cultivating cadres of expert leaders who are individually independent but nevertheless collaborate and learn together as effective teams

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Like populations of social animals that rely heavily on collective learning and navigational, human expert communities depend on accumulation of knowledge by relatively small leadership cadres who then share it with their emerging successors. Correspondingly, they are vulnerable to collapse if those key individuals are regularly lost, denied learning opportunities, or prevented from passing on what they know. Large shared programmes that enable inclusive, active participation in programme management by all responsible lead

investigators, especially less experienced emerging investigators, play a key role in establishing such essential peer-to-peer knowledge exchange. They should therefore be led by management committees that include all the responsible lead investigators as de facto peers. Such formal management committees should be composed exclusively of investigators responsible for delivering the programme objectives, all of whom are formally assigned equal concrete voting powers in relation to resource allocation decisions, regardless of current career stage. Note, however, that such collectively managed large-scale programme awards should complement rather than substitute for the regular small-to-medium sized project awards that enable continued growth of early-to-mid career investigators. Funders and principal investigators of large-scale programme awards should therefore avoid subsuming the project ideas and funding opportunities that allow competitive emerging investigators to establish their independence as established investigators in their own right.

Keyword: Capacity strengthening

ABS-664

Field assessment of resting boxes for the surveillance of malaria vectors in the Central Highlands of Madagascar

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Malaria remains a public health concern in Madagascar. Assessment of the resting box (RB), a trap mimicking a resting place for mosquitoes, as a malaria vector sampling tool was conducted in order to develop a new method for entomological surveillance. Resting boxes were monitored in different places in the village of Ambohidrangory and in its immediate surroundings, in the district of Tsiroanomandidy, western Central Highlands of Madagascar, from January to July 2022. They were either unbaited or baited with zebu urine or BG-Lure. Muirhead Thomson pits (MTPs) were used as a standard method to compare the effectiveness of the RBs. *Anopheline* mosquitoes were collected and identified. Bloodmeal origin of engorged females as well as malaria parasite infection of females were determined. Both RBs (N = 47) and MTPs (N = 5) collected the same eight anopheline species, including all malaria vectors known to be present in the study site. In RBs, 0.4 (early July) to 4.0 (Mid-May) Anopheles per trap per day were collected whereas, 2.0 (early July) to 48.0 (early January) Anopheles per trap per day were collected in MTPs. Thus, RBs captured ~ 18 times less Anopheles than MTPs. No effect, neither of the attractant, nor of the location of the RBs was found. Blood meal analyses showed the presence of both anthropophilic and zoophilic vectors from the RBs. Mosquitoes infected by malaria parasites were also collected from both RBs and MTPs, with

sporozoïtic indice values for An. coustani of 14.3% for the RBs and 2.5% for the MTPs. The components of the tested RB are easily to find on the local market, cheap, secured and reassuring for the local community. Improvement of such device could lead to its exploitation as a community-based entomological sampling tool for the monitoring of anopheline mosquito populations and hence, the assessment of the malaria transmission risk.

Keyword: Resting trap, Muirhead Thomson pit, Anopheles, Malaria, Madagascar

ABS-44

Species Composition, Blood Meal Preference and Sporozoite Infectivity of Malaria Vector in an Agrarian Community Adjourning Osogbo, South-Western, Nigeria

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Mosquitoes are important vectors transmitting infectious diseases including malaria. Adequate knowledge on their dynamics, biting behaviour and infectivity rate is important in planning effective control strategies. This study was therefore designed to determine the species composition, identification, blood meal sources and sporozoite rate of *Anopheles* mosquitoes in a farm settlement adjoining Osogbo metropolis southern Nigeria. The mosquitoes were sorted using standard morphological keys and subjected to PCR to determine the sibling composition of *Anopheles gambiae s.l*, blood meal source and sporozoite rate in *An. gambiae s.l*. Adult mosquitoes were collected between June to December, 2021 using CDC light trap and PSC. A total of 318 mosquitoes were collected, out of which 185 (58.18%) were *An. gambiae s.l,* 4(1.26%) Ae. aegypti, 104 (32.70%) Cx. quequinfasciatus and 25 (7.86) M. uniformis. Overall mosquitoes collected in the wet season were significantly higher the dry season ($p>0.05$). All An. gambiae s.l identified were confirmed to be *An. gambiae* (S and M form) with PCR. Further analysis reveals that of *An. gambiae* shows preference to human blood meal. However, none of the *An. gambiae* Collected were positive for sporozoite. This study concludes that there is possibility of Ongoing transmission of malaria, lymphatic filariasis and other mosquito-borne diseases in the study area. Conclusively, this study provides an essential information, which can be used as baseline data for planning strategies in controlling malaria in this agrarian community

Keywords: Mosquitoes, Malaria, *Anopheles gambiae s.l*, Blood Meal, Sporozoites, Agrarian, Osogbo, Nigeria

ABS-64

Anopheles funestus populations across Africa are broadly susceptible to neonicotinoids but with signals of possible cross-resistance from the GSTe2 gene

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Evaluating the susceptibility of malaria vectors to the new WHO-recommended products is key step before large scale deployment. We mapped the susceptibility profile of *Anopheles funestus s.l*. to neonicotinoids across Africa and established the diagnostic doses of acetamiprid and imidacloprid with acetone+MERO as solvent. Indoor resting *An. funestus* were collected in 2021 in Cameroon, Malawi, Ghana and Uganda. Susceptibility to clothianidin, imidacloprid and acetamiprid was evaluated using CDC bottle assays. The L119F-GSTe2 marker was genotyped to evaluate the potential cross-resistance between clothianidin and this DDT/pyrethroid-resistant marker. The mortality varied from 28.21 ± 8.5 Chikwawa (Malawi) to 95.6 ± 2.82 Gounougou (Cameroon) for Clothianidin diluted in ethanol, and from 22.55% ± 3.95 for Mayuge (Uganda) to 100% for Gounougou (Cameroon) with Clothianidin diluted in acetone. When associating MERO, Mosquitoes were full susceptible to the three neonicotinoids (mortality = 100%). For Imidacloprid and Acetamiprid, the same low mortality was observed with ethanol/acetone only and the dose of 6 µg/ml and 4 µg/ml were established as diagnostic concentration respectively with acetone+MERO. Pre-exposure to synergists significantly restored the susceptibility to clothianidin showing that metabolic enzymes could contribute to Clothianidin resistance. Also, a positive correlation was observed between L119F-GSTe2 mutation and clothianidin resistance with the homozygote resistant mosquitoes being significantly more able to survive than heterozygote or susceptible. This study revealed that *An. funestus* populations across Africa are susceptible to neonicotinoids and as such this insecticide class could be effectively implemented to control this species using IRS. However, potential cross-resistance confers by GSTe2 calls for regular re-sistance monitoring in the field.

Keywords: Malaria, *Anopheles funestus*, neonicotinoids, clothianidin, L119F-GSTe2, MERO

ABS-292

Status of WHO malaria elimination certification in Cabo Verde

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Over the last three decades there have been significant reduction in residual malaria transmission in Cabo Verde, with zero local malaria transmission reported since January 2018, despite periodic reports of imported cases. This makes the archipelago eligible for the WHO malaria elimination certification process that was initiated in 2021. We provide updates on the status of the external evaluation process by WHO experts to certify Cabo Verde as free of malaria. A survey was made of all the stages of evaluation that the country has gone through to become certified, from the application for certification to the WHO in 2021 until the present. From 2022 to 2023, Cabo Verde has already received 3 evaluations by WHO experts, developed its plan to prevent malaria re-introduction and standard operating procedures in the context of elimination, and several trainings for health professionals and partners involved in the fight against malaria. Cabo Verde is now on track to be certified malaria-free by the end of 2023. Required resources must be allocated to sustain this status, in particular, continued funding and support to maintain entomological and epidemiological surveillance throughout the country to prevent the re-introduction of malaria. The certification will demonstrates the country's commitment to eliminate vector-borne diseases and is an encouragement to other African countries that it is possible to defeat malaria.

Keywords: Elimination; Malaria; Cabo Verde; Certification

Day 4

Parallel Scientific Session 16: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health (Student track – student competition)

ABS-192

Impact of irrigation induced environmental modification on the dynamics, seasonality and behavior of malaria vectors; and the risk of transmission in Ethiopia: The case of Arjo-Didessa Sugarcane Irrigation Scheme

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Ethiopia is expanding irrigation projects to meet food demand of rapidly growing population. However, the impact of such projects on vector bionomics and malaria transmission risk is poorly studied. This study investigated impact of sugarcane irrigation on malaria vector bionomics and transmission intensity. Adult anophelines were collected using CDC light traps and human landing catches from irrigated and non-irrigated clusters of Arjo-Didessa sugarcane irrigation scheme in wet and dry seasons of Ethiopia, between 2018 to 2021. Mosquitoes were identified to species morphologically and using molecular technique. Mosquito composition, abundance, seasonality, behavior (biting & feeding) and infection rates were compared between the two clusters. Mosquito host blood meal sources were determined by multiplex blood meal PCR. Plasmodium sporozoite infections were analyzed using CSP-ELISA. Chi-square was used to compare mosquito abundances while t-test was used to compare mean values. Of 6,058 female Anopheles mosquitoes collected, 72.3% (n=4379) were from irrigated and 27.7% (n=1679) from non-irrigated clusters. Six species were identified in irrigated than four in non-irrigated clusters. Mosquito composition, abundance and density were significantly higher in the irrigated than non-irrigated clusters during wet and dry seasons. *Anopheles gambiae s.l.* had higher human blood index (54.2%, 103/190) in irrigated than non-irrigated (22%, 13/59) clusters. Mosquitoes showed overnight and outdoor biting activities in the irrigated clusters. A 2-fold higher Plasmodium infection rates were recorded in the irrigated than non-irrigated areas. Arjo-Didessa sugarcane irrigation created suitable ground for mosquito propagation, behavioral alterations and risk of transmission in dry and wet seasons. Thus, currently applied vector interventions, including LSM, need to be strengthened to reduce vector density and risk of malaria transmission.

Keywords: Vector Behavior, Irrigation, Environmental modification, Infection rate, Anopheles, Malaria, Seasonality, Bionomics, Ethiopia

ABS-199

Assessing shifts in biting patterns of *Anopheles gambiae* and *Anopheles funestus*, the major malaria vectors in southeastern tanzania

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Long-lasting Insecticidal Nets (LLINs) and Indoor Residual Spraying (IRS) have been key malaria vector control strategies in Africa, including Tanzania. Due to long-term LLIN and IRS use, mosquitoes have evolved physiological and behavioral resilience to insecticides. Hence, residual malaria transmission has increased, endangering malaria elimination efforts. This study examines how mosquito-biting behavior changes could affect malaria epidemiology in Tanzania's South Eastern area. The mosquito electrocuting trap (MET) was used to gather Anopheles mosquitoes from November 2019 to September 2020 in the Rufiji, Kilwa and Kibiti districts. Samples were collected

weekly (18:00 - 06:00) from 22 villages, with three houses per village sampled over three days. For each house, two METs-each including a volunteer-were employed; one trap was set inside the house and the other was positioned 15 meters away outside the house. 3,586 *Anopheles* mosquitoes were collected: 1,912 (53.32%) *An. gambiae s.l* and 1,666 (46.46%) *An. funestus.* Kiwanga village in Rufiji had the highest *An. gambiae* abundance(n=375,19.6%) followed by Ignito Kati(n=291,15.2%) in Kilwa. Mtawanya village in Kibiti had the highest abundance of *An funestus*(n=1113,67%). Overall, *An gambiae* exhibited a greater preference for outdoor biting [p=0.03], at a rate of 0.32 bites/person/hour during the 20:00-21:00hr, increasing progressively through the night to a peak of 0.48 bites/person/hr during 00:00-01:00hr, while *An funestus* showed a higher preference for indoor biting at a peak of 0.35 and 0.29 bites/person/hour outdoors.Though there is a higher portion of *An gambiae* bites experienced outdoors, indoor biting still persists peaking at 2100 to 2300hrs with 0.24 bites per person per hour. Prompt implementation of supplementary interventions is needed to control outdoor biting malaria vectors with the goal of managing residual malaria transmission and achieving elimination.

Keywords: Residual transmission, vector behaviour, malaria

ABS-216

Unravelling the phenotypic and genomic divergence within sub-populations of the major malaria vector *Anopheles gambiae*

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Malaria remains a huge threat to public health. Vector control remains the most effective method in reducing disease transmission. However, increase in resistance to different vector control tools combined to increasing drug resistance and high costs of implementation, make malaria resurgence a grim reality. New strategies with novel tools that complement LLINs and IRS to target the major vectors could prevent the resurgence of the disease and hasten malaria elimination. Despite the central role of oviposition preference in selecting suitable environments in blood-feeding insects, its contribution to ecological specialization and local adaptation remains elusive. Population studies at early stages or ecological/genetic divergence provide an excellent opportunity to assess the role of oviposition preference in local adaptation of mosquitoes. Combining laboratory dual choice experiments and whole genome sequencing, we conducted the first assessment of phenotypic variation among some subpopulations of the *Anopheles gambiae* mosquito that are emerging along gradients of anthropogenic disturbance in sub-Saharan Africa. When offered a choice, gravid females released individually in cages under standard conditions lay eggs almost exclusively in water collected from their locality of origin. This extreme source-specialization prevails in populations belonging to the same ecological biome and displaying very low levels of genome-wide divergence. Interestingly, females maintained in laboratory conditions using regular water for five generations retained water discrimination and were still able to choose between source water and exogenous water. Favorable aquatic oviposition sites though highly heterogeneous in form, space and time are strong drivers of ecological specialization in the presence of extensive gene flow in mosquitoes and act as signature cues at early stages of divergence in gravid *Anopheles* mosquitoes seeking to lay.

Keyword: Oviposition preference, *Anopheles gambiae*, Rapid adaptation, genetic divergence, phenotypic variation

ABS-264

Molecular Drivers of Multiple and Elevated Resistance to Insecticides in a Population of the Malaria Vector *Anopheles gambiae* in Agriculture Hotspot of West Cameroon

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Field mosquitoes have been shown to survive upon exposure to high insecticide concentrations. Here, we aimed to elucidate the pattern of resistance escalation in the malaria vector *Anopheles gambiae* and its impact on vector control tools. The resistance profile of F1 stage female mosquitoes from Mangoum following the WHO protocol. Molecular characterization was performed using SINE and TaqMan-based PCR. The transcription profile of candidate resistance genes was performed using qRT-PCR methods. Characterization of the breeding water and soil from Mangoum was achieved using the HPLC technique. *An. gambiae s.s.* was the only species in Mangoum with 4.10% Plasmodium infection. These mosquitoes were resistant to all the four classes of insecticides. Synergist assays with PBO revealed only a partial recovery of susceptibility to pyrethroïds. Only PBO-based nets (Olyset plus and permaNet 3.0) and Royal Guard showed an optimal efficacy. A high amount of alpha-cypermethrin was detected in breeding sites (5.16-fold LOD) suggesting ongoing selection from agricultural pesticides. The 1014F-kdr allele was fixed whereas the 1575Y-kdr and the 119S-Ace-1R were moderately present. Elevated expression of P450s, respectively, in permethrin and deltamethrin resistant mosquitoes (CYP6M2, CYP6Z1, CYP6Z2 and CYP9K1) supports their role in the observed resistance besides other mechanisms including chemosensory genes (SAP1, SAP2 and SAP3) and cuticular genes (CYP4G16 and CYP4G17). However, these candidate genes were not associated with resistance escalation as the expression levels did not differ significantly between 1×, 5× and 10× surviving mosquitoes. Intensive and multiple resistance is being selected in malaria vectors from a pesticide-based agricultural hotspot of Cameroon leading to loss in the efficacy of pyrethroid-only nets. Further studies are needed to decipher the molecular basis underlying such resistance escalation to better assess its impact on control interventions.

Keywords: Anopheles gambiae; Cameroon; malaria; pyrethroids; resistance escalation; cytochrome P450s

ABS-289

Optimising adult mosquitoes housing to increase mating success in colonised *Anopheles funestus*

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In nature, malaria vectors mate in swarms that form at dusk in relation to different ground markers that either affect the amount of light or contrast light at the point of swarm formation. The dusking process of sunset has been simulated by the use of artificial lights and dimming systems for laboratory rearing of *Anopheles*. These conditions have proven effective for rearing vector species in the *Anopheles gambiae* complex in insectaries but the same has not been achieved with the *An. funestus* group. *Anopheles funestus* have shown lower mating success in laboratory cages which is a major bottleneck for the colonisation. This study aimed to evaluate parameters to increase the mating success of *An. funestus* under laboratory conditions. This study evaluated the impact of adult housing conditions on the mating success of two Anopheles funestus strains by manipulating the environment of adult mosquito-holding cages with artificial horizons and visual markers to simulate natural swarm cues. This study found that manipulating adult cages by covering with black cloth or placing a light-contrasting marker on the cage increases mating success in *An. funestus*. But, *An. funestus* from different geographical regions were affected differently by the same cage manipulation. Covering the top half of the cage with black opaque cloth and placing a black light-contrasting marker on the base of the cage significantly increased mating success of *An. funestus* from Mozambique, while the same species from Angola only showed increased mating success when the side of the cage was covered. These findings indicate that the mating rate of *An. funestus* in the laboratory is likely to be influenced by geographical locations or underlying genetic differences and may differ in their response to the same mating enhancing cue. Hence, adult mosquito housing should be well customised in attempt to colonize new stains as well as in mass-production of malaria vectors

Keywords: Cage cover, visual markers, Anopheles funestus, mating success, insectary, light contrast

ABS-300

Genetic structure of *An. gambiae s.l* (Diptera: Culicidae) populations in Burkina Faso, west Africa.

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The genetic complexity of malaria vectors constantly enables the rapid adaptation processes to ecological changes resulting in a permanent persistence of the vector populations despite the intensive deployment of vector control tools. Using the whole genome sequencing data of the Ag1000G project, we investigated the genetic dynamics and the population structure of the *An. gambiae s.l.* populations in the western part of Burkina Faso. The genetic diversity was almost identical between *An. gambiae s.s.* and *An. coluzzii* with a genome-wide negative Tajima's D indicating an excess of low frequencies SNPs in the populations. The genetic divergence was low between *An. gambiae s.s.* vs. *An. coluzzii* (FST ~ 0-0.05; Ne.m~4.8-5.2) and relatively high between *An. arabiensis* vs. *An. gambiae s.s.* and *An. coluzzii* (FST ~ 0.26 – 0.30; Ne.m ~ 0.6 – 0.7) showing an important taxonomic gene flow between *An. gambiae s.s.* and *An. coluzzii*. PCA showed that the 3 species of *An. gambiae* are distinct and no sub-cluster was identified between populations of the same species collected in different villages. A strong signal of positive selection was observed in the *An. gambiae* genome especially the regions involved in insecticide resistance. Most of the main genetic variants involved in insecticides resistance were identified at high frequencies and in strong selection pressure in all the populations. This situation strongly threatened the effectiveness of the new insecticide-based vector control tools including PBO synergist nets and actellic IRS. These results reiterated the need for a nationwide molecular malaria vector surveillance policy in order to monitor the evolution of insecticide resistance mechanisms, vector genetic dynamics and polymorphism of the target genomic regions of Gene Drive to guide the national malaria control program in their strategies building.

Keywords: Populations genomics, Insecticide resistance, *An. gambiae s.l.*, Burkina Faso

ABS-378

Investigating the impact of larviciding as a supplementary malaria vector control tool in rural South Eastern Tanzania: a simulation study.

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Even after a huge reduction of malaria burden due to the massive use of insecticide-treated nets (ITNs) and indoor residual spraying (IRS), residual transmission continues in most of sub-Saharan Africa. Larviciding is an intervention that controls mosquitoes in the larval stage and

has shown a positive contribution in vector control to be considered as a supplementary tool. This study shows an impact assessment of larviciding using a mathematical model, based on Rufiji district found in the South Eastern Tanzania and having a (80-85)% ITN coverage. The Vector Control Optimization Model was adapted and simulated with 80% ITN coverage as a baseline. To evaluate the effect of larviciding on the mortality rate of An. gambiae, mature and immature mosquitoes were collected in two phases, before (2016-2017) and after (2019-2021) larviciding application. The entomological inoculation rates (EIR), reproduction number (R0) and biting rate were used as the primary outcome measures. In the simulation of 1 year, larviciding was predicted to reduce EIR by 76.43% and mosquito biting rate (approximately 60%) relative to the scenario without larviciding. Sensitivity analysis over a range of likely values for the biting rate and mosquito lifespan shows comparable the estimated impact between scenarios. This indicates that the predicted impact is robust to uncertainty in model parameters and assumptions. The application of larviciding has practical challenges, such as hardship in attaining high coverage, however it gives an assurance to vector control especially targeting the spreading *An. Stephensi.* Studies have shown *An. Stephensi* can only be controlled by this intervention. This study supports larviciding as a successful strategy that policymakers and public health professionals, like the NMCP, may use to control malaria vectors based on WHO application recommendations.

Keywords: Vector Control Optimization Model, Larviciding, Entomological Inoculation Rate

ABS-413

Associations between land cover characteristics and aquatic habitats of the malaria vector, *Anopheles funestus*, during the dry season

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Anopheles funestus is a major malaria vector in many African regions due to its preference for larger and permanent aquatic habitats. The identification of these habitats is crucial for effective larval control. This study aimed to identify the environmental characteristics of *An. funestus* larval habitats and predict their locations during the dry season. We investigated the land use and environmental factors associated with *An. funestus* positive habitats in southern Tanzania in the dry season (Sept-Nov 2021) and developed a habitat suitability model to predict the likelihood of *An. funestus* larval habitats. A systematic survey was conducted in 19 villages to identify water bodies and examine presence of *An. funestus* larvae. Water bodies were characterized based on type, size, and presence of emergent vegetation.

Multiple logistic models were used to evaluate the association between the proportion of each landcover type within 300m and other physical characteristics of aquatic habitats and presence of *An. funestus habitats*. This analysis was then followed by developing a habitat suitability model using predictors identified in logistic model. Out of 1466 aquatic habitats, 440 (30%) were found to have *An. funestus* larvae. The main habitat types were streams 322 (73%), large pond 67 (15%), and man created habitats 24 (5.5%). Most of *An. funestus* larvae were found in permanent clear water, slow-moving with emergent vegetation. Of all the land cover variables, forest within a 300m buffer was the most important predictor of the presence of *An. funestus* aquatic habitats: with the probability of finding *An. funestus* larvae in water bodies increasing 3-fold. Conversely, proportion of built area within 300m was negatively associated. These findings suggest that regions with more forest cover and permanent clear water bodies are more likely to harbor *An. funestus* and thus could be prioritized for effective larval control in dry season.

Keyword: GIS, remote sensing, aquatic habitat, *Anopheles funestus*, land use

ABS-467

Characterization of natural infections with the bacterial strain Wolbachia w-Anga in mosquitoes of the *Anopheles gambiae* complex in Western Burkina Faso

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The spread of insecticide resistance threatens malaria control. In this context, biological control based on the use of endosymbiotic bacterium Wolbachia is a complementary control tool. However, to optimize the performance of this bacterium, it is imperative to characterize it by evaluating the stability of its transmission over generations of *Anopheles* and by determining its impact on *Plasmodium* infections in these mosquitoes. *Anopheles gambiae* complex mosquitoes were collected in Bama, Western Burkina Faso then blood fed and gravid female oviposited individually. After oviposition, the species of females' parents and their w-Anga infection status was determined. Additionally, we performed amplification of circumsporozoite protein gene to determine *Plasmodium falciparum* infection status and then determined the generational infection rate of w-Anga to assess the stability of its transmission from positive females to their offspring. Finally, we determined the species and w-Anga infection status of collected *Anopheles gambiae* complex mosquitoes to determine the prevalence of w-Anga. From these analyses, the overall frequency of w-Anga infection was 13.84%. However, this frequency was higher in *Anopheles coluzzii* mosquitoes, in those collected in month of September, and in those originating from district 7 of Bama; VK7. Also, the frequency of w-Anga transmission from F0 generation infected females to the F1 offspring was 13.67%. In addition, w-Anga positive

females were less infected (4.59%) with Plasmodium falciparum compared to negative females (22.02%). Our work shows that natural w-Anga infection was present in *Anopheles gambiae* complex mosquitoes in Burkina Faso and was negatively correlate with *Plasmodium falciparum* infection. However, the transgenerational transmission of the bacterial strain of Wolbachia w-Anga was not stable in *Anopheles coluzzii* in the laboratory assays.

Keywords: Malaria, *Anopheles gambiae* complex, w-Anga, stability, *Plasmodium falciparum*, Burkina Faso.

ABS-611

Comparison of the impact of VectoMaxG, Spinosad and S-Methoprene larvicides on non-target fauna : larvicide effective against malaria and environmentally friendly

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Malaria control through the use of larvicides such as Spinosad (NatularDT, NatularG30), S-Methoprene (AltocidP35) and combination of Bti and Bs (VectoMaxG) have already been proven in some countries in the world. However, their effects on the environment, especially on non-target fauna, have not yet been evaluated in Cameroon. Thus, the present work aims to compare the influence of these larvicides on the abundance and diversity of non-target aquatic fauna cohabiting with mosquito larvae during their application in Yaounde to select the best larvicide for the Cameroonian contest. The study took place from August to September 2022 (pre-intervention phase), October 2022 to March 2023 (treatment phase). In each of the 3 districts, 12 sites were randomly distributed by drawing : 2 sites/larvicide and 4 control sites. The treatment frequencies were once/month for AltocidP35 and NatularG30, twice/ month for VectoMaxG, and 1 time/2 Months for NatularDT. Assessments were made on a monthly basis, with collection of abiotic variables, sampling of Zooplankton, Benthic Macro-Invertebrates, Batrachians, Fish and identified in the laboratory followed by data analysis. Highest abundance of Macroinvertebrate organisms was found in the larval sites treated with NatularDT (207 ind, 13% of the total abundance, 6 taxa, Physa acuta dominanted (115 ind)) contrary to the sites treated with VectoMaxG, NatularG30 and AltocidP35 with respectively 109(7,06%), 127(8,23%),142(9,20%) individuals and 7, 6, 8 taxa. However, among the 616,416 zooplankton identified, the highest density was found in the sites treated with AltocidP35 (27.81%, 39 Taxa), then those treated with VectoMaxG (18.59%, 25 Taxa). No significant influence

was observed for any of the larvicides studied on non-target aquatic fauna and the larvicide Spinosad (NatularDT) is best suited for malaria control without any real environmental concerns in the city of Yaoundé.

Keywords: Macroinvertebrate, Zooplankton, NatularDT, NatularG30, VectoMaxG, AltocidP35, Mosquito, Malaria, Yaoundé, Cameroon.

ABS-655

Repelling mosquitoes with electric fields using standard house electrical wires

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To control and prevent mosquito-borne diseases, insecticides are often our only option, but their excessive use has led to the rapid development and spread of insecticide resistance. Health experts have called for intensified efforts to find new approaches to reduce mosquito populations and human-mosquito contact. A new tool that is currently being piloted is the use of high-power electrical fields (EFs) that repel mosquitoes by creating an invisible mosquito barrier. The technology is being integrated into outdoor aluminum window blinds, but our aim is to make the technology more accessible and more widely implementable by using cheap, over-the-counter insulated electrical wires. We quantified the number of *Aedes aegypti* mosquitoes that were successfully repelled by EFs, using house electrical wires, at voltages ranging from 0V (control) to 10kV/cm over 23h periods. Mosquitoes were released in a free-flight room, and lured into a BG-Pro trap equipped with a BG-counter, that was baited with CO2 using dry ice. Mosquitoes had to pass through a window that contained a single row of vertical house electrical wires with alternating polarity. EFs using house electrical wires prevented 60-80% of mosquitoes from flying through the window, at voltages >4kV/cm. Stronger EFs did not lead to a stronger repellent effect at this point in time (23h after release). However, shortly after release (e.g., within 1 or 2 hours after release) over 90% of the mosquitoes were repelled, indicating there is a strong time-voltage-repellency interaction. Detailed voltage-repellency curves will be presented at the conference, as we are concluding our experiments at the time of writing. But our data clearly highlight that standard house electrical wires can generate sufficiently strong EFs to repel host-seeking mosquitoes, which will reduce human-mosquito contact.

Keywords: Electric fields; insect repelling; vector control; new mosquito control tools

ABS-535

Evaluation of Interceptor® G2 LN patch versus whole Interceptor® G2 LN against insecticide resistant *Anopheles gambiae s.l.* in experimental huts at MBe, Côte d'Ivoire.

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Evidence for mosquito contacts being concentrated on mosquito net roof opens up the prospect to strategically design nets that optimise insecticide use. The efficacy of mosaic nets made of patches of Interceptor® G2 LN (IG2) and untreated net versus whole IG2 was assessed in experimental huts in Central Côte d'Ivoire. The mosaic nets differed from IG2 by the spatial location of the IG2 patch on the net, either on all net sides or just the roof. An experimental hut trial was performed in M'Bé, central Côte d'Ivoire to compare the efficacy of untreated polyester nets having "IG2 sides" (IG2 on the side panels only) and "IG2 roof" (IG2 on roof panel only) versus whole IG2 against wild pyrethroid-resistant *Anopheles gambiae s.l.* Protection against *An. gambiae* bites derived from "IG2 sides" was similar to that from whole IG2 and so were mortality rates induced by both treatments ($p > 0.05$). IG2 roof" was less effective, both at protecting and killing resistant *An. gambiae* ($p < 0.001$). The use of "IG2 sides" provides similar protection to whole Interceptor® G2 LN. Chlorfenapyr is an expensive insecticide; Saving on this AI in addition to alphacypermethrin from the roof is beneficial and will reduce production and therefore procurement costs.

Keyword: *Anopheles gambiae s.l.*; Insecticide resistance; Long-lasting insecticidal nets; Next generation nets; Interceptor G2; Experim

ABS-574

L119F-GSTE2 metabolic resistance allele affects vector competence of *Anopheles funestus*

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Malaria control heavily relies on insecticide-based interventions against *Anopheles* vectors. Unfortunately, these vectors has in turn selected for resistance mechanisms, which are now widespread coinciding with the rebound of malaria cases. However, the overall impact of insecticide resistance on malaria transmission remains poorly characterized. This study investigated the impact of glutathione S-transferase-based resistance on P. falciparum development in *Anopheles funestus*. Gravid *An. funestus* were collected indoors and allowed to oviposit. Genotypes of the L119F-GSTe2 metabolic resistance marker was determined using PCR-based method and Plasmodium

infection was determined at oocyst and sporozoite levels using Taqman assay. F1 females were infected with natural *P. falciparum* gametocytes through artificial parafilm membrane system and midguts were dissected at day 7 post infection for detection/quantification of oocysts. DNA was extracted from carcasses of dissected mosquitoes for L119F-GSTe2 genotyping. Infection parameters were subsequently compared between genotypes. Among the 112 Fo mosquitoes genotyped, the frequency of the L119F-GSTe2 was 51.34% and heterozygote resistant genotypes (60%) were more prevalent. The infection rates were higher in resistant genotypes compared to susceptible ones, both at oocyst (RR: 41.67%; RS: 38.81%; SS: 23.81%) and sprozoite (RR: 12.5%; RS: 7.69%; SS: 5.56%) stages. Similarly, of the 403 mosquitoes dissected and genotyped, homozygous resistant (mean oocyst: 5.8) and heterozygous (mean oocyst: 7.3) exhibited significantly higher oocyst infection intensity compared to susceptible genotype (mean oocyst: 2.9). This study showed that L119F-GSTe2-based metabolic resistance likely increase *An. funestus* vector competence, potentially enhancing malaria transmission. There is an urgent need to implement resistance management strategies in African malaria endemic countries.

Keywords: L119F-GSTE2, insecticide resistance, vector competence, *Anopheles funestus*

ABS-595

Bioefficacy of Vectron in Experimental huts against laboratory and wild populations of mosquitoes in Magugu, Northern-Tanzania

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Insecticide resistance among disease vectors has emerged as the hindering factor for vector control activities. A novel compound that can increase vector populations' mortality is a priority in managing insecticide resistance. This study evaluated the bioefficacy of the novel insecticide Vectron against laboratory and wild populations of *Anopheles gambiae s.l*. Comparative biological efficacy trial was conducted in the experimental huts to determine the efficacy of VECTRON™ T500 against the wild populations of *Anopheles* mosquitoes. The efficacy of Vectron T500 was compared with that of Klypson 500WG. Indoor surfaces of cement and mud were sprayed with Vectron 500TM, Klypson 500WG and water. The bioefficacy of the two compounds was evaluated monthly for six months against the laboratory and field-derived *An. gambiae s.l.* using the standard WHO cone bioassays. VECTRON™ T500 was evaluated at a rate of 100mg/m2 in mud and cement-walled experimental huts for 6 month. In mud and cement walls, the laboratory and wild vector populations had a low knockdown effect to Vectron and Clonithiadin. A total of 3,840 mosquitoes were used of which 2,880 were laboratory colony of *An. gambiae s.s.* and

960 were wild populations of *An. gambiae s.l.*. VECTRON™ T500 induced 97.8%-98.1% mortality in laboratory population and 83.2% to 95.0% in wild vector mosquitoes in huts while Clonithiadin ranged from 89.6% to 99.0% for wild and 99.0% to 99.3% for the laboratory populations. The knockdown with VECTRON™ T500 was 7.08% in the six months, while for Clonithiadin was 16.04-17.50%. Monthly in situ wall cone bioassay mortality with VECTRON™ T500 also remained over 80% for 6 month post spraying for both populations. VECTRON™ T500 demonstrated prolonged efficacy against both laboratory and wild populations when applied for indoor residual spraying on both surfaces.

Keywords: Mosquito, mortallity, mud wall, cement wall, knockdown,

ABS-598

Space spray efficacy of Fludora Co-Max EW against insecticide-resistant *Aedes aegypti*, *Culex quinquefasciatus* and *Anopheles gambiae* mosquitoes from Côte d'Ivoire

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Insecticide space spraying is an important tool for controlling mosquito-borne diseases but threatened by insecticide resistance. We evaluated the space spray efficacy of Fludora Co-Max EW (new mixture of flupyradifurone and transfluthrin with film forming aqueous spray technology (FFAST)) against wild insecticide-resistant *Aedes aegypti, Culex quinquefasciatus* and *Anopheles gambiae* mosquitoes, in comparison with K-Othrine EC (deltamethrin-only product), in small-scale trials in Côte d'Ivoire. We collected insecticide-resistant *Ae. aegypti*, *Cx. quinquefasciatus* and *An. gambiae* larvae in Abidjan and Tiassalé, Côte d'Ivoire. Larvae were reared to adults. Fludora Co-Max EW and K-Othrine EC were tested against caged adult females. The evaluation cages were placed at 10, 25, 50, 75 and 100 m from spaying line outdoors, and at ceiling, mid-height and floor indoors. Insecticides were sprayed using ultra-low volume fogging (ULV) and thermal fogging (TF) methods. Mortality was recorded and compared by treatments. Fludora Co-Max induced significantly higher mortality in the wild insecticide-resistant *Ae. aegypti*, *Cx. quinquefasciatus* and *An. gambiae* populations compared with K-Othrine EC. In all three mosquito species, mortality was 90-100% up to 100 m with ULV outdoors, and ~100% indoors with ULV and TF. K-Othrine EC effected high mortality indoors (97.9-100%) in all species, whereas outdoor mortality rapidly declined from 96.7% to 36.7% with ULV, and 85.0% to 38.3% with TF, from 10 to 100 m. Fludora Co-Max EW performed better with ULV than with TF. Fludora Co-Max EW induced high

mortality against insecticide-resistant *Aedes, Anopheles* and *Culex* mosquitoes, and performed better than K-Othrine EC. The presence of flupyradifurone and transfluthrin and FFAST technology in Fludora Co-Max EW may have broadened its killing capacity. Fludora Co-Max EW is an effective adulticide and a promising tool for arbovirus and malaria control.

Keyword: Fludora Co-Max EW, Aedes aegypti, *Anopheles gambiae*, *Culex quinquefasciatus*, Space spray, resistance, Côte d'Ivoire

ABS-485

Patterns of Insecticide Resistance in *Anopheles funestus* populations in Central Senegal

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The insecticide resistance status of the malaria vector *Anopheles funestus* and the underlying resistance mechanisms remain uncharacterised in many parts of Senegal. To fill this gap in our knowledge, we investigated the status of insecticide resistance and the role of metabolic mechanisms in the resistance of *Anopheles funestus* populations in central Senegal. Mosquitoes were collected inside houses in the districts of Nioro and Ndoffane using mouth aspirators. WHO susceptibility tests, PBO (Piperonyl butoxide) synergist assays and resistance intensity tests were performed on the F1 offspring of wild Anopheles funestus females. Four classes of insecticides were evaluated. The results showed that *An. funestus* was resistant to pyrethroids (deltamethrin, lambda-cyhalothrin, permethrin, alpha-cypermethrin and cylfuthrin) in Nioro and Ndoffane. However, the populations were susceptible to organochlorines (DDT and dieldrin) and organophosphates (pyrimiphos-methyl, fenitrothion, malathion) except in Ndoffane where resistance to fenitrothion (86.4% mortality) and suspected resistance to DDT (96.4% mortality) were recorded. Resistance to carbamate (bendiocarb) was recorded only in Nioro (83 % mortality). *An. funestus* populations showed moderate to high intensity of resistance to pyrethroids and carbamates when exposed to 5X and 10X the diagnostic dose. PBO synergist assays indicated that resistance to pyrethroids and carbamates are primarily mediated by cytochrome P450 mono-oxygenases. Our study revealed that *An. funestus* populations in central Senegal exhibit moderate to high intensity of pyrethroid resistance associated with resistance to bendiocab and fenitrothion in some locations. Our results indicate that metabolic mechanism plays major role with probable involvement of monooxygenases (P450s) in the resistances observed. Therefore, our results support the use of PBO net for a better control of *An. funestus* in these districts.

Keyword: *Anopheles funestus*, Insecticide Resistance, Malaria, Metabolic Resistance, PBO, Resistance Intensity, Central Senegal

ABS-626

Functional validation of the role of CYP6P4a and CYP6P4b duplicated genes in pyrethroid insecticide resistance in *Anopheles funestus*; a major African malaria vector

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Insecticide resistance (IR) in malaria vectors is jeopardising malaria elimination efforts. For felicitous IR management, deciphering its molecular basis and designing diagnostic tools is fundamental. We thus embarked on the study at molecular level, of the role of CYP6P4a and CYP6P4b genes, found overexpressed in wild pyrethroid-resistant *A.funestus* in Ghana (West Africa). CYP6P4a/b allelic variants were characterized by sequencing the exon of *A. funestus s.s* mosquitoes sampled from Ghana, Cameroon, Uganda and Malawi in 2021. We then expressed both genes in vitro in *E. coli,* to investigate their interactions with pyrethroid insecticides and in vivo in Drosophila melanogaster, to investigate the impact of their overexpression on pyrethroid IR. Finally, we developed field-applicable DNA-based diagnostic tools using key mutations and assessed the impact of CYP6P4a/b on bed net efficacy using WHO cone assay. Analysis of CYP6P4a/b polymorphisms established a reduced diversity at these loci in all populations. Functional characterization of the genes supports their role in IR, with recombinant enzymes efficiently metabolising pyrethroid type I and II (50-70% depletion, $P<0.05$). Transgenic expression of CYP6P4a/b alleles in D. melanogaster conferred pyrethroid IR (<60% mortality) with findings highlighting that overexpression and allelic variation are key factors in IR. Sequence comparison allowed design of DNA-based molecular assays for CYP6P4a/b-mediated pyrethroid IR with which we found that the mutations were at >70% frequency in Ghana. Importantly, the markers increase pyrethroid resistance and reduce the efficacy of current pyrethroid ITNs with mutants surviving more (OR 588). Our findings show that CYP6P4a/b genes are the major drivers of pyrethroid IR in Ghana and the markers developed can be used to track and anticipate development of IR and guide on the appropriate vector control tools to be used in Ghana and Africa.

Keywords: Metabolic resistance, P450, allelic variation, heterologous expression, GAL4/UAS expression, pyrethroids, Anopheles funestus

ABS-638

A single mutation in the P450 gene CYP9K1 is driving pyrethroid resistance in the major African malaria vector *Anopheles funestus* leading to reduced efficacy of bed nets

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Resistance to insecticides has escalated and is now threatening the continued effectiveness of control tools such as LLINs. Lack of molecular markers of such resistance in the vectors hinder efforts to improve resistance management. In this study, we elucidated the role of CYP9K1 (P450 gene) in conferring resistance to Pyrethroid in *An. funestus*. Genetic polymorphism of CYP9K1 was investigated in samples collected in 2020 across Africa compared to 2014. Transgenic Drosophila flies approach was used to assess whether this gene confers pyrethroid-resistance through overexpression and/or allelic variation. Interestingly, we designed a simple DNA-based diagnostic assay which helped to established the impact of this gene on the efficacy of LLINs using cone test and experimental hut trials (EHT). Analysis of samples from 2014 revealed a dominant CYP9K1 haplotype (G454A) within Uganda (100%), but at very low frequency in other African regions including Cameroon (10%) and Malawi (8%). However, the same haplotype was found fixed in 2020 in Cameroon (100%) but still at very low frequency in Ghana (0%) and Malawi (8%). Drosophila transgenic flies expressing the 454A-CYP9K1 resistant allele were significantly more resistant to pyrethroid than the wild type allele G454-CYP9K1 and controls. Using the newly established diagnostic assay, we noticed a strong correlation with pyrethroid resistance and analysis of the geographical distribution revealed a fixation of the resistant allele in Eastern and some Central African countries and absence in Western and Southern Africa. Further EHT showed that CYP9K1-mediated resistance reduces the efficacy of LLINs including new nets. This study highlights the ability of CYP9K1 resistant allele to reduce efficacy of vector control tools and also offers a new DNA-based assay to monitor resistance in the field and improve resistance management strategies.

Keyword: Pyrethroid, insecticide, CYP9K1 gene, *Anopheles funestus*

ABS-169

Efficiency of World Health Organization (WHO) Tunnel test under varied exposure time and duration: considerations for laboratory animal ethics

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The tunnel test is used to evaluate the efficacy in terms mortality and blood feeding success of insecticide treated nets in an experimental chamber. The traditional overnight exposure of restrained unsedated guineapigs as bait in tunnel tests causes them extended isolation, and starving. This study aimed at optimizing the tunnel test to enable daytime and shorter exposure times using sedated guinea pig baits. Tunnel tests were conducted at the Kilimanjaro Christian Medical University Collage- PAMVERC project GLP certified test facility. Three alternatives exposure time were compared to the standard WHO tunnel test (Control) using the WHO guidelines. Blood-feeding success, penetration rate and 24 hours mortality were assessed against susceptible *An. gambiae* strain using a test of proportions. In 1-hour tunnel assay with sedated bait, blood feeding (81%) was significantly higher ($P < 0.05$) compared to 3-, 6- and 13-hours (overnight) tunnel assays with restrained unsedated guinea pigs. Mortality at 24-hours in all tunnel tests was ≤ 10%. By passing the WHO validity criteria of 24 hours control mortality ≤ 10% and blood-feeding rate ≥50%, the study shows that tunnel assays can be conducted with sedated guinea pigs, at day time and for short exposure time; thus promoting a state of good animal welfare.

Keywords: World Health Organisation, tunnel test, exposure time, blood-feeding succession, penetration rate, 24 hours mortality.

ABS-649

Pyrethroid Resistance in Anopheles arabiensis Patton along Lake Kariba of Southern Zambia is Driven by Metabolic Mechanisms and its Implications on Malaria Elimination Programme

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Populations of malaria vectors are increasingly developing resistance to public health insecticides. Mechanisms driving the resistance phenotypes in *Anopheles gambiae s.l* remains limited in Southern Zambia and hampering decision-making processes at national scale. This study monitored species composition, insecticide resistance, and its underlying metabolic resistance mechanisms in *An. gambiae s.l.* from southern Zambia. Mosquito larval collections were conducted in Sinazongwe, Gwembe and Siavonga district using WHO standard dippers from 2015 to 2020. Insecticides susceptibility bioassays were conducted based on WHO and PMI protocols. Females of *An. gambiae s.l.* aged 2 to 4 days were exposed to deltamethrin (0.05%) and permethrin (0.75%), bendiocarb (0.1%) and propoxur (0.01%), malathion (5%), pirimiphos methyl (0.25%) and DDT (4.0%) and dieldrin (4.0%) and clothianidin (2.0%). Control papers were used alongside each

test conducted. Mortality rates of *An. gambiae s.l* were scored at 24 hours and after 7 days for clothianidin. To identify metabolic resistance mechanisms in *An. gambiae s.l.*, a synergist; piperonyl butoxide (PBO) was used, while sub-species identity of *An. gambiae s.l.* was done by polymerase chain reaction (PCR). *An. arabiensis* was the only species detected in the *An. gambiae* complex. *An. arabiensis* showed resistance to deltamethrin and permethrin and dieldrin. In contrast, all specimens of *An. arabiensis* showed complete susceptibility to bendiocarb and propoxur, pirimiphos methyl and malathion, DDT and clothianidin in the study areas. Pre-exposure of *An. arabiensis* to PBO restored full susceptibility status to pyrethroids but not to dieldrin in southern Zambia. Pyrethroid resistance in *An. arabiensis* is driven by metabolic mechanisms. To achieve maximum impact of LLINs on malaria epidemiology and transmission, PBO-based LLINs are required in areas targeted for malaria elimination in southern Zambia.

Keywords: malaria, insecticide resistance, piperonyl butoxide, long-lasting insecticidal nets, metabolic resistance mechanisms

ABS-577

Identification and characterization of *Anopheles* breeding habitats in Dabakala, central-east Côte d'Ivoire

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Malaria is a major public health problem in Côte d'Ivoire which its control is essentially based on long-acting insecticide-treated nets. However, the resistance of malaria vectors to the insecticides used to impregnate these control tools threatens their effectiveness. Faced with this resistance, the control of malaria vectors is necessary. It is within this framework that this study was conducted to identify and characterize Anopheles larvae breeding sites in the district of Dabakala, one of the districts reporting the most cases of malaria. Larval surveys were conducted in the rainy season (July 2020) and dry season (February 2021) in urban and rural areas. Data were analyzed with Stata. Multivariate logistic regression was used to show the relationship breedings sites characteristics and Anopheles presence. Principal component analysis was used to establish the relationship between larval density and physico-chemical parameters. Of the 102 potential breeding sites identified, 53 were positive, including 38 Anopheles sites and 15 other Culicinae sites. The majority of *Anopheles* breeding sites were found in the rainy season in both rural (n=9, 90%) and urban area (n=18, 64.3%). In rural area, the highest *Anopheles* larval densities were observed in rice fields (1.15 larvae / dipper) whereas in urban area, temporary water impoundments (1.97 larvae/dipper) and rice fields (1.15 larvae/dipper) presented the highest larvae densities. The temperature, pH, and depth of water were positively correlated with the density of Anopheles larvae. This study showed that in Dabakala district temporary water impoundments, and rice fields were the preferred sites for *Anopheles* larvae. The dry season is the period of high larval densities in Anopheles breeding sites. These results could help to plan and orientate the control of Anopheles larvae.

Keywords: *Anopheles l*arvae, breeding sites, larval density, Dabakala, rural, urban

ABS-269

Vegetable oil surfactants are synergists that can bias neonicotinoid susceptibility testing in adult mosquitoes.

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The standard operating procedure for testing the susceptibility of adult mosquitoes to clothianidin, a neonicotinoid, recommends using a vegetable oil ester as surfactant, but it has not yet been determined if this ingredient is inert or if it is synergist that could bias the test. Using CDC bottle bioassays, we tested the synergistic effects of a vegetable oil surfactant on a spectrum of active ingredients including four neonicotinoids (acetamiprid, clothianidin, imidacloprid and thiamethoxam) and two pyrethroids (permethrin and deltamethrin). Laboratory strain (kisumu) and field collected mosquitoes were exposed either to the insecticide solution alone, to a blend containing the active ingredient and 1% (v/v) linseed oil soap or pre-exposed to the soap component of the blend then to insecticide solutions. Three different formulations of linseed oil soap used as surfactant were far more effective than the standard insecticide synergist piperonyl butoxide in enhancing neonicotinoid activity in Anopheles mosquitoes. At the concentration used in the standard operating procedure (1%v/v), vegetable oil surfactants lead to more than 10-fold reduction in lethal concentrations, LC50 and LC99, of clothianidin in a multi-resistant field population and in a susceptible strain of *Anopheles gambiae*. At 1% or 0.5% (v/v), the surfactant restored susceptibility to clothianidin, thiamethoxam and imidacloprid and increased mortality to acetamiprid from 43% ±5.63 to 89 ±3.25 ($P<0.05$) in resistant mosquitoes. By contrast, linseed oil soap had no effect on the level of resistance to permethrin and deltamethrin suggesting that the synergism of vegetable oil surfactants may be specific to neonicotinoids. Our findings indicate that vegetable oil surfactants are not inert ingredients in neonicotinoid formulations, and that the probability of detecting early stages of resistance while using synergists in standard testing procedures is low.

Keywords: clothianidin, neonicotinoids, Anopheles, bioassays, resistance

ABS-295

Relationships between biological age, distance from aquatic habitats and pyrethroid resistance status of *Anopheles funestus* mosquitoes in south-eastern Tanzania

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Malaria transmission can be highly heterogeneous between and within localities, and is influenced by factors such as survival and biting frequencies of *Anopheles* mosquitoes. This study investigated the relationships between the biological age, distance from aquatic habitats and pyrethroid resistance status of *Anopheles funestus* mosquitoes, which currently dominate malaria transmission in south-east Tanzania. Female *An. funestus* were collected in houses located 50–100 m, 150–200 m or over 200 m from the nearest known aquatic habitats. The mosquitoes were exposed to 1×, 5× and 10× the diagnostic doses of deltamethrin or permethrin, or to the synergist, piperonyl butoxide (PBO) followed by the pyrethroids, then monitored for 24 h-mortality. Ovaries of exposed and non-exposed mosquitoes were dissected to assess parity as a proxy for biological age. Adults emerging from larval collections in the same villages were tested against the same insecticides at 3–5, 8–11 or 17–20 days old. Mosquitoes collected nearest to the aquatic habitats (50-100 m) had the lowest mortalities compared to other distances, with a maximum of 51% mortality at 10× permethrin. For the age-synchronized mosquitoes collected as larvae, the insecticide-induced mortality assessed at both the diagnostic and multiplicative doses (1×, 5× and 10×) increased with mosquito age. The highest mortalities at 1× doses were observed among the oldest mosquitoes (17–20 days). Pre-exposure to PBO increased the potency of both pyrethroids. The proportion of parous females was highest among mosquitoes collected furthest from the habitats. Older *An. funestus* near the center of the village are more susceptible to pyrethroids than those at the edge of the village. Pyrethroid-based interventions may remain at least moderately effective despite widespread pyrethroid-resistance, by killing the older, less-resistant and potentially-infective mosquitoes.

Keywords: Insecticide resistance, mosquito age, *Anopheles funestus*, piperonyl butoxide, aquatic habitats.

ABS-353

Developing a cattle-based pyriproxyfen delivery tool for malaria mosquito control

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Cattle are blood-hosts for a range of biting arthropods that can cause diseases in animals and humans. A large number of malaria vector mosquitoes are naturally zoophilic, including the Africa-invading *An. stephensi*, whilst many of the human-biting vectors seek alternative blood hosts due to the insecticidal indoor interventions. Biorational, outdoor control tool with different mode of action on the insects, such as the insect growth regulator, pyriproxyfen (PPF), might be good additions to the tool box and provide potential impact on both, human and animal disease vectors. We tested fabric panels treated with increasing loads of three commercial PPF products (10% emulsified concentrates, Afifen®, Profen® and NyGuard®), for sterilizing impact on *Anopheles* females landing on the fabric. After laboratory tests, we selected the optimum load and tested the product under semi-field conditions. Treated fabric panels were positioned around a cow and host-seeking mosquitoes released in the system. Two of the test products (Afifen® and Profen®), caused unexpected high mortality of mosquitoes during laboratory experiments, suggesting other active ingredients in the test products being insecticidal, hence only one product (NyGuard®) was further evaluated. At a PPF fabric load of 122 mg/m2 active ingredient, 80% of all females exposed in lab tests were sterilised. The semi-field experiments showed that, females were resting either prior, or after the bloodmeal, on the fabric panels, even if other resting sites were provided. Contact with the PPF-treated fabric resulted in 80% of released females being sterilised. The few females that laid eggs, laid significantly fewer than the unexposed. PPF-treated fabric panels around alternative blood hosts, or around outdoor resting areas of people, might be an effective intervention for management of insecticide resistance and integrated control of human and livestock disease vectors.

Keywords: Insecticide resistance, Disease arthropod vector control, Pyriproxyfen, Cattle-based Malaria mosquito control, Fabric pannels

ABS-355

First indoor residual spraying in Cameroon highlights a great potential of Fludora® fusion (mixture of deltamethrin and clothianidin) to better control the wild pyrethroid-resistant malaria vectors *Anopheles funestus* and *An. gambiae*

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The spread of pyrethroid resistance in the malaria vectors threatens the efficacy of vector control tools in Africa leading to increased malaria transmission. New interventions such as Fludora® fusion and interceptor G2 have been introduced in public health to mitigate this challenge. We evaluated the efficacy of Fludora fusion against pyrethroid-resistant malaria vectors from Cameroon and assessed the

potential of cross-resistance. The performance and residual efficacy of Fludora® Fusion was evaluated in experimental huts in comparison with deltamethrin and clothianidin applied alone. CDC bottle tests were used to determine the susceptibility profile of various mosquito strains. The L119F-GSTe2 and L1014F Kdr-w markers were genotyped to established their impact on the efficacy of Fludora® Fusion. All *Anopheles* species tested were fully susceptible to Fludora® Fusion in CDC bottle assay; while resistance to deltamethrin (36% and 78% for *An. gambiae* and *An. funestus* respectively). Fludora® Fusion and clothianidin induced significantly higher mortality rates in experimental huts than deltamethrin (62.83%, 64.42% and 42.42% respectively with free flying An. funestus from Elende); however, lower mortality rates were recorded against *An gambiae* from Nkolondom (50%, 45.56% and 26.68% respectively). In-situ cone test on the wall showed a high residual efficacy of Fludora® Fusion and clothianidin on the susceptible Kisumu strain (>12 months) and moderate one on the highly pyrethroid-resistant *An gambiae* from Nkolondom (6 months). Although no association was observed for both L119F-GSTe2 and L1014F Kdr-w pyrethroid-markers and the ability of mosquitoes to survive Fludora Fusion exposure. This study highlights the high efficacy and residual effects of Fludora® Fusion in controlling pyrethroid resistant malaria vectors. This could be therefore an appropriate tool for vector control in malaria endemic regions.

Keywords: Malaria, insecticide resistance, indoor residual spraying, Fludora® Fusion, clothianidin, L119F-GSTe2 mutation, kdr

ABS-363

PermaNet® Dual, a new deltamethrin-chlorfenapyr mixture net, shows improved efficacy against pyrethroid-resistant *Anopheles gambiae sensu lato*: a laboratory and experimental hut evaluation.

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The World Health Organisation (WHO) recommended pyrethroid-chlorfenapyr nets after a prototype net (Interceptor® G2) showed improved impact in epidemiological trials. More net brands are needed however, to expand access in endemic countries. We evaluated the efficacy of a new deltamethrin-chlorfenapyr net (PermaNet® Dual) in a laboratory study and experimental hut trial according to WHO guidelines. In laboratory studies, we assessed the regeneration time and wash-resistance of PermaNet® Dual by performing cone bioassays and tunnel tests on unwashed and washed net pieces. Tests were conducted with susceptible and pyrethroid-resistant mosquito strains to separately assess the deltamethrin and chlorfenapyr components. We then performed an experimental hut trial to evaluate the efficacy of PermaNet® Dual against pyrethroid-resistant *Anopheles gambiae* in Covè, Benin compared to other ITNs and Interceptor® G2. Wild mosquitoes entering huts were collected each morning and scored for mortality and blood-feeding. The regeneration time of

deltamethrin and chlorfenapyr in PermaNet® Dual was 1 day. In wash-resistance tunnel tests, PermaNet® Dual induced high mortality (≥80%) of susceptible and pyrethroid-resistant mosquitoes after 20 washes. In experimental huts, PermaNet® Dual induced superior mortality compared to a pyrethroid-only net and a pyrethroid-piperonyl butoxide net when unwashed (77% with PermaNet® Dual vs. 23% with PermaNet® 2.0 and 56% with PermaNet® 3.0, p<0.001) and after 20 washes (75% with PermaNet® Dual vs. 14% with PermaNet® 2.0 and 30% with PermaNet® 3.0, p<0.001). Using a provisional margin defined by WHO, PermaNet® Dual was also non-inferior to Interceptor® G2 for mortality (79% vs. 76%, OR=0.854, 95% CIs: 0.703–1.038) but not blood-feeding (35% 32 vs. 26%, OR=1.445, 95% CIs: 1.203–1.735). PermaNet® Dual provides another option of the highly effective pyrethroid-chlorfenapyr net class for improved malaria control.

Keywords: LLINs, ITNs, experimental hut, insecticide resistance, chlorfenapyr, Anopheles

ABS:385

The effect of repeated washing of the royal guard, interceptor g1 and g2 nets on blood feeding behavior and survival of *Anopheles'* mosquitoes

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Long-lasting insecticidal nets offer longer time protection because they are wash resistant. This study assessed the wash resistance of two new nets, Interceptor G2 (IG2) and Royal guard (RG) compared to the mono-treated version of Interceptor G1 and a negative control (untreated net). Blood feeding behavior and mortality was measured against *Anopheles* mosquitoes. WHO cone bioassays were conducted using 2-3 days female *Anopheles gambiae* Kisumu and *Anopheles gambiae s.l* mosquitoes. A total of 2,800 mosquitoes were exposed to un treated net and 0-20th washed IG1, IG2 and RG nets for 3minutes. Each test had 10 replicates and 50 mosquitoes per replicate. Knockdown was observed from 5 minutes to 60 minutes after which a hand of a person was placed on top of a cup containing the mosquitoes to feed for 20 minutes. Final mortality was observed from 24hrs to 72 hrs for each net. High mortality (>80%) of mosquitoes and no blood fed (0%) was observed across the washes for all the three treated nets and test mosquitoes. Time to knock down increased with number of washes for IG1. There was a significant difference in knock down Mortality for An. gambiae s.l between untreated vs RG (95% CI -98.26 to -92.54, p=<0.001). The difference was not significant in IG1 and IG2 (95% CI -5.737 to 2.137, p=0.6317). No difference was observed in blood feeding and mortality due to repeated washing of the two new nets, Interceptor IG2 and Royal Guard nets which shows that the distribution of these nets in Malawi may have a positive impact in reducing malaria vectors. There is need to explore the physical integrity

of these nets and also assess the resistance of the wild caught Anopheles mosquitoes directly exposed to the unwashed nets and washed nets.

Keywords: repeated washing, mortality, blood feeding, IG1, IG2, Royal guard

ABS-404

What can be learned from the residual efficacy of three formulations of insecticide (pirimiphos-methyl, clothianidin and deltamethrin mixture, and clothianidin alone treated on walls at large scale in community trial in two departments of North Benin, Wes

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In Alibori and Donga, two departments of high malaria incidence of Northern Benin, pirimiphos-methyl, mixture deltamethrin + clothianidin, as well as clothianidin were used at large scale for IRS. The present study aims at assessing the residual efficacy of these products.Immatures of *An. gambiae s.l*. collected in the communes of Kandi and Gogounou (Alibori), Djougou and Copargo (Donga) were reared until adulthood. Females aged 2 to 5 days were used for susceptibility tube tests following the WHO protocol. The tests were conducted with deltamethrin (0.05%), bendiocarb (0.1%), pirimiphos-methyl (0.25%) and clothianidin (2% weight per volume). For cone tests performed on cement and mud walls, the *An. gambiae* Kisumu susceptible strain was used. After the quality control of the IRS performed one-week post-campaign of 96 houses, the evaluation of the residual activity of the different tested insecticides/mixture of insecticides was conducted on 480 houses for each type of wall per year of assessment and per insecticides. Deltamethrin resistance was observed in all the communes. With bendiocarb, resistance or possible resistance was observed. In 2019 and 2020, full susceptibility to pirimiphos-methyl was observed, while possible resistance to the same product was detected in 2021 in Djougou, Gogounou and Kandi.

With clothianidin, full susceptibility was observed 4-6 days post-exposure. The residual activity lasted 4-5 months for pirimiphos-methyl, and 8-10 months for clothianidin and the mixture deltamethrin + clothianidin. A slightly better efficacy of the different tested products was observed on cement walls compared to the mud ones. Overall, *An. gambiae s.l.* was susceptible to clothianidin, while resistance/possible was observed the other tested insecticides. Clothianidin-based insecticides showed a better residual activity compared to pirimiphos-methyl, showing thus their ability to provide an improved and prolonged control of pyrethroid resistant vectors.

Keywords: *Anopheles,* Indoor Residual Spraying, Wall surface type, Integrated vector management, Malaria.

ABS-453

Field durability monitoring of pyrethroid plus piperonyl-butoxide insecticide-treated nets under operational settings in Bagamoyo Tanzania: Preliminary findings

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Insecticide-treated nets (ITNs) containing a mixture of pyrethroid and piperonyl-butoxide (PBO) that restores the susceptibility of pyrethroid resistant mosquitoes to pyrethroids are effective in reducing malaria in areas of pyrethroid resistance. However, their loss from the household, bio-efficacy, fabric integrity and insecticide content under operational settings are not well characterized. To generate data that will guide procurement decisions and replenishment planning, we conducted a field durability study of PBO ITNs in Bagamoyo Tanzania. Five commonly-used polyethylene ITNs (3 pyrethroid-PBO, 2 pyrethroid) were included in the study. Bio-efficacy and resistance to damage (RD) score were conducted at baseline followed by a prospective household randomized controlled study. Annual follow-up surveys were conducted for 2 years following WHO guidelines. The functional survival for each brand was calculated. All study nets met WHO bio-efficacy criteria (i.e. ≥95% knockdown or ≥80% mortality) up to 24 months against pyrethroid susceptible *Anopheles gambiae s.s.* and a metabolic resistant *An. arabiensis* strain. The RD score was related to functional survival (FS). Pyrethroid net with RD score 79 had 44% FS, Pyrethroid-PBO with RD score 61 had 31% FS and Pyrethroid-PBO with RD score 35 had 15% FS. All study nets met WHO bio-efficacy thresholds up to 24 months but the functional survival of PBO nets under operational condition in Bagamoyo was less than 24 months and it was related to the RD score suggesting that some products have greater functional survival than others. These findings suggest a more frequent replenishment of ITNs is needed to retain access and context specific evaluations of products may help malaria programs select optimal products for their setting.

Keywords: Insecticide-treated nets, durability, piperonyl-butoxide, Bagamoyo

ABS-603

Sterilized *Anopheles funestus* can autodisseminate sufficient pyriproxyfen to breeding sites under semi-field settings

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Anopheles funestus, the main malaria vector, prefer to oviposit in permanent and/or semi-permanent breeding habitats located far from human dwellings. Difficulties in identifying and accessing these habitats jeopardize the feasibility of conventional larviciding. In this way, we conducted a semi-field study to assess the potential of autodissemination of pyriproxyfen (PPF) by An. funestus for its control. The study was conducted inside a semi-field system. Therein, two identical separate chambers, the treatment chamber with a PPF-treated clay pot (0.25g AI), and the control chamber with an untreated clay pot. In both chambers, one artificial breeding habitat made of a plastic basin with one liter of water was provided. Three hundred blood-fed female *An. funestus* aged 5-9 days were held inside a clay pot for 30 minutes and 48 hours before being released for oviposition. The impact of PPF on adult emergence, fecundity, and fertility through autodissemination and sterilization effects were assessed by comparing the treatment with its appropriate control group. Mean (95% CI) percentage of adult emergence was 15.5% (14.9 – 16.1%) and 70.3% (69 – 71%) in the PPF and control chamber for females exposed for 30 minutes ($p < 0.001$) whereas, was 19% (12 – 28%) and 95% (88 – 98%) in the PPF and control chamber for female exposed for 48 hours ($p < 0.001$) respectively. Eggs laid by exposed mosquitoes and its hatch rate were significantly reduced compared to unexposed females ($p < 0.001$). Approximately, 90% of females exposed for 48 hours retained abnormal ovarian follicles and only 42% in females exposed for 30 minutes. The study demonstrated sterilization and adult emergence inhibition via autodissemination of pyriproxyfen by An. funestus. These findings warrant further assessment of the autodissemination of pyriproxyfen in controlling wild population of *Anopheles funestus*, and highlights its potential for complementing LLINs.

Anopheles funestus, Autodissemination, Pyriproxyfen, Sterilization, Semi-field settings.

ABS-573

Bionomics of *Aedes aegypti* populations from Burkina Faso: Implications for Aedes-borne disease control

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West Africa is an emerging hotspot for dengue, as illustrated by Burkina Faso outbreaks in 2016 and 2017. Data from Africa on *Ae. aegypti* bionomics, including insecticide resistance, resting and feeding behavior, and population structure, are currently lacking for most African populations. We have collected data since 2016 on these aspects of *Ae. aegypti* ecology and behavior to assist control and preparedness for arbovirus diseases in Africa. We detected an increase in resistance to pyrethroid insecticides, underpinned primarily by changes in the frequency of the kdr 410L and 1016I resistance mutants. However, susceptibility to carbamates and organophosphates, suggest these classes remain viable option for control. *Ae. aegypti* has been found to utilize a variety of breeding sites, including used tires, water storage containers, and handwashing stations recently introduced against COVID-19. The preference ratio for containers is variable and varies among localities, and breeding site characteristics affect larval and pupal densities in containers. Adult densities also vary strongly among urban and rural localities, and exophilic behavior is common. The majority of bloodmeals in the samples were from humans. Investigation of the morphology based on scale patterns shown in Burkina, the traditional *Ae ae aegypti* vs. *Ae. ae formosus* dichotomy is unreliable, and was also unrelated to genetic variation at 12 microsatellites genotyped in samples from 12 localities. However, the results clearly showed that *Ae aegypti* populations clustered genetically according to ecoclimatic zone and rainfall. The results indicated that *Ae aegypti* populations displayed bionomic variation which may present greater challenges for control than non-African populations. Community-based reduction of domestic and public places containers will be an essential component of sustainable control, but newer methods for adult control require trials in West Africa.

Keyword: *Aedes aegypti*, bionomics, ecology, dengue, behavior, tires, breeding containers, vector control, insecticide resistance

ABS-480

Current and future opportunities of autodissemination of pyriproxyfen approach for malaria vector control in urban and rural Africa

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Despite the progress made in reducing the malaria burden, new ways to address the emerging threats of insecticide resistance and the spread of *Anopheles stephensi* in Africa are urgently needed. Identification and treatment of prolific habitats seem to be added advantages of the autodissemination approach (ATD) over conventional larviciding in rural settings in Africa. ATD rely on the resting behavior of gravid mosquitoes to transfer lethal concentrations of chemical insecticides such as pyriproxyfen (PPF), to their oviposition sites and inhibit adult emergence. The growing and promising evidence for its use in malaria vector control in Africa highlights the momentous research that needs to be sustained. This article reviews the evidence for the efficacy of ATD with PPF and its potential as a complementary malaria vector control intervention in Africa. Database searching employing key terms in PubMed, Google Scholar, Cochrane Database of Systematic Reviews, and reference lists of all identified studies, followed by the removal of duplicates, abstract screening, and assessing eligibility. 6 studies under controlled semi-field settings and applied mathematical models with malaria vectors Anopheles gambiae, *Anopheles arabiensis,* and *Anopheles quadrimaculatus* say were found to discuss the potential use of ATD with PPF for malaria control. The review summarized the success of ATD with PPF in controlling malaria vectors under controlled semi-field settings. Empirical evidence and biology-informed mathematical models to demonstrate the utility of this approach to control wild populations of malaria vectors under a field environment either alone or in combination with other tools are underway. Notable key determining factors for the future introduction of ATD at scale is having scalable ATD devices, optimized PPF formulations, assessing community perception and acceptance, and its integration into existing conventional larviciding.

Keywords: Autodissemination, Pyriproxyfen, Malaria, Larval source management

ABS-564

The Paradox of Plant Preference: Why the malaria vectors *Anopheles gambiae* and *Anopheles coluzzii* select suboptimal food sources for survival and reproduction?

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It is now well documented that malaria vectors can use a wide variety of plant species as food sources and display some degree of selectivity among these species. However, it remains unclear whether *Anopheles gambiae s.l.* prefers plant species that offer optimal nutrient intake and improve its survival and reproduction (i.e. a positive performance-preference relationship). Following an extensive screening of the effects of 31 plant species on *An. coluzzii* in Burkina Faso, we selected three species for their contrasting effects on mosquito survival, namely *Caesalpinia pulcherrima*, *Combretum indicum* and *Ixora coccinea.* Secondly, we characterized the sugar content of these plant species and further investigated their influence on mosquito survival rate, insemination rate and sugar positivity using both *Anopheles coluzzii* and *Anopheles gambiae* (and using glucose 5% and water as controls). Thirdly, we used a multiple-choice experimental device to determine the relative attractiveness of these plant species to *An. gambiae* and *An. coluzzii* females. Plant species displayed varying sugar content and differentially affected the survival, sugar intake and insemination rate of mosquitoes. Our behavioral trials showed that all 3 plants were much more attractive to mosquitoes than glucose 5% or water. Overall, *An. gambiae* was more responsive to plant food sources than *An. coluzzii* in our device. Surprisingly, *C. indicum* was the most attractive plant species although providing the lowest mosquito survival and insemination rate. This plant also had the lowest sugar content. Taken together, our findings revealed a mismatch between performance and preference for plant food sources in the primary malaria vectors *An. coluzzii* and *An. gambiae*. Several possible reasons for this negative correlation between performance and preference will be proposed.

Anopheles gambiae s.l., *Caesalpinia pulcherrima*, *Combretum indicum*, *Ixora coccinea*, Performance, Preference

ABS-521

Scaling New Biological Vector Control Solutions: Developing A New Targeted, Self-Limiting Solution for Control of the Invasive Malaria Vector, *Anopheles stephensi*

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Anopheles stephensi is posing a new urban public health threat to the African continent. From its first discovery in Djibouti, this invasive vector has now reached Ethiopia, Kenya, Sudan, Somalia and Nigeria, raising the threat of malaria outbreaks in major cities across Africa as it continues to spread. Against another urban vector - the dengue-transmitting *Aedes aegypti* - the deployment of self-limiting 'Friendly™' male mosquitoes has proven highly effective in controlling the vector in densely populated Brazilian urban communities. Friendly™ male mosquitoes mate with wild female mosquitoes, and all of their female offspring die. Now commercially approved there, 'just-add-water' Friendly™ Aedes devices are currently being sold at scale to city governments, households and businesses nationwide. This same self-limiting technology is now being applied to *An. stephensi*, to build a targeted and safe solution for this difficult-to-control invasive malaria vector. In parallel with development of Friendly™ *An. stephensi* strains and scaled-up rearing systems, a new public-private partnership has been launched to validate this solution in Djibouti and the wider region. Les Moustiques Alliés Djibouti - a coalition made up of the Government of Djibouti, the public health not-for-profit Association Mutualis, and the biocontrol solutions developer, Oxitec – has established a new research hub and a growing team of experts in Djibouti City. In preparation for field pilots of the self-limiting strain, the program team has been conducting preparatory field ecology studies since 2021 in malaria-threatened communities around Djibouti, enabled by community partnerships and extensive stakeholder engagement. We will share more about the Djibouti Friendly™ Mosquito Program, how we're partnering with malaria-threatened communities in Djibouti, and how Friendly™ *Anopheles stephensi* can deliver a solution for impact at scale across Africa against this urban malaria threat.

Keywords: *Anopheles stephensi*, IPM, malaria, invasive vectors

ABS-618

Evaluation of the specific characteristics of visual markers related to the attractiveness of *Anopheles coluzzii* swarms in Burkina Faso

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Genetic control is an innovative method of malaria control. This method targets *Anopheles* mating behaviour. Mating of *Anopheles coluzzii*, one of the major vector of malaria in Burkina Faso, takes place in swarms. Swarms usually form on visual markers and the role that these markers play in swarm formation was unknown. Swarms were studied in "Vallée du Kou", Burkina Faso from June to November 2021 in order to assess the specific characteristics of visual markers that attract *Anopheles coluzzii* swarms. Swarms and markers were characterized with help of volunteers and a manipulation of visual markers was performed to determine the impact of three colours on the attractiveness of the swarms by covering the visual markers with sheets of different colours. The colours used for manipulation were blue, black and white. A total of 470 probable swarm markers were identified in our study area and 63.17% of these markers were occupied by swarms. The dark contrast was a characteristic of the markers that attracted swarm formation. For swarming, *Anopheles coluzzii* males needed a clear view of the sky and an opening to the setting horizon of the sun. When obstacles blocked the opening to the sunset horizon, swarms positioned themselves higher than the obstacles. In terms of swarm manipulation, black colour significantly increased the number of males and the number of couples in the swarms and white coloured sheets significantly reduced the number of males and the number of couples in the swarms. The blue colour had no impact on the swarms. Our results show that there are factors that attract swarm formation and highlight the possibility of manipulating the visual markers to target mating behaviour through intervention.

Keywords: Swarms, visual markers, *Anopheles*

ABS-654

A decision-tree approach to cost comparison of different workflows for measuring entomological indices in malaria surveillance

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The initial outlay and maintenance costs for MALDI-TOF MS in diagnostic labs are high, however, the cost of sample processing has been demonstrated to be less than 0.5 USD per sample in medical microbiology, and potentially requires much less time for sample processing when compared to gold standard diagnostic tests. The potential for cost savings using MALDI-TOF MS in routine entomological

surveillance has never been evaluated. This study compares the costs of current diagnostic methods used in entomological malaria surveillance in Kenya to the expected costs when using MALDI-TOF MS. Materials and methods: We developed a decision tree analytic model to determine the comparative costs of conventional diagnostic approaches vs MALDI-TOF MS in measuring 4 key entomological parameters for malaria surveillance: infection status, species identification, parity status and blood meal sources of the mosquitoes. A decision tree visually shows the path that entomological specimens may take under the two diagnostic scenarios and is used to simulate the outcomes of each approach and their associated costs over time. We compare the cost of analyzing 15,000 mosquito samples in a malaria surveillance program under each diagnostic approach, which is the approximate number currently analyzed in the Kenyan National Malaria control Program. Expected output: The analysis will demonstrate the potential for cost savings when using MALDI-TOF MS, accounting for cost of materials, labor, and maintenance costs. An estimate of cost per sample analyzed will be determined. We expect to present a cost-comparison analysis for the use of current diagnostic methods vs MALDI-TOF MS in entomological malaria surveillance in Kenya.

Keyword: Decision-tree, MALDI-TOF MS, Surveillance, cost comparison

ABS-114

Entomological surveys in two contrasted epidemiological settings in Cameroon reveal that the extremely high malaria transmission in the main African malaria vector *Anopheles funestus* is associated with GSTe2 metabolic resistance

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Recent reductions in malaria transmission in Africa are predominantly due to increased use of pyrethroid-impregnated bed nets. Alarmingly, pyrethroid resistance is threatening their continued effectiveness, though the real impact on malaria transmission remains poorly characterised due to the lack of resistance markers for robust assessment. We investigated how L119F-Gste2 metabolic gene influences entomological parameters underpinning mosquitos' propensity to transmit Plasmodium species. Longitudinal studies were carried out in Mibellon and Elende, two epidemiological settings in Cameroon where mosquitoes were collected using HLC, CDC-LT and PSC techniques. Plasmodium sporozoite parasites were detected by TaqMan and Nested PCR, and blood meal origin with ELISA. The allele-specific PCR

method was used to genotype the L119F-GSTe2 marker and association with malaria transmission was established by comparing key transmission parameters such as the Entomological Inoculation Rate (EIR) between individuals with different L119F-GSTe2 genotypes. *An. funestus s.l* was the predominant malaria vector collected during the entomological survey in both sites (86.6% and 96.4% in Elende and Mibellon respectively) followed by *An. gambiae s.l* (7.5% and 2.4%). *An. funestus s.s* exhibited a very high EIR (66 ib/h/month and 792 ib/h/year) and was solely responsible for 98.6% of all malaria transmission events. Human Blood Index was also high (HBI=94%). *An. funestus s.s.* individuals with both 119F/F (RR) and L119F (RS) genotypes had a significantly higher transmission intensity than their susceptible L/L119 (SS) counterparts. This study highlights *An. funestus s.s* still sustains an extremely high malaria transmission in Cameroon mainly driven by the GSTe2 metabolic resistance. This indicates that new vector control tools integrating the GSTs inhibitor can help reduce malaria transmission in the areas of high GSTe2 expression.

Keywords: *An. funestus*, sporozoite infection, malaria transmission, Entomological Inoculation Rate, L119F-GSTe2, Cameroon.

ABS-168

Application of MALDI-TOF MS in parity status analysis of field collected malaria vectors

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Mosquito parity analysis is an important parameter for monitoring the effectiveness of vector control interventions over time which majorly impact on the daily survival of mosquitoes. To be of epidemiological significance, mosquitoes must survive the Plasmodium extrinsic incubation period. By tracking changes in the age composition and parity rates of mosquito populations we can determine the impact of control interventions. Therefore, the aim of this study is to determine if MALDI-TOF MS can categorize wild-caught mosquitoes

based on their parity status using their unique protein signatures. The solution would provide a way to attain information on parity status simultaneously with species identification using the same platform (MALDI TOF MS) reducing need for dissection in the field. Adult mosquito sampling was done in Mopeia, Zambezi region of Mozambique using CDC light traps. Upon sampling, they were morphologically identified into different complexes. Individual unfed female mosquitoes were then dissected, and the ovaries were examined under a microscope and categorized into either parous or nulliparous. The remaining mosquito carcases were stored individually in RNA later then transported to KEMRI Wellcome Trust Research programme for further analysis. The head and thorax of each mosquito was used for protein extraction for MALDI-TOF MS analysis. Spectra of good quality with known parity status were divided into training and test dataset. The training dataset (nulliparous and parous) were used to create a database for parity analysis and the test dataset was used to query the database and validate the method. Analysis is ongoing. We expect to present the performance of MALDI-TOF MS in parity determination of field collected mosquitoes.

Keyword: Age grading, MALDI-TOF MS, Mosquitoes

ABS-175

Sub-lethal exposure to chlorfenapyr kills Plasmodium parasites in surviving insecticide-resistant *Anopheles* mosquitoes

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To overcome pyrethroid resistance, Interceptor® G2, a 'first-in-class' dual insecticidal net combines alpha-cypermethrin with chlorfenapyr. Chlorfenapyr is a pro-insecticide, requiring bio-activation by oxidative metabolism within the insect's mitochondria, constituting a mode of action preventing cross-resistance to pyrethroids. Recent epidemiological trials conducted in Benin and Tanzania confirm Interceptor® G2's public health value in areas with pyrethroid-resistant *Anopheles* mosquitoes. As chlorfenapyr might also interfere with the metabolic mechanism of the Plasmodium parasite in infected *Anopheles* mosquitoes, we hypothesized that chlorfenapyr may provide additional transmission blocking effects even if a mosquito survives a sub-lethal dose. The effect of chlorfenapyr net treated with 200 mg/m2 to reduce malaria transmission was evaluated using a modified WHO tunnel test, were 100 pyrethroid-resistant Anopheles gambiae s.s. (kdr) were exposed for 8 hours overnight per tunnel. Exposed mosquitoes (control and chlorfenapyr) were provided with a gametocytemic blood meal. Prevalence and intensity of oocysts were determined on day 8 and day 16 respectively post

feeding. Proportion of oocyst infected mosquitoes were 44.05 (95%CI: 38.27-49.84) in control and 22.72 (95%CI: 19.90-26.56) in chlorfenapyr (OR=0.33, 95%CI: 0.2- 0.46). Low oocyst intensity was observed in chlorfenapyr (IRR=0.30, 95%CI: 0.22-0.41). Low sporozoite infection was observed in chlorfenapyr exposed mosquitoes compared to control (OR=0.43, 95%CI: 0.25-0.73). Low sporozoite intensity was observed in chlorfenapyr compared to the control; However, there was no significant difference (IRR=0.41, 95%CI: 0.13-1.30). Chlorfenapyr substantially reduces the proportion of Plasmodium-infected mosquitoes at sub-lethal doses. Ongoing studies are further exploring the nature of this mechanism and chlorfenapyr's overall ability to affect malaria transmission.

Keywords: Chlorfenapyr, Transmission blocking intervention, WHO modified tunnel assay

TURBO TALKS ABSTRACTS

Day 1

Parallel Turbo Talks Session 1: LLINS, IRS and insecticide resistance management.

ABS-215

Improving Malaria control: The role of UDP-glycosyltransferases in Insecticide resistance

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Insecticides targeting the malaria vector accounted for 80% of cases averted from 2000-2015; however, their efficacy is threatened by widespread insecticide resistance (IR). Understanding IR mechanisms of Anopheles is vital for improving malaria control. For example, insecticide-treated bednets (ITNs) with pyrethroids plus synergists such as piperonyl butoxide (PBO) are more successful than pyrethroid-only ITNs in areas of high IR. PBO works by inhibiting cytochrome P450s (P450s) which are major metabolisers of pyrethroid insecticides. Knowledge of metabolic resistance in Anopheles is predominantly of P450s and glutathione S-transferases. These families have been definitively linked to IR and have been used for monitoring and implementation of new chemistries aimed at subverting these mechanisms. Here we show evidence that uridine diphosphates (UDP)-glycosyltransferases (UGTs) are involved in IR. UGTs are detoxification enzymes involved in secondary metabolism of toxins, and thus could play an important role in insecticide metabolism. Lab-based study. Differential expression analysis was completed using qPCR. Phenotypic characterisation involved RNAi and inhibition of

UGTs with key pyrethroids. Initially, candidate UGTs were identified from previously published transcriptomic datasets from resistant Anopheles species across Africa. Using qPCR, these UGTs were found to be overexpressed in resistant *An. coluzzii* and *An. gambiae* with evidence of differing IR mechanisms, in specific tissues, and following deltamethrin exposure. Whilst RNAi of single UGTs did not impact IR, inhibiting UGTs using a chemical synergist in *An. gambiae, An. arabiensis, An. coluzzii* and *An. funestus* restores susceptibility to pyrethroids, demonstrating involvement of UGT-based metabolism in IR across major African Anopheline vectors. The evidence produced here outlines a novel resistance mechanism in both the *An. gambiae* complex and *An. funestus.*

Keywords: Insecticide Resistance, Insecticide Detoxification, Metabolic Resistance

ABS-221

Utilization of electronic system in targeted distribution campaign (TRC) of Insecticide-treated Nets (ITNs) during COVID-19 pandemic in Southern (Sub-national) Councils of mainland Tanzania: Challenges and lesson learnt.

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National routine data in Tanzania showed increased malaria incidence for six councils in 2020-2021, from Lindi and Mtwara regions. Modelled population ITN access was also below 40%. These conditions necessitated a Targeted Replacement Campaign (TRC) in these councils, using an electronic system, in order to raise ITNs ownership, access and ultimately reduce malaria incidence in the community. Tanzania National Malaria Control Programme (NMCP) in collaboration with implementing partners planned and distributed Piperonyl Butoxide (PBO) nets in the six councils in mid-2022. A digitalized approach called Electronic Targeted Replacement Campaign using Management Information System (eTMRC-MIS) developed by Ministry of Health's Information and Technology section was used. A total of 369,991 households were registered in six councils i.e., about 110% of estimated households compared to the Tanzania 2012 population and housing census projections. The TRC issued a total of 818,644 PBO ITNs through fixed distribution points, organized by keeping at least one meter a part and limited group of ten people during ITNs issuing to 369,991(100%) households as COVID-19 precautions. The app reduced interpersonal contact, generated real time data, used for tracking and monitoring at all levels during implementation. Data were visualized in a dashboard with online and offline modes. Challenges included internet connectivity in remote villages, requiring

teams to relocate to successfully submit data. Transporting ITNs to hard-to-reach villages was facilitated by good logistical planning and coordination between implementing partners and local leaders. The eTMRC-MIS model is highly recommended for use in similar targeted replacement campaigns to address low population access to ITNs, while improving effectiveness of the planned intervention, data quality, security real-time data and managing the threats of COVID-19 pandemic in Tanzania.

Keywords: Digitalization Insecticides Treated Nets-PBO mass distribution

ABS- 285

Effects of agricultural pesticides on the susceptibility and fitness of malaria vectors in rural south-eastern Tanzania

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Agricultural pesticides may exert strong selection pressures on malaria vectors during the aquatic life stages and may contribute to resistance in adult mosquitoes. This could reduce the performance of key vector control interventions. The aim of this study was to investigate effects of agrochemicals on susceptibility and fitness of the malaria vectors. An exploratory mixed-methods study was conducted to assess pesticide use in four villages (V1-V4) in south-eastern Tanzania. Larvae were collected from agricultural fields and their emergent adults examined for insecticide susceptibility, egg-laying, and wing lengths. These tests were repeated using two groups of susceptible laboratory-reared *An.arabiensis*, one of which was pre-exposed to sub-lethal aquatic doses of agricultural pesticides. Farmers lacked awareness of the link between public health and agriculture sectors but were interested in being more informed. Agrochemicals usage was reported as extensive in V1, V2 & V3 but minimal in V4. Similarly, mosquitoes from V1-V3 but not V4 were resistant to pyrethroids, and either pirimiphos-methyl, bendiocarb or both. Adding the synergist, piperonyl butoxide, restored potency of the pyrethroids. Pre-exposure of laboratory-reared mosquitoes to pesticides during aquatic stages did not affect insecticide susceptibility in emergent adults of the same filial generation. There was also no effect on fecundity, except after pre-exposure to organophosphates. Wild mosquitoes were smaller than laboratory-reared ones, but fecundity was similar. The susceptibility of mosquitoes to public health

insecticides was lower in villages reporting frequent use of pesticides compared to villages with little or no pesticide use. Variations in the fitness parameters, fecundity, and wing length, marginally reflected the differences in exposure to agrochemicals and should be investigated further.

Keywords: Insecticide susceptibility/resistance, agricultural pesticides, fecundity, malaria, focus group discussion and Ifakara Health

ABS-356

Updates on insecticide resistance status in malaria vector populations and insecticide resistance management in Eswatini

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The national malaria programme of Eswatini (NMPE) is currently in the malaria elimination phase and uses indoor residual spraying (IRS) and insecticide-treated nets (ITNs) as the major malaria vector interventions. The NMPE entomology control unit lacks current insecticide resistance (IR) profile for malaria vectors in the country. insecticide resistance management (IRM) data has not been updated over the past two years due to delays in procurement of who-impregnated papers and the lack of a susceptible colony to perform susceptibility tests. Insecticide resistance is monitored annually to generate data on malaria vectors in the country. the study started in July 2022 and was conducted in the Lubombo and Hhohho regions of Eswatini. The study design was both descriptive and experimental. data was generated through larval and adult collections. Interviews were conducted with respondents from 16 relevant stakeholders to assess the knowledge, benefits, need, challenges, commitment, and support of the stakeholders towards generating insecticide resistance data for the country. Interview data was analyzed using the 5ws and an h method. Emergent adults were then subjected to insecticide resistance testing following standard world health organization (WHO) test tube procedures. the local malaria vectors are currently susceptible to all four classes of insecticides tested. Ninety percent of the community members did not know about IR but valued IRS because of its impact on the communities. the health care workers had extensive knowledge of IRM and agreed to commit to /and support the initiative. IRM is key for the programme to guide vector control deployment process and absence of IRM could lead to serious implications such as failure to reach elimination targets. high-quality IRS and insecticide rotation is also key to prevent IR.

Keywords: resistance, insecticide resistance management, susceptible, indoor residual spraying, insecticide treated nets, elimination

ABS-301

Characterization of phenotypic resistance in malaria vector species in space and time

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Malaria continues to be a life-threatening disease with over 95 percent of cases and mortality occurring in sub-Saharan Africa. Various malaria control strategies have been in use to control malaria cases, among them vector control strategies. The increasing phenotypic and genotypic insecticide resistance (IR) among the vector species populations threatens the gains achieved in malaria control so far. Continuity of this trend can potentially result in increased cases of malaria incidence and mortality. Past studies on spatio-temporal modeling of the phenotypic and genotypic resistance among the vectors unveil their increasing spread across Africa. However, in regions and countries where data on IR is unavailable, scarce or heterogeneously distributed, it becomes challenging to establish the underlying trends. We present a model for characterizing phenotypic resistance in malaria vector species in space and time, using the cellular automata approach coupled with principles of thermodynamics. In our approach, we consider one country for model development subdivided into grid cells and formulate transition rules based on the thermodynamics state and drivers of phenotypic resistance within each cell at discrete time intervals, starting with the initial time when the first case of phenotypic resistance was established. Our model is validated by deploying it in countries where actual phenotypic resistance patterns have been observed in-order to compare the actual and predicted spatio-temporal patterns of phenotypic resistance. Our approach enables the unraveling of the spatial and temporal patterns of phenotypic resistance and its prediction in countries and regions where the data is unavailable or scarce.

Keywords: *Anopheles gambiae*, insecticide resistance, cellular automata, malaria

ABS- 305

Changing climate-associated habitat characteristics drives the spatial and temporal occurrences of resistant *Anopheles gambiae*

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Malaria is a disease caused by Plasmodium parasites transmitted by Anopheles mosquitoes. Control of malaria vectors is primarily achieved through the use of insecticides, which are sprayed on walls of houses or applied on bed nets. However, mosquitoes develop resistance to insecticides over time, leading to decreased effectiveness of malaria control programs. This is exacerbated by climate variability that favours resistant populations' adaption of their behavioural ecology and physiology in response to the changes in the surrounding environment. For instance, phenotypic resistance refers to changes in the mosquito's behavior or physiology due to several environmental conditions such as climate and habitat characteristics that allow them to survive exposure to insecticides. Hence this study investigated the relationship between changing climate-associated habitat characteristics and the occurrence of phenotypically resistant Anopheles gambiae to various classes of insecticides in the region. Specifically, the study investigates how climate and habitat characteristics affect the spatial and temporal occurrences of the resistant Anopheles gambiae mosquito in Sub-Saharan Africa using a rule-based approach. The research analyzes satellite-derived land use land cover and climatic data to model the spatial and temporal distribution of Anopheles gambiae level of resistance to insecticides under changing climate. Results suggest that changes in habitat characteristics and climate variability play a significant role in shaping the resistance of the Anopheles gambiae mosquito, leading to varying spatial and temporal occurrences of the insect. The findings highlight the importance of incorporating environmental factors in predicting and controlling mosquito-borne diseases in Sub-Saharan Africa.

Keywords: Rule-based, Spatial and temporal, Mosquito-borne, Sub-Saharan Africa, Insecticide resistance, Phenotypic.

ABS-315

Comparative efficacy of three types of dual-active-ingredient insecticidal nets against pyrethroid-resistant Anopheles gambiae in southern Benin

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Pyrethroid-PBO nets were recommended based on epidemiological evidence of additional protective effects against malaria vectors. However, the magnitude of the resistance phenomenon in malaria vectors has led the World Health Organization to promote the evaluation of a new generation of insecticide-treated nets. Entomological studies are therefore needed to perform the comparative effectiveness of these new generation nets to that of PermaNet 3.0, the pyrethroid-PBO net.An experimental hut trial was performed in Zakpota (southern Benin) to evaluate the efficacy of PermaNet 3.0 and new generation nets (Interceptor G2 and Royal Guard) against free-flying wild Anopheles gambiae mosquitoes following World Health Organization guidelines. Mosquitoes collected in the hut were followed for 3 days to assess the adult survivorship. PermaNet 3.0 (60.65%) induced a higher exophilic rate than Royal Guard (52.3%) and Interceptor G2 (47.32%). Significantly higher immediate mortality was observed with PermaNet 3.0 compared to Royal Guard (OR = 4.71, $p < 0.001$). Similar performance in terms of blood feeding reduction was recorded with Royal Guard (OR = 0.14, p=0.14) and Interceptor G2 (OR = 0.12, p =0.07) compared to PermaNet 3.0. Survival analysis, based on mortality recorded 72 hours after, showed that the highest risk of mosquito death was observed with PermaNet 3.0 (HR = 3.5, $p<0.001$) and Interceptor G2 (HR = 2.6, $p<0.001$) PermaNet 3.0 and Interceptor G2 nets showed comparable efficacy against the wild An. gambiae population in Zakpota, southern Benin.

Keywords: *Anopheles gambiae*, Pyrethroid resistance; new insecticide-treated nets, Pyrethroid-PBO.

ABS-423

Determination of the residual efficacy of micro-encapsulated pirimiphos-methyl (Actellic®300CS) Insecticide Formulation Applied on Standard Tents Used in Humanitarian Emergencies and Plywood Tiles against Malaria Vectors

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The rate of decay of the biological efficacy of insecticides used for indoor residual spraying (IRS) may vary when applied on different building materials and wall surface types. In this study, the decay rate of Actellic® 300CS insecticide formulation was determined by spraying the insecticide formulation on standard tents and plywood tiles. The interior surfaces of three tents and six plywood tiles (three painted and three unpainted) were sprayed with the recommended dose of Actellic® 300CS (1000mg ai/m2) in this trial. The surfaces of two tents and two plywood tiles (one painted and one unpainted) were sprayed with water as control. Both the unpainted and painted plywood tiles were affixed to the walls of experimental huts using nails. The spray was conducted in March 2022 and the decay rate was monitored from April to November 2022 using laboratory strain *An. arabiensis* from Sekoru insectary, Ethiopia. In the tent surfaces, the mean 24-hour mosquito mortality rates were over 80% in the first four months. On the other hand, mean mosquito mortality rates 24 hours post-exposure were over 80% for eight months in both the painted and unpainted plywood tile surfaces. Mean mosquito mortality rates 24-hour post-exposure in both the tent and plywood control surfaces was less than 10%. Actellic® 300CS is a promising insecticide formulation to be used for IRS for the control of malaria in areas where standard tents are used as temporary shelters in humanitarian crises areas of humanitarian emergencies, and plywood tiles used for partitioning the interior of houses. Largescale field trials are needed to determine the efficacy of the insecticide formulation in different operational conditions.

Keywords: Pirimiphos-methyl, IRS, Tents, Plywood tiles, Malaria, Ethiopia

Parallel Turbo Talks Session 2: Vector bionomics: vector biology, ecology, taxonomy and population genetics

ABS- 55

IgG anti-gSG6-P1 response as biomarker exploring the seasonal heterogeneity of human exposure to Anopheles gambiae bites in rural area of Cameroon in Central Africa

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The applicability of specific human IgG antibody response to Anopheles gambiae salivary Gland Protein-6 peptide 1 (gSG6-P1) as biomarker to correlate exposure to mosquito bites with seasonal variations has not yet been evaluated in Central African subregions. Question: How the immune response to gSG6-P1 salivary peptide can be able to distinguish mosquitoes seasonal variation? Objective: To generate pilot data on IgG anti-gSG6-P1 response in individuals living in rural Cameroon and according to seasonality. Dry blood spots were collected in 2020 during rainy and dry seasons from individuals living in the Bankeng village in the forest area of Centre Cameroon region. IgG Anti-gSG6-P1 level was assessed by ELISA. Adult female mosquitoes were collected to assess vector bionomics and the presence of Plasmodium antigens. Mosquitoes were both endophagis and exophagis and they were more aggressive during the rainy season (13.81 b/p/n) compared to the dry season (1.5 b/p/n). Infected mosquitoes with Plasmodium CSP were collected only during the rainy season (10.52% S.I and EIR=1.45 ib/p/n). This data correlated with the prevalence of malaria that vary significantly between the rainy (77.57%; 83/107) and dry seasons (61.44%; 51/83) (p=0.039). The level of IgG Anti-gSG6-P1 response was detected with high inter-individual heterogeneity and its correlated significantly with the rainy season (p<0.0001). The level of IgG response to the gSG6-P1 was significantly higher during the rainy-season and correlated with the higher HBR observed during the same period. This reveals that the level of human immune response to gSG6-P1 correlates with malaria vector density. This study highlights the importance of anti-gSG6-P1 IgG response as an accurate immunological biomarker to detect individual exposure to *Anopheles gambiae s.l* bites during low malaria transmission risks in Bankeng.

Keywords: gSG6-P1 IgG response, seasonal transmission, mosquito density, human biting rate, sporozoite infection rates, rural area, Cam

ABS- 129

Semi-field evaluations of the impact of novel bite prevention interventions on Anopheles minimus landing and key life history traits in Thailand

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The downward trend in the global malaria burden has stalled. Malaria vector control relies on indoor residual spraying (IRS) and insecticide treated nets (ITNs), targeting mosquitoes resting and feeding indoors. As outdoor biting is increasingly prominent, interventions targeting outdoor resting/biting mosquitoes and complement IRS and ITNs are needed. This semi-field study evaluated transfluthrin- and metofluthrin-based volatile pyrethroid spatial repellents (VPSRs), and etofenprox-treated clothing for their protective efficacies against two pyrethroid-susceptible Anopheles minimus strains at two research sites in Thailand. A block-randomized crossover design was applied; the intervention and control were randomly assigned to one of two chambers for a block of four days, and switched for a 2nd block of 4 days. Human landing catches (HLCs) collected mosquitoes for 6-hour replicates, and backpack aspirations collected remaining mosquitoes after 6 hours. Impact of these interventions on mosquito landing, immediate knockdown, post-exposure blood feeding, and 24-hour mortality was estimated. Preliminary results indicate that most interventions prevented in excess of 50% landing when new (data analysis to be completed by June 2023). All VPSRs, etofenprox-treated forest ranger uniforms and civilian clothing (long trousers), and the combined intervention (VPSR1 + treated civilian clothing (long)), suggest potential to offer community protection by preventing diversion to nearby non-users through mosquito disarming. Treated civilian clothing (short trousers) did not reduce landing, but did reduce post-exposure blood feeding success and increase 24-hour mortality, also suggesting the potential to provide community protection by disarming and preventing diversion. This study suggests that using SFS with multiple endpoints beyond landing helps understand the total effect of the interventions in the community.

Keywords: Semi-field system, repellents, bite prevention, *Anopheles minimus*

ABS -130

Field evaluation of novel mosquito bite prevention tools against Anopheles mosquitoes in Cambodia

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In Cambodia, malaria transmission is confined to forest environments, where aytime Anopheles biting and low bed net use limit the effectiveness of vector control interventions used in the villages (IRS, ITNs). Interventions targeting outdoor and daytime biting mosquitoes are required alongside IRS and ITNs. A field evaluation in Mondulkiri Province, Cambodia, estimated novel bite prevention interventions impacts on Anopheles landing for a transfluthrin-based volatile pyrethroid spatial repellent (VPSR), etofenprox-treated forest ranger uniform and civilian clothing with a topical repellent, and combined VPSR+treated civilian clothing. A 7×7 Latin-square randomized design was replicated seven times. Using nightly human landing catches (HLCs), mosquitoes were collected from seven structures on a transect. From the 8,294 Anopheles collected, 15% were confirmed to species via molecular methods: An. dirus Form A (n=429), An dirus sl (n=29), Subgroup Leucosphyrus (n=428), An. maculatus (n=4), An. minimus (n=3), and An. kochi (n=2). All interventions provided protection against Anopheles landing. The VPSR was the most protective single-intervention against landing, preventing 94% of landing (RR 0.06 (95% CI 0.04 – 0.09)). Treated clothing interventions also provided protection (civilian: RR 0.22 (0.17 – 0.30)); ranger: RR 0.28 (0.21 – 0.37)) and washing only slightly increased landing risk (civilian: RR 0.40 (0.30 – 0.54)); ranger: RR 0.36 (0.26 – 0.48)) providing some information for retreatment frequencies. Combining this VPSR with treated clothing made no substantial difference to the level of protection provided against landing (RR 0.05 (0.03 – 0.07)). These interventions are useful bite prevention tools for forest-dwellers and -goers to reduce human-vector exposure occurring outside sleeping hours. This study should be replicated in other settings, as mosquito bionomics and susceptibility profiles are variable and deeply affect how these interventions work.

Keywords: field evaluation, repellents, Anopheles

ABS-446

Variation of *Aedes aegypti* life-history traits across different climatic zones of Burkina Faso

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Aedes aegypti is the main vector of various arboviruses including dengue, yellow fever, Zika and chikungunya virus. This species originated in Africa but has a wide distribution colonising various ecological zones. The transmission dynamics of arboviruses depends on environmental factors, but also on mosquito life history traits including development time, fecundity and longevity. The objective of this study was to assess the variation in life history traits of Aedes aegypti mosquitoes collected in different geographical regions in Burkina Faso. *Aedes aegypti* mosquitoes were collected as eggs from different geographical zones in Burkina Faso: Dori, 1200 logements, Toudweogo and Bobo-Dioulasso. Cohorts of mosquitoes were reared in standardized laboratory conditions to assess the life history traits parameters. Emerged adults were discriminated into morphotypes according to the density of white scales on the first abdominal tergite. Fecundity, longevity, development time and body size were assessed and linear models were fitted to the traits parameters to assess the effect of other covariables. Average *Aedes aegypti* development time was estimated to be 7.35 days; 7.40 days; 6.98 days and 7.40 days respectively for Dori, 1200 logements, Bobo-Dioulasso and Toudweogo. The fecundity did not vary across study sites and was not associated with the body size. The longevity varied according to the study sites with the mosquitoes from Bobo-Dioulasso having the longest longevity while the shortest longevity was found at Dori. Fed mosquitoes had longer longevity compared to unfed ones. Morphological identification showed that Aedes aegypti aegypti-like mosquitoes were more predominant than Aedes aegypti formosus-like mosquitoes in all study sites, suggesting the predominance of Aedes aegypti in the urban environment. Our results suggest that the life history traits was not affected by difference geography/ecology in Burkina Faso.

Keywords: *Aedes aegypti*, immature stage, traits, fecundity, longevity, body size, Burkina Faso

ABS- 275

Mating competitiveness of paternal male-bias *Anopheles coluzzii* transgenic males compare to their wild type in insectary, Burkina Faso

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Anopheles colluzzii non-gene drive paternal male-bias (Ac(PMB)1) expresses a homing endonuclease variant protein which cuts the male X chromosome while leaving the Y intact during meiosis and leads to production of >95% male offspring. This study investigated the mating competitiveness of males carrying the PMB1 transgene in a local Burkina Faso *An. coluzzii* colony compared to non-transgenic wild type (WT) with same genetic background. Virgin adults in equal proportion were added to cages; 120 PMB1 males, 120 WT males and 120 WT females. After blood feeding gravid females were transferred individually into larval rearing pots. Transgenic status was determined in larval progeny by presence of DsRed marker protein using fluorescent microscopy. The study was replicated three times with two cages each replicate. Mating status of each female was informed by numbers of transgenic (PMB1) and non-transgenic (non-PMB1) larvae observed. Double mating with PMB1 and WT were determined where progeny transgenic status deviated significantly from 1:1 ratio expected from a single mating with males heterozygous for PMB1 transgene. Only females that had single mated with PMB or WT were included in mating competitiveness analysis. Mating status of 237 females were assessed. In total (average percent per replicate), 82 (34.6±8.4%) were single mated to PMB1 males and 101 (42.6±9.2%) to WT males. Double mattings (PMB1 + WT) accounted for 29 (12.2±2.6%) and it was not possible to determine single vs double mating status for 25 (10.5±2.6%). Excluding double or undetermined mattings, Chi-square analysis found no significant difference ($\chi 2 = 1.973$, DF=1, $p = 0.1602$) from a 50:50 ratio as expected from equal mating competitiveness. Our results show that Ac(PMB)1 males do not have a significant different mating competitiveness compared to Ac(WT) when competing for wild type females in insectary.

Keywords: *Anopheles coluzzii*, Male-bias transgenic, Wild type, Mating competitiveness, Insectary, Burkina Faso

ABS -662

Evidence of high contribution of kdr and GSTE2 in populations of Anopheles gambiae suggest multiple insecticide selection pressure in populations of mosquitoes in Nigeria

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Insecticide resistance is becoming a big challenge in vector control in Nigeria. The mosquitoes are now resistant to all classes of insecticides and this multiple resistance is now widespread. In the latest report, multiple resistance mechanism was observed phenotypically. Therefore, we investigate the assortment of kdr and GSTE2 in populations of Anopheles gambiae that are resistant to pyrethroids in Nigeria. Anopheles larvae were sampled from 7 states in Nigeria using standard methods. Adult mosquitoes were exposed to diagnostic concentrations of 0.75%permethrin and 0.05%deltamethrin using the WHO standard. A total of 1,400 (100 each per state for each insecticide) mosquitoes were identified morphologically and through PCR, and further screened for kdr and GSTE2 mutations. The mosquitoes were resistant to the diagnostic concentrations of both permethrin and deltamethrin. The prevalence of kdr and GSTE2 mutations were 569(40.6%) and 748(53.4%) across all populations respectively. The survivors had significantly higher kdr ($\chi 2 = 6.749$, $p = 0.009$) and higher GSTE2 ($\chi 2 = 3.250$, $p = 0.041$) as compared with the dead suggesting that both mutations are responsible for the multiple insecticide resistance mechanisms. Furthermore, majority of the populations had both mutations confirming the insecticide selection pressure on kdr and possibly high selection pressure organochlorines, though past data have shown high level of resistance to organochlorines in the populations. This study establishes the multiple insecticide selection pressure for both pyrethroids and organochlorines in Nigeria and further highlights the need to regular monitoring of resistance complexity in populations of *Anopheles gambiae* in the country

Keywords: *Anopheles gambiae*, kdr, GSTE2, Nigeria

ABS-652

Profiling Vector Species Composition, Parasite infection, Seasonality, Biting and Resting Behaviour of Malaria Vectors To Guide Targeting of Vector Interventions along Lake Kariba of Southern Zambia

Javan Chanda (PATH)*

Indoor residual spraying (IRS), long-lasting insecticidal nets (LLINs) and larval source management (LSM) are critical for pushing malaria elimination agenda in Africa. In the absence of longitudinal entomological data, malaria programs face operational challenges towards optimal targeting of vector interventions. This study monitored entomological indicators in areas earmarked for malaria elimination in southern Zambia. Longitudinal and cross-sectional surveys were conducted from 2015 to 2020 using CDC light traps, pyrethrum spray catch, human landing catches and larval collections. Field mosquitoes were morphologically identified and sub-species of An. gambiae s.l and An. funestus group were identified by polymerase chain reaction (PCR). Operational IRS with an organophosphate; ACTELLIC® 300 CS (pirimiphos methyl) and mixture; Fludora® Fusion (Deltamethrin and Clothianidin) were implemented in four districts of southern Zambia. Following the scale up of IRS, vector species composition changed from 2015 to 2020 with *An. arabiensis* rising in proportion while *An. funestus* declining. Operational IRS was more effective against endophilic *An. funestus* than the exophilic *An. arabiensis*. *Anopheles funestus* was found biting mostly indoors with outdoor biting recorded in some study areas over the years. Contrarily, *An. arabiensis* was found biting outdoors and early evening (18:00 to 20:00) over the years. Seasonal abundance of An. arabiensis peaked during the rainy season while *An. funestus* spiked during the dry season. Parasite infection rates declined over the years with higher rates observed in *An. funestus* than in *An. arabiensis.* Longitudinal entomological studies generated local evidence that guided the national malaria elimination program (NMEP) to design, select, target, and implement sustainable integrated vector control strategies in areas targeted for malaria elimination in Southern Province of Zambia.

Keywords: Malaria, Vector Species Composition, Biting, Seasonality, Resting, Long-Lasting Insecticidal Nets, Indoor Residual Spraying

ABS- 81

Genomic copy number variations for adaptation of livestock to climate resilience

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Domestications have shaped the genome of all living things on our globe. Changes in temperature and climate were shaped the genetic landscape of the populations. Genomic Copy number variations (CNVs) are shaped using mutation, selection, and demographic history within and between livestock species. Genomic copy number variations play significant roles in designing and implementing genetic intervention plans for climate resilience and improve livestock production in developed and developing countries. For instance, copy number variable genes are olfactory receptors (ORs) important roles for food foraging, mate recognition, and detection of volatile

chemicals in the environment. Copy number variations prominent roles surveying unique adaptive, productivity, and survivability traits of African livestock populations display under challenges of environmental pressures, disease, nutritional, and water shortages. Establishing livestock with the appropriate genetics to improve heat resilience in tropical countries and maximize their productivity and subsequently reduce their overall carbon footprint. The individual coat types of domesticated bovine breeds vary widely, with yak breeds (Bos grunniens) selected for hair length and cold tolerance, and short-haired cattle of zebu (Bos indicus) selected for hot and tropical environments. The improvement of breeds through the transfer of genes into highly selected breeds for better match livestock to harsh conditions and maintain productivity. Phenotype traits to consider for a genetic basis of resilience in all biological functions of interest and the potential inclusion in selection indices for breeding schemes. Therefore, this review determines the present eminence of copy number variations associated with the adaptation of livestock to climate change.

Keywords: Association, copy number variation, climate, gene, livestock

Parallel Turbo Talks Session 3: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health

ABS- 367

Nationwide status of insecticide resistance of the major dengue vector *Aedes aegypti* in Burkina-Faso

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Burkina-Faso has recorded successive outbreaks of dengue with *Aedes aegypti* as the main vector. Better understanding of the spread of insecticide resistance and underlying mechanisms is crucial for an effective insecticides based response. The susceptibility profile to main public health insecticide classes was assessed throughout the country to inform decision-makers. WHO tube adults bioassays were performed on *Ae. aegypti* females from eggs collected in 2019 and 2020 using ovitraps in the thirteen regional capitals. Mosquitoes were exposed to pyrethroids, carbamates, and organophosphates insecticide classes and mortality was recorded 24 hours following exposure. Target sites mutation resistance mechanisms were assessed by genotyping for the F1534C, V1016I, and V410L kdr mutations genes using qPCR analysis in the set of 50 unexposed mosquitoes per region. The populations of Ae. aegypti from all 13 regions showed strong resistance to pyrethroids insecticides with mortality rates ranging from 13.4% to 29.1% for alpha-cypermethrin and 2.0% to 68.7% for deltamethrin. Seven (07) out of thirteen Aedes population showed resistance to carbamates Bendiocarb with mortality ranging from 35% to 98.1%. The resistance to the organophosphates insecticides malathion and Pirimiphos-methyl was moderated and reported in six (06) and five (05) regions with mortality ranging from 54.7% to 100% and 56.4% to 100% respectively. The kdr allele F1534C was the most prevalent mutation with an overall frequency of 0.89. The V1016I was found with an average frequency of 0.38 while the newly reported V410L kdr mutation was found with a frequency ranging from 0.23 to 0. 54. Our study reported a nationwide spread of pyrethroids resistance in Ae. aegypti while some populations were still susceptible to carbamates and organophosphates. Thus, a national strategy for monitoring and continuous surveillance of the resistance of *Ae. Aegypt*i is needed.

Keywords: *Ae. aegypti*, insecticide resistance, Kdr mutations, dengue, Burkina-Faso.

ABS- 606

Malaria vector feeding, peak biting time and resting place preference behaviors in line with indoor based intervention tools and its implication: scenario from selected Sentinel Sites of Ethiopia

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In Ethiopia, malaria incidence has significantly reduced in the past decade through the combined use of conventional vector control approaches and antimalarial drug treatment. However, the sustainability of this achievement is threatened by the shift in biting and resting behaviors and the emergence of insecticide resistance by the primary malaria vector. Therefore, continuous monitoring of the

behaviour of malaria mosquitoes in different sentinel sites is crucial to design effective prevention and control methods in the local context. In 2017, the survey was carried out between July and December. A longitudinal study approach was used. Medebay Zana (Northern Ethiopia), Mirab Abaya (Southern Ethiopia), and Wondo Genet (South Eastern Ethiopia) were used for entomological monitoring. Each site's ten CDC, ten PSC, ten PFS, and five HLC homes were selected at random. SPSS 25.0 was used to analyse the data. the mean mosquito density between indoor and outside collections was calculated. One-way ANOVA was used to evaluate the average variation in mosquito densities across various species, locations, and months. A total of 8,297 Anopheline mosquitoes were collected from the three sites, of which 4,525 (54.5 %) were *An. gambiae*, s.l. 2,028 (24.4 %) were An. *pharoensis*, 160 (1.9 %) were *An. funestus* and the rest 1,584 (19 %) were other anophelines *(An. coustani*, *An. cinereous*, and *An. tenebrosus*). No significant variation (P = 0.476) was observed between indoor (25.2/trap-night and outdoor collections (20.1/trap-night). Six hundred seventy-six (43.3%) of *An. gambiae* s.l. (primary vector) were collected between 18:00 and 22:00 h. Biting activity declined between 00:00 and 02:00 h. The national malaria control program should pay close attention to the shifting behavior of vector mosquitoes as the observed outdoor feeding tendency of the vector population could pose challenges to the indoor intervention tools IRS and LLINs.

Keywords: *An. gambiae*; biting behavior ; malaria; resting behavior; Ethiopia

ABS-501

GIS-based Multi-criteria analysis for selection of suitable field site for genetically modified mosquitoes' small-scale testing

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Genetically modified mosquito technology is one of the most promising malaria vector-control techniques. The field assessment of this technology for vector control requires a better characterisation of the sites in which field release of genetically modified mosquitoes will be performed. In this context, this study used geographical, entomological and socio-anthropological data to investigate suitable sites for field trials of genetically modified mosquitoes in Burkina Faso. A methodology combining GIS-based multi-criteria analysis and field visits was used. First, selection criteria were defined and implemented in the Model Builder of Arc GIS 10.8. Then, spatial, climatic, demographic, health and security data were used to feed the model. Finally, a field visit by a multi-disciplinary team was used to select suitables sites for the study based on their receptivity to the subject and the species composition of the mosquito population. Multi-criteria analysis in GIS resulted in the selection of 39 locations that met the criteria out of a total of 11 559 in the national database. Field verification resulted

in the selection of the top 4 best locations based on social organisation, susceptibility and species composition of the mosquito population. This study demonstrated the importance of the use of GIS, multi-criteria analysis and a multi-disciplinary approach in the selection of study sites.

Keywords: GIS, multi-criteria analysis, genetically modified mosquitoes, vector-control, malaria

ABS-557

Use of *Anopheles* salivary biomarker to assess seasonal variation of human exposure to anopheles bites in children living near rubber and oil palm cultivations in Côte d'Ivoire

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Agricultural practices and activities can impact malaria transmission. In the objective to evaluate this impact on the human-vector contact, the level of human exposure to *Anopheles* vector bites was assess by an immuno-epidemiological indicator based on the assessment of the human Immunoglobuline G (IgG) antibody response to the *Anopheles gambiae* gSG6- P1 salivary peptide, previously validated as a pertinent biomarker. Two cross-sectional surveys were carried out in the dry and rainy season in three villages with intensive agricultural plantations (N'Zikro with rubber cultivation, Ehania-V5 and Ehania-V1 with palm oil exploitation) and in a control village without plantations (Ayébo). Overall, 775 blood samples were collected in filter papers from children aged 1 to 14 years-old for immunological analysis by ELISA. The IgG levels to the gSG6-P1 salivary peptide significantly differed between studied villages both in the dry and the rainy seasons ($P<0.0001$) and were higher in agricultural villages compared to the control area. In particular, the level of specific IgG in Ehania-V5, located in the heart of palm oil plantations, was higher compared to other agricultural villages. Interestingly, the level of specific IgG levels classically increased between the dry and the rainy season in the control village ($P < 0.0001$) whereas it remained high in the dry season as observed in the rainy season in agricultural villages. The present study indicated that rubber and oil palm plantations could maintain a high level of human exposure to Anopheles bites during both dry and rainy seasons. These agricultural activities could therefore represent a permanent factor of malaria transmission risk.

Keywords: Malaria, *An gambiae*, Salivary Biomarker, Rubber An Oil Palm Cultivation

ABS-399

Prevalence of Asymptomatic Malaria Infection and Ancillary of Care to Enhance Education Development Among School Age Children Attending School in Mining Regions of North-Western Province of Zambia.

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Schools-age children are vulnerable to asymptomatic malaria and usually researchers are faced with unmet health needs of research participants. The aim was to ascertain the malaria prevalence using a school-based diagnosis and treatment to enhance learning among children in mining region schools of North-Western. A total of 4889 randomly selected school going children aged 5 to 14 years with consent and assent were enrolled in the survey in randomly selected schools. A small sample of blood was taken for testing of malaria parasites using RDTs. Interviews were conducted using a structured questionnaire to capture information about their residential area and mosquito control in their household. Descriptive and chi-square test analysis were conducted. Findings revealed that 54% of the participants were female, 65% were aged between 10-14 years and 31% (CI: 29%-32%) had a malaria positive RDT (Pf) result. Despite the high malaria prevalence, only 6% of the children were on treatment. Ancillary of care was provided to children who had a Malaria RDT (pf) positive result by providing treatment according to the national malaria treatment guidelines. Envisaging and planning for treatment of malaria during research was cardinal to successful implementation of ancillary of care. Findings reveal that 49% normally used mosquito bednets,51% of the households received IRS, 48% reported missing school due to illness, 45% had a fever in the last 2 weeks and 12% were hospitalised in the past 12 months. There was a significant association between sex of the children (P=0.006), household size (P=0.020) and having a positive RDT (Pf) result. Lack of early detection and treatment of malaria in school age children could contribute to infectious reservoir of plasmodium transmission. There is urgent need for interventions including research studies to incorporate ancillary-care to mitigate unmet health needs of school going children.

Keywords: Prevalence, School age children, Asymptomatic Malaria, Ancillary Care

ABS- 246

Abstract Title: Development and validation of an empirical model to forecast malaria outbreaks at Amhara Region, Ethiopia: a retrospective Follow-Up Study

Fetlework Workineh Asress (JVPCA)*; Worku Awoke (Bahir Dar university); Zelalem Mehari (Bahir Dar university)

Malaria remains a significant public health concern in developing countries including Ethiopia. It is one cause of high-level of morbidity in the Amhara region. the purpose of this study was to forecasting malaria outbreaks by using an empirical model developed in the Amhara region, Ethiopia . A retrospective follow-up study was conducted from April 01 to 30, 2022 from 34 woredas in Amhara region . Bivariable logistic regression analysis was done, and the forecasting model was developed by backward stepwise multivariable logistic regression. Time series seasonal decomposition was included. The best model was selected by likelihood ratio score. Model accuracy was assessed by the area under the curve and calibration plot. and internally validated by the bootstrapping method. The results of significant predictors were reported as coefficients with 95% confidence intervals. A total of 919,586 malaria cases were confirmed from 34 woredas out of 3,839,034 total laboratories tests with a test positivity rate of 23.9%. Presence of irrigation (OR = 1.522, 95% CI = 1.161-2.142), sunshine above the mean (SH>=7.167) (OR = 4.104 95%, CI = 1.706-9.791), rain fall above the mean (>=98.178) (OR = 21.73% CI = 5.755-141.326) and minimum temperate pressure (OR = 0.956, 95% CI = 0.956-0.997) were significantly associated with malaria outbreaks in Amhara region. The p-value of the calibration belt was 0.798. Sensitivity and specificity of the model was 99.12% and 3.72% respectively. Sunshine, minimum temperature, rain fall and irrigation were important forecasting determinants for malaria outbreak in the Amhara region. Moreover, the risk model developed from the risk score had comparable prediction accuracy with a model created using coefficients. Climatic data, irrigation, distance related to malaria area, migrants related to its origin and other climatic related factors should be recorded from the origin.

Keywords: Malarial outbreak, forecast, model, Ethiopia

ABS -389

Laboratory and field evaluation of MAÏA®, an ointment containing N,N-diethyl-3-methylbenzamide (DEET) against mosquitoes in Burkina Faso

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Malaria vector control relies upon the use of insecticide-treated nets and indoor residual spraying. However, as the emergency of insecticide resistance in malaria vectors grows, the effectiveness of these measures could be limited. Alternative tools are needed. In this context, repellents can play an important role against exophagic and exophilic mosquitoes. This study evaluated the efficacy of MAÏA®, a novel repellent ointment, in laboratory and field conditions in Burkina Faso. For field assessment, 20 volunteers were enrolled and trained

for nocturnal collection of mosquitoes using human landing catches (HLC). In the laboratory tests, 2 mg/sq cm of MAIA® or 1 ml of 20 % DEET were used to assess median complete protection time (CPT) against Anopheles gambiae and Aedes aegypti species, following WHO guidelines. For both species, two strains consisting of susceptible and local strains were used. The susceptible strains were Kisumu and Bora Bora for An. gambiae and Ae. aegypti, respectively. For the field test, the median CPT of MAÏA® was compared to that of a negative (70 % ethanol) and positive (20 % DEET) after carrying out HLCs in rural Burkina Faso in both indoor and outdoor settings. Laboratory tests showed median Kaplan-Meier CPT of 6 h 30 min for *An. gambiae* (Kisumu), 5 h 30 min for *An. gambiae* (Goden, local strain), and 4 h for *Ae. aegypti* for both the local and sensitive strain. Anophelines represented 98.5 %, with culicines (Aedes) making up the remaining 1.5 %. The median CPT of 20 % DEET and MAÏA® were similar (8 h) and much longer than that of the negative control (2 h). These results showed that MAÏA® offers high protection against anophelines biting indoors and outdoors and could play an important role in malaria prevention in Africa.

Keywords: *Aedes aegypti; Anopheles gambiae*; Burkina Faso; MAÏA®; Malaria; Mosquito; Repellent.

ABS- 491

Creating geospatial disease heat maps using routine HMIS data and DHIS2

Isaac Lyatuu (Ifakara Health Institute)*

DHIS2 is a software application that works with country's Health Management Information System (HMIS) to provide effective mechanism to collect, aggregate and disseminate routine HMIS data in a country. DHIS2 application is used in over 73 countries worldwide and with more additional countries continuing to adapt broadly. Despite it's broad use and potential, some researchers have questioned quality of the data coming from the DHIS2 database, in particular in relation to data incompleteness, implausible values due to data entry errors, and duplicates records. In this paper, we use DHIS2 data to create geospatial disease heat maps for Tanzania mainland and assessed its quality relative to other empirical studies. We downloaded data from the DHIS2 OPD dataset containing data element names and values. We grouped the data and values by health outcome categories. We limited the data between the period 2015 to 2019 and calculated total number of disease diagnoses for each of the defined health outcome category per 1000 population per year and by average. We assigned a semi-quantitative measure of (none)/low/medium/high to each calculated value using quartile (equal counts) method from QGIS (QGIS 3.4, 2020) and created geospatial disease heat maps to represent council-level variation for each health outcome category. The result shows that there is heterogeneity from disease group indicators across different councils in the Tanzania mainland. Of interest, the distribution of malaria diagnoses across Tanzania mainland shows a high-density of malaria along the north-west and south-east. This

similar to that of Malaria Indicator Survey 2017 and other empirical studies. This exploratory analysis reveal that DHIS2 data has potential to contribute to scientific research and empirical studies. We urge for more collaboration between MoH and public heath researchers to further promote its use.

Keywords: routine HMIS, DHIS2, disease reporting, spatial data

ABS- 126

Perception of autodissemination of pyriproxyfen for malaria control among community members in southern Tanzania

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The autodissemination of pyriproxyfen to suppress malaria mosquitoes has been proven under semi field environment in Tanzania. However, the information on how best communities should be engaged for its routine and large-scale adoption are lacking. This study assessed the level of knowledge, acceptability and in-depth perceptions of community members on the autodissemination approach and its potential for malaria control. This was a concurrent mixed methods study, comprised of a community-based survey of 400 household representatives and eight focus group discussions. The study was conducted in two villages in Mlimba district in southern Tanzania between June and August 2022. Although the knowledge about the autodissemination approach was relatively low among the community members surveyed (36.00%, n = 144), when it was explained to them, the community support was relatively high (97.00%, n = 388). One of the major perceived benefits of the autodissemination approach was the reduction of malaria transmitting mosquitoes and consequently malaria, while some of the major concerns included health impacts of pyriproxyfen to non-target organisms. When provided with information on how it works and its safety, a majority (93.50%, n = 374) of the survey respondents said that they would allow the PPF-contaminated pots to be placed around their homes. Similarly, participants of the FGDs were receptive towards the autodissemination approach but emphasized on the need of raising awareness among community members before field trials. This study indicates a low knowledge but high support for scaling up of autodissemination approach as a complementary tool for malaria control in rural Tanzania. A majority of the community members who participated in the study asserted the relevance of community sensitization activities to further improve community acceptability and trust prior to autodissemination of pyriproxyfen field trials.

Keywords: Autodissemination, Pyriproxyfen, Malaria, Community, Tanzania.

ABS- 265

Understanding hidden drivers of persistent malaria transmission in rural southern coast of Tanzania: exploring human behaviours, structural factors, and rural livelihoods

Christina Makungu (Ifakara Health Institute)*; Alicia Davis (University Of Glasgow); Heather Ferguson (University Of Glasgow); Nicodem Govella (Ifakara Health Institute)

Despite progress in reducing malaria burden through wide-distribution and use of insecticide-treated nets (ITNs), effective drugs and improved diagnosis, residual transmission remains high in Tanzania's southern coast. Identification of the underlying reasons for such resilience is critical for optimizing control strategies. This study explored livelihood activities, behaviours and structural factors that increase human exposure to malaria vector bites in outdoor settings in one village in Kilwa district. Qualitative methods including 20 participant observations in households and water sources, 7 in-depth interviews and 6 focus group discussions were used to collect data in the dry season (September-November 2022). Participants included farmers and pastoralists, men and women, and village leaders. The study village has no access to piped water sources and participants rely on natural wells, and ponds, far from their homes as the main sources of water. Water fetching was commonly observed and reported to occur early morning and overnight at times when malaria vectors are actively biting. Participants also report seasonal migrations from village homes closer to water sources for gardening activities where they live in semi-open structures, work early morning and night times leading to exposure to mosquito bites. Sleeping outside in semi-open structures near cattle sheds to guard livestock, was observed in pastoralist households. Our study indicates how outdoor malaria risk behaviours are rooted in wider local livelihood needs, and play out at daily and seasonal levels in rural village life. Current interventions such as Indoor Treated Nets are insufficient to reduce malaria in this setting, therefore complementary outdoor strategies should be prioritized. Improving the infrastructure for domestic water supply may reduce malaria risk, and that calls for a broad-based, inter-sectoral approach to malaria control efforts.

Keywords: Malaria, Residual transmission, Outdoor biting, Livelihood activities, Structural factors, Behaviours, Qualitative methods

ABS- 365

Co-production of a cattle-targeted vector control intervention in coastal and western Kenya - potential role and limitation of veterinary extension service

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Insects like mosquitoes, ticks and tsetse flies impact human and animal health because of diseases they transmit. Control of these vectors has been hampered by increase in insecticide resistance. Through a participatory process, stakeholders suggested more integrated approaches for the control of vector-borne diseases affecting humans and livestock with a single intervention. Novel biopesticides might be promising tools to achieve this. Stakeholders were engaged to explore the best community-based intervention strategies to be employed in testing such a novel One Health intervention. Key informant interviews were conducted with 46 participants in western and coastal Kenya exploring the quality of extension services, implementation strategies of a field trial and long-term sustainability of such a proposed cattle-targeted intervention. Interviewees included government veterinary officials, private practitioners and livestock keepers. Both practitioners and end users, felt that the current extension services were ineffective in supporting the farmers needs due to lack of resources for their operations. Inter-sectorial collaborations between health and agricultural departments in the local government exists but has little field relevance. Veterinary departments were keen to be trained and contribute to integrated projects but would always require financial support. The application of a biorational agent for vector control on cattle was welcomed by all respondents if safety was guaranteed. In western Kenya, it was proposed that central cattle spraying points (crush pens) be used and trained community members provide the services. In the coastal region, where households are far apart, interviewees strongly recommended to equip farmers with a knapsack sprayer and train them. Participatory research through engagement of key stakeholders provide practical strategies best suited to the circumstances of the communities involved.

Keywords: Participatory Research, Biorational, One Health, Cattle-targeted

ABS- 374

Occupational exposure to malaria, leishmaniasis and arbovirus vectors in endemic regions: a systematic review

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Vector-borne diseases of dengue, leishmaniasis and malaria, may be more common among individuals whose occupations or behaviours bring them into frequent contact with their vectors away from homes. A systematic review was carried to ascertain at-risk occupations and situations which expose individuals to vectors of these diseases in endemic regions and identify the best suite of interventions. The PRISMA guidelines were followed for searching 16 online databases for articles published between 1945 and October 2021. The main outcome was the incidence or prevalence of dengue fever, leishmaniasis, or malaria. Except for ecological and qualitative research, abstracts only, letters, commentaries, reviews, and studies on laboratory-acquired infections, all epidemiological studies were included. Each study's quality was evaluated, and data were extracted. Different bite prevention strategies were evaluated for their applicability for each risk group. Out of 1170 screened articles, 99 were included, covering malaria, leishmaniasis and dengue in 47, 41 and 24 articles respectively. Soldiers were the most presented population (38%). Risk of exposure was categorised into round-the-clock, evening-only or day-only, and also semi-permanent settlements. Long-lasting, wash-resistant insecticide-treated clothing is effective for outdoor transmission of malaria, leishmaniasis, and dengue for mobile populations providing a round-the-clock protection. Bed nets and Indoor residual spraying is effective for stationary locations, Occupational exposure to disease vectors is a significant risk for outdoor workers, and refugees who are disproportionately affected. Improved access to prompt diagnosis and treatment, along with vaccines for dengue and malaria, is a sustainable long-term solution. Control of leishmaniasis a neglected disease is of growing concern, particularly among refugees in endemic areas.

Keywords: Aedes, Anopheles, Dengue, Farmers, Forestry, Leishmaniasis, Malaria, Migrants, Military, Miners, Missionaries, Mosquito, Occu

Parallel Turbo Talks Session 5: Precision public health, NTDs, Genomics, Social Science, Women in Science; other

ABS- 203

Combating Vectors with Venoms: Potential effects of three novel mosquitocidal peptides isolated from spider venoms against Aedes *Aegypti Linnaeus.*

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Sassan Asgari (The University of Queensland); Glenn King (The University of Queensland); Volker Herzig (University of the Sunshine Coast)

Aedes aegypti transmits arboviruses such as dengue fever, yellow fever, chikungunya, and Zika virus. Thousands of human lives are lost annually due to these diseases with 1/3 of the human population being at risk of infection, especially in Africa. Effective control of these diseases is primarily achieved through vector control using chemical insecticides. However, the emergence of insecticide resistance in *Ae. aegypti* undermines the current control efforts. Arachnid venoms are rich in toxins with activity against dipterous insects and a few peptides have been patented for the control of insects. The study was designed to isolate and characterize mosquitocidal peptides from the venom of arachnids. Accordingly, 41 spider and 9 scorpion venoms were screened for mosquitocidal activities in *Ae. aegypti.* Assay-guided fractionation aided the isolation of 3 novel peptides from the venom of two tarantulae, Hysterocrates gigas and Lasiodora klugi that showed activity against adult *Ae. aegypti*. Furthermore, Edman degradation/LC MS MS analysis and online SWISS-MODEL/AlphaFold2 colab revealed the peptide sequences and structures respectively. The peptides, named U-TRTX-Hg1a, U-TRTX-Lk2a, and U-TRTX-Lk1a; are made up of 40, 41, and 49 residues and have monoisotopic masses of 4502.11 Da 4687.02 Da, and 5718.88 Da, respectively. All these peptides caused potent irreversible paralysis and 100% mortality within 24 h. The peptide U-TRTX-Hg1a, isolated from H. gigas exhibited an LD50 of 23.2 pmol/g and its modeled structure conformed to the disulfide-directed β-hairpin motif. Similarly, the peptides U-TRTX-Lk1a and U-TRTX-Lk2a, isolated from L. klugi. exhibited an LD50 of 38.3 pmol/g and 45.4 pmol/g and their modeled structures conformed to the inhibitor cystine knot and the disulfide-directed β-hairpin motifs respectively. The isolated spider venom peptides are potential leads for developing novel controls for *Ae. aegypti* mosquitoes to combat the range of diseases they transmit.

Keywords: *Aedes aegypti*; Lasiodora klugi; Hysterocrates gigas; insecticidal toxin; disulfide-directed beta-hairpin; inhibitor cystine k

ABS- 308

Bed Net damage assessment from images using a digital segmentation tool and image processing

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The assessment of fabric integrity of insecticide-treated nets (ITNs) is done by manually counting the holes and tears, which are classified by size in four categories (thumb, fist, head, larger than head). This method is labor-intensive and calculates an approximate hole surface

area based on average hole size. It is known to overestimate the holed area and to be subject to operator bias. As a first step towards a fully automatized method, we investigate whether photographs could be used to rapidly assess this area.Digital photographs of nets were taken on a net frame, fitted with a black cloth with a rectangular grid on it. A Graphical User Interface (GUI) was developed to manually segment the holes on the photographs. This tool also collects the frames' grid points to correct distortions caused by the wind using geometric transformations. To validate the method's accuracy, white A5 papers (area = 31,100 mm^2) were placed on the nets and their surface area was computed from their segmentations. These results were compared to the WHO method's estimations. Preliminary results on a reduced dataset yielded an average A5 area of 31,839 ± 1001 mm^2. This corresponds to an error of 3.38 ± 1.80 %. On the other hand, the WHO method estimated the A5 area to be between 10,000 to 100,000 mm^2. Additional results using a larger dataset are expected by September 2023. Preliminary results indicate that the computation of total hole surface area of ITNs using digital computation from photographs shows promise as a fast, simple and reliable alternative to estimate total hole net area. Future work will include image analysis using Machine Learning to support the automatization of the assessment of ITN conditions for its use during field surveys.

Keywords: ITN, image analysis, hole surface estimation

ABS- 314

Socio-cultural factors shaping individual night time exposure to Malaria transmission in Malawi: case of Chikwawa district

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Continuous interaction between malaria vectors, the human host and the society result in persistent malaria transmission despite the availability of insecticide-treated nets (ITNs) and indoor residual spraying (IRS). Increased outdoor biting by Anopheles mosquitoes are contributing to ongoing malaria transmission due to various day-to-day activities people engage in. In this study, detailed socio-cultural activities contributing to outdoor malaria transmission were investigated in Chikwawa district, southern Malawi. Participant observations and informal interviews helped us learn individuals' behaviours within their environment of Chadula village for six weeks. Twenty In-depth interviews and four focus group discussions were conducted to triangulate with the participant observations. Study participants were selected through convenient sampling. Themes were drawn in response to the social-ecological model and structure vulnerability through NVivo 12. Socio-cultural activities such as initiation ceremonies Zoma for girls and Jando for boys, traditional dances (Zilombo,and Nayawu), celebrations of the dead (Zipilala), weddings, funerals and other celebrations called for men, women and children to be outdoors during the night and be at risk of being exposed to malaria vectors. Jando, grave digging early morning, attending gule and

nyawu exposed men. Similarly, zoma, weddings, zipilala, traditional dances, funerals, and other celebrations and functions, such as the birth of newborn family member(s) exposed women and children as they had less or no protection from mosquito bites across the events. Socio-cultural factors shape exposure to malaria vectors in adults and young people. Social research generates knowledge on developing innovative and tailor-made vector control interventions that respond to people's needs and look into alternative interventions such as repellents for vector control.

Keywords: Outdoor transmission; vector control; outdoors; socio-cultural practices, socio-ecological framework, Malawi

ABS- 511

Seroprevalence and demographic risk factors of dengue fever in Burkina Faso through national survey

Siaka Debe (INSP/CNRFP)*

Since 2017, dengue fever evolves in Burkina Faso in endemic form. Literature review revealed missing information on the epidemiological burden of dengue nationwide. This study aims at evaluating dengue seroprevalence in populations living in Burkina Faso and identify if demographic covariates are associated with dengue seropositivity. We conducted a cross-sectional survey in May 2022 stratified by administrative regions and urban/rural settings. All eligible residents aged over 5 years were included in randomly selected households. Sociodemographic data were collected followed by sampling 5 mL venous blood. Dengue serology was performed using IgG rapid diagnosis test. Logistic multivariate analysis was performed to compute Odd-ratio using STATA. We enrolled in total 5977 participants. Overall seroprevalence was 0.44 (95%CI=[0.27;0.62]). It was higher in urban compared to rural settings corresponding to 0.52 (95%CI=[0.33;0.70]) and 0.26 (95%CI=[0.21;0.32] respectively. Study showed a 3-fold higher rate in urban with OR=2.94 (95%CI=[1.17;7.36] p=0.023), a 6-fold higher rate in adults with OR=6.3 (95%CI=[4.48;8.65] p<001) compared to children and a similar rate in male compared to female with OR=1.04 (95%CI=[0.86;1.27] p=0.643). The study showed a high rate of dengue fever in Burkina Faso. This prevalence is significantly higher in population living in urban areas and in adults. Subsequent entomological and KAP data will capture other risk factors of dengue.

Keywords: Seroprevalence, dengue, cross-sectional

ABS- 524

Assessment of community knowledge on genetic concepts to enhance stakeholder engagement for gene drive technology

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In order to inform international guidance for stakeholder engagement in gene drive research and implementation for malaria elimination, there is a need for assessing community knowledge on key concepts related to genetic modification, including gene, chromosome, enzyme, DNA and gene modification in which two-ways dialogue has been based. The current paper describes the wording used by local communities to express concepts surrounding genetics and genetic modification. Data was collected, through a qualitative approach, in western part of Burkina Faso. 40 interviews and 2 focus group discussions were conducted with key informants, men and women in the Dioula local language. Interviews were recorded, transcribed and analysed thematically. Communities have knowledge on genetics concepts rooted in their daily experience, such as the physical characteristics of human such as the size of people, the color of skin or type of hair. Their knowledge also comes from their experience in the cross-breeding of species in farming and cattle breeding, by selecting certain characteristics associated to good profiles of the specie. This traditional knowledge is transferred to the reflection on genetic modification of mosquito and expressed in local language Dioula. Therefore the word such yelemani do soso siè-là is used by local community to translate genetically modify mosquito. Community knowledge on genetic concepts could be integrated in stakeholder engagement strategy to improve gene drive understanding and enhancing the acceptance of the technology.

Keywords: genetic concepts, social science, community knowledge, stakeholder engagement, Burkina Faso

ABS-66

Malaria Prevalence among different Age Groups and Gender in Subsistence Crop Farming and Fishing Communities in Greater Kamuli District, Uganda: Implications for Control

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Malaria remains a major health threat in Uganda. This study aimed at comparing the malaria prevalence rates among different age groups and gender between subsistence crop farming and fishing communities in greater Kamuli district, Uganda. Malariometric surveys covering 519 people (224 adults and 295 children) living in 70 households in Nabwigulu crop farming communities and Bukungu fish landing site were carried out using Rapid Diagnostic Tests. Overall, 25.1% (130 out of 519) of the people screened in the two sites combined had

malaria. Malaria burden was found to be higher among the subsistence farming community (46%) compared to the fishing community (26.3%). Generally, males had the same risk of malaria infection as females among the fishing communities, while in the subsistence farming communities, males (26.7%) had higher malaria prevalence than females (18.3%). The prevalence (58.3%) of malaria among school-going children (6 to 11 years) in the subsistence farming community was similar to that of <5 years old (53.8%). Malaria prevalence was lowest among children 12 to 17 years (17.6%). Children under five years apparently had the highest malaria prevalence in the fishing community (43.3%). Overall, adults (>18 years) had a malaria prevalence of 47.4%. Malaria transmission risk factors include poor cultivation and fishing-related activities, poor housing, and the lack of collective malaria control and prevention efforts among the communities were responsible for the high malaria burden. Livelihood-related factors in the study area played a big role in malaria transmission among the different age groups and gender. Community sensitizations on malaria transmission risk factors are recommended, while safety measures against malaria risk should be considered for all age groups and gender in both livelihoods. .

Keywords: Malaria, Age, Gender, Subsistence Farming, Fishing

ABS- 590

The Spatiotemporal dccurrence and peri-domestic infestation of *Anopheles stephensi* in selected towns across varying eco-epidemiological settings of Ethiopia

Temesgen Ashine Amenu (Armauer Hansen Research Institute)*; Adane Eyasu (Jimma University); Yehenew Asemamaw (Armauer Hansen Research Institute); Eba Alemayehu Simma (Jimma University); Endalew Zemene (Jimma University); Nigatu Negash (Armauer Hansen Research Institute); Abena Kochora (Armauer Hansen Research Institute); Endashaw Esayas (Armauer Hansen Research Institute); Ahmed Zeynudin (Jimma University); Fekadu Massebo (Arba Minch University); Luigi Sedda (Lancaster University); Koen Peeters (Institute of Tropical Medicine); Thomas Churcher (Imperial College London); Alison M Reynolds (Liverpool School of Tropical Medicine); Anne L Wilson (LSTM); David Weetman (Liverpool School of Tropical Medicine); delenasaw yewhalaw (Jimma University); Endalamaw Gadisa (Armauer Hansen Research Institute); Martin Donnelly (LSTM)

Anopheles stephensi has extended its range to Africa including Ethiopia. We investigated spatiotemporal distribution and patterns of peri-domestic infestation in selected urban centers of Ethiopia. Longitudinal entomological sampling was conducted in 26 urban centres to map the distribution. Four rounds of mosquito collection were made every three months from 20 structures/site, with 10 structures replaced each round. To determine peri-domestic infestation of An. stephensi, sampling of adults was conducted in 50 randomly selected

structures and compounds and within a 50 meter radius of selected structures for immature. Adult mosquitoes were collected using Prokopack aspiration and CDC light traps with standard dipping for larvae. Morphological identification was performed and Anopheles mosquitoes were preserved for molecular analysis. DNA extracted from adult and immatures for species typing. Of all the surveyed towns, 30.7 % (8/26) were positive for An. stephensi larvae and/or adults. Of which 50% (4/8) are positive for both adults and larvae. A total of 1,698 adult Anopheles mosquitoes were collected from 96.2% (25/26) study sites in all four rounds, among which, 83.9% (n=1426) *An. gambiae s.l*, 5.7% (n=97) *An. pharoensis*, 4.8% (n=82) *An. coustani* group, 3.5% (n=60) An. stephensi and 1.9% (n=33) *An. funestus* groups. Most An. stephensi, 41.9% were caught between mid to late October, and 25.6% were collected in early April 2022. Of 50 surveyed structures, 30% (n=15) in Danan, 26% (n=13) in Awash Sebat kilo, 18% (n=9) in Methahara were infested with *An. stephensi*. Among morphological identified adult *An. stephensi*, 80% (12/15) are confirmed with PCR end-point assays. The distribution of *An. stephensi* appears to be extending with heterogeneous peri-domestic infestation. An in-depth investigation is needed to better understand its bionomics and contribution to malaria transmission to target for effective control.

Keywords: *Anopheles stephensi*, Spatiotemporal distribution, Household infestation

ABS- 121

Prevalence of dhps K540E and A581G mutations in Plasmodium falciparum isolates among asymptomatic parasitaemic pregnant women attending antenatal care booking in Nchelenge district Northern Zambia

Bertha kasonde (Tropical Diseases Research Centre)*

Interventions to reduce the burden of malaria in pregnancy in sub-Saharan Africa are inadequate. Malaria infection during pregnancy is responsible for adverse birth outcomes. To protect against adverse pregnancy outcomes, WHO recommends providing intermittent preventive treatment with sulfadoxine-pyrimethamine (IPTp-SP) to pregnant women at each scheduled antenatal (ANC) visit as directly observed therapy from the second trimester to delivery with at least one month between doses. However, the loss of parasite sensitivity to SP has compromised the efficacy of IPTp-SP. Studies have revealed that resistance to SP is associated with single nucleotide polymorphisms in the dihydrofolate reductase and dihydropteroate synthase (dhps) genes. The objective of this study was to estimate the prevalence of the K540E and A581G mutations in samples of 200 malaria-positive women. The study was conducted in four health facilities of Nchelenge district, from November 2019 to August 2022. Dried blood spot samples were collected from all the participants on Whatman 3mm filter paper. Parasite DNA was isolated using the Chelex DNA extraction method and detected using SYBR green on the ABS 7500 fast real-time polymerase chain reaction (PCR) platform. The mutations were detected using PCR restriction fragment length

polymorphism method. The K540E and the A581G resistance markers were found in 74.8% (95% CI=61.2-74.1) and 5.03% (95% CI=1.2-8.1) of the samples respectively. The data suggest a high prevalence of *P. falciparum* K540E and a low prevalence of A581G mutation, which may explain the reduced efficacy of IPTp treatment in Zambia. More efficacious antimalarials are urgently needed to address malaria in pregnancy.

Keywords: IPTp-SP; sulfadoxine-pyrimethamine resistance; malaria; mutation; Pfdhps.

Day 2

Parallel Turbo Talks Session 6: LLINS, IRS and insecticide resistance management

ABS-364

Copy number variation in sensory appendage protein coding genes in the malaria-transmitting vectors *Anopheles coluzzii* and *Anopheles gambiae*

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In the last two decades, insecticide-treated bed nets in addition to the agriculture insecticide used, exerted an intense selection pressure which led to the emergence and widespread of insecticide resistance mechanisms in vector populations, threatening current malaria control interventions. A new metabolic resistance mechanism mediated by the sensory appendage protein coding gene SAP2 (member of chemosensory proteins (CSP)) has been identified to confer pyrethroid resistance in *Anopheles gambiae*. In some mosquito species, copy number variations (CNVs) of detoxification genes have been linked to the resistance phenotype. The current work aims at exploring CNVs in CSP genes in *Anopheles gambiae* and *Anopheles coluzzii*. *An. gambiae* and *An. coluzzii* CNV call data from Ag1000G project phase 3 were analysed to identify CNVs in the eight CSP genes using the malariagen-data Python package in Google colaboratory. SAP1 and SAP2 deletions were detected only in *An. coluzzii* from Mali in 2013. Amplifications up to 4 copies were detected for SAP1 in *An. gambiae* from Ghana (2017). In *An. coluzzii*, a maximum of 3 copies were detected for CSP1 in Gambia (2012), for SAP1 in Ghana (2017), and for SAP1

and SAP2 in Benin (2017). Surprisingly, all individuals carrying SAP2 duplication simultaneously harboured SAP1 duplication. Both genes duplication (Dupli_SAP1,2) was found in *An. gambiae* mosquitoes from only Guinea (2012), Burkina Faso (2014), and Ghana (2017). In Benin, Dupli_SAP1,2 was found only in *An. coluzzii*. The frequencies of all detected CNVs can be visualized at http://195.138.202.39:8080/carto/. This work reveals duplication in genes associated with pyrethroid insecticide detoxification. Although detected randomly and at low frequency in different countries, further studies are needed to investigate the likely effect of SAP genes duplication on the effectiveness of chemical insecticides tools currently used for malaria vector control.

Keywords: SAP genes, copy number variation, metabolic resistance, Anopheles, Malaria

ABS-407

Insecticide resistance in vector control: Knowledge gap and way forward

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Insecticide resistance is a heritable change in the sensitivity of a pest population that manifests as a product's repeated failure to achieve the expected level of control when used according to the label recommendation for that pest species. The mechanisms of resistance include target site resistance and metabolic resistance, penetration resistance and behavioral resistance. Insecticide resistance is of two types: cross resistance and multiple resistance. Pyrethroid has been employed in the treatment of long-lasting insecticide nets and as part of indoor residual spray (IRS); however, overuse/reliance on single insecticide has caused *Anopheles gambiae* to develop resistance to the pyrethroid insecticides which has led to a collapse in malaria vector control. In this study, both quantitative and qualitative published materials from reputable journals were accessed using the key words “insecticide resistance and resistance management”. A comparative approach was used to understand the present knowledge of resistance among vectors and the way forward to achieving integrated vector management (IVM). To foster Insecticide Resistance Management (IRM), there is a need to understand each vector's resistance mechanism, the chemistry of insecticides, and discover many more insecticides with different modes of action like VECTRON TM T500 (Knowledge gap). Studies have revealed that combining P450 pyrethroids with piperonyl butoxide (PBO) could lower the pyrethroid resistance rate in malaria vectors. The way forward is to engage in the rotation of several novel insecticides with different modes of action.

Another way of managing resistance is to embrace botanical insecticides by developing methods and standards of application. The botanical insecticides applications will bring the issue of resistance to an end and reduce environmental pollution.

Keywords: Insecticide resistance, resistance management, vector control, pyrethroid.

ABS-462

Experimental hut evaluation of the efficacy and wash resistance of two alpha-cypermethrin and piperonyl butoxide nets (Duranet®Plus and Duranet®Plus 2.0): A multi-centre study against pyrethroid-resistant malaria vectors in Benin, Cameroon and Cote d'Ivoire

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Pyrethroid-Piperonyl butoxide (PBO) nets have demonstrated improved efficacy for control of malaria transmitted by pyrethroid resistant mosquitoes compared to pyrethroid-only insecticide treated nets (ITNs). To improve access to these nets and maintain a healthy ITN market for malaria control, more efficacious brands of pyrethroid-PBO ITNs are needed. We performed experimental hut trials in Cove, Benin, Mbe, Cote d'Ivoire and Mibellon, Cameroon against wild pyrethroid-resistant *Anopheles gambiae s.l.*, *Anopheles coluzzii* and *Anopheles funestus* strains respectively to assess the efficacy and non-inferiority of two new alpha-cypermethrin-PBO nets (DuraNet®Plus 2.0 and DuraNet®Plus) compared to a pyrethroid-PBO ITN that has demonstrated improved efficacy in randomised controlled trials (Olyset Plus). The trials followed WHO guidelines. WHO susceptibility bioassays confirmed high levels of pyrethroid resistance in all 3 experimental hut sites and showed evidence of a synergistic effect with pre-exposure to PBO. DuraNet®Plus and DuraNet®Plus 2.0 LN induced superior levels of mosquito mortality compared to an alpha-cypermethrin-only net (Duranet®Plus: 29% in Benin, 27.8% in Cameroon and 19.2% in Cote d'Ivoire; Duranet®Plus 2.0: 33% in Benin, 38.1% in Cameroon and 30.8% in Cote d'Ivoire vs. Duranet®: 20% in Benin, 13% in Cameroon and 9.2% in Cote d'Ivoire). The non-inferiority assessment revealed that both DuraNet®Plus and DuraNet®Plus 2.0 were non-inferior to Olyset Plus in terms of their ability to kill and induce blood-feeding inhibition of wild pyrethroid-resistant malaria vectors in all three study sites using a margin of non-inferiority recommended by the WHO. DuraNet®Plus and DuraNet®Plus 2.0 show potential to provide improved control of pyrethroid resistant malaria vectors across West and Central Africa compared to pyrethroid-only ITNs and was non-inferior to a net that has shown empirical evidence of improved public health value.

Keywords: Experimental hut, Insecticide resistance, PBO.

ABS-452

Bio-efficacy re-evaluation of actellic 300 cs for indoor residual spray against anopheline mosquitoes under field conditions in solwezi district of north-western province.

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Indoor residual spraying (IRS) has proven effective in reducing the malaria burden. Little is known on the established operational residual efficacy of various insecticides considering that soil pH, humidity, temperature, etc. differ per locality. The objective of the assessment is to re-evaluate the residual efficacy of Actellic® 300CS considering their knockdown and mortality rates on different indoor surfaces. Selected households with plastered, painted, burnt, unburnt bricks and tents were included in the sample. The field design and methodology were based on the standard WHO protocols for insecticide susceptibility testing and monitoring of residual efficacy. The study period is seven (7) months (October 2022-April 2023), observing the knockdown and mortality rates of female laboratory bred anopheles mosquitoes. Susceptibility tests were done on local mosquitoes. Descriptive and difference in proportion tests were used for data analysis. In October, 100% 24hr mortality was achieved on all surfaces. Subsequent months showed a 100% mortality within 24 to 48 hours on all sprayed surfaces. At month 5(February 2023), all surfaces showed a stable (above 80% 24 hr. mortality) except for plastered walls which reached 100% mortality at 48 hours. The proportional mortality rate varied significantly ($p < .05$) between surfaces. Control mortality was within acceptable range. Susceptibility test showed high 1-hour-knockdown and 100% 24-hour mortality to all exposed mosquitoes. Actellic 300 CS is an effective IRS insecticide for prevention of malaria. It has shown sustained and prolonged residual activity that is essential for malaria endemic regions thereby reducing the mosquito density. Appropriate use of Actellic 300 CS has potential to eliminate the primary malaria vector and offer community protection against malaria.

Keywords: susceptibility, residual efficacy, entomological monitoring, vector

ABS-522

Experimental hut trials reveal a greater loss of the efficacy for the pyrethroid-only nets than with PBO-based nets from the mass distribution campaign 2018-2021 against resistant malaria vectors in Cameroon.

Benjamin Djantio Menze (CRID)*

Malaria is still a major public health concern in Cameroon. Strategies against malaria rely heavily on long lasting insecticidal nets (LLINs) distribution. The rise of insecticide resistance in major vectors is now a major concern for the National Malaria Control Program (NMCP).

To tackle this, National Malaria Control Program (NMCP) has introduced new PBO-based LLINs in its policy and there is scare data on the effectiveness of these in nets against Anopheles mosquitoes in Cameroon. This study

aimed to investigate the performance of PBO LLINs and Pyrethroid LLINs only against malaria vector in natural condition using experimental hut trials and cone test. After experimental hut trial, the mass killing effect against the pyrethroid resistant Anopheles funestus from Mibellon was higher with PBO-based nets (Olyset Plus) compared to pyrethroid-only nets (Duranet and Olyset). Similarly, the personal protection provided by PBO nets either washed 0 or 20 times was also higher compared to the pyrethroid-only nets. However, the mortality obtained in experimental hut trial (<20%) as well as in the lab using cone test (<50%) were low suggesting a loss of efficacy of bed nets in circulations in Cameroon. Overall, the performance of nets washed 0 time compared to the nets washed 20 times did not significantly (P≥0.05) for most of the parameters assessed. This study shows greater efficacy of PBO-based nets against pyrethroid resistant malaria vectors. However, a reduced performance of PBO and pyrethroid only nets was observed. This result is an urgent call to National Malaria Control Program to consider other alternatives in order to control malaria in Cameroon.

Keywords: Malaria vectors, Long Lasting Insecticidal Nets, Insecticide resistance, Anopheles funestus, Piperonyl butoxide

ABS-604

Experimental hut evaluation of a pyriproxyfen treated net against resistant An. gambiae (Tiassalé strain) mosquitoes

Emile F S Tchicaya (Centre Suisse de Recherches Scientifiques)*

Recently, the insect growth regulator pyriproxyfen (PPF) has been introduced in public health. To confirm the promising results observed with PPF-treated nets, particularly in a high multiresistance area, more studies are needed. The objective of this study was to demonstrate the efficacy of Royal Guard®, a PPF treated net, against strongly resistant *Anopheles coluzzii*. The efficacy of Royal Guard® LNs (investigational item) was evaluated in terms of reproductive outcomes (i.e. sterilisation of adult female mosquitoes), mortality and blood-feeding inihibition, and mosquito exit and entry compared to a pyrethroid-PBO LN (Olyset Plus®), pyrethroid-only (Royal Sentry®2.0 – standard comparator) LNs and PPF only (PPF nets – standard comparator) in Cote d'Ivoire. Royal Guard® showed superiority compared to Olyset Plus and Royal Sentry in terms of its ability to sterilise surviving pyrethroid resistant mosquitoes through the pyriproxyfen component. Concerning mortality and blood feeding, Royal Guard® showed comparable efficacy to the pyrethroid-only LLINs through the effect of the alpha-cypermethrin component. The study provides also entomological evidence of enhanced malaria vector mortality induced by the addition of PBO to pyrethroid ITNs in an area of metabolic pyrethroid resistance that supports evidence of the public health

benefit of PBO nets for malaria control. Regarding the Combination of feeding inhibition, mortality and sterilization of females that du survive feeding, Royal Guard® could be recommended in areas of high pyrethroid resistance to improve malaria vector control.

Keywords: resistance; pyriproxyfen; malaria

ABS-683

Wind-assisted high-altitude dispersal of mosquitoes and other insects in East Africa

Harrysone Etemesi Atieli (Tom Mboya University)*

Knowledge of insect dispersal is relevant to the control of agricultural pests, vector-borne transmission of human and veterinary pathogens, and insect biodiversity. Previous studies in a malaria endemic area of the Sahel region in West Africa revealed high altitude, long-distance migration of insects and various mosquito species. The objective of the current study was to assess whether similar behavior is exhibited by mosquitoes and other insects around the Lake Victoria basin region of Kenya in East Africa. Insects were sampled monthly from dusk to dawn over one year using sticky nets suspended on a tethered helium-filled balloon. A total of 17,883 insects were caught on nets tethered at 90, 120 and 160 meters above ground level; 818 insects were caught in control nets. Small insects (<0.5 cm, n=15,250) were predominant regardless of height to large insects (>0.5cm, n=2,334) and mosquitoes (n=299). Seven orders were identified; dipterans were most common. Barcoding molecular assays of 184 mosquitoes identified 6 genera, with Culex being the most common (65.8%) and Anopheles being the least common (5.4%). The survival rate of mosquitoes experimentally exposed to high altitude overnight was significantly lower than controls maintained in the laboratory (19% vs. 85%). There were no significant differences in mosquito survival and oviposition rate according to capture height. These data suggest that windborne dispersal activity of mosquito vectors of malaria and other diseases occur on a broad scale in sub-Saharan Africa.

Keywords: altitude, migration, mosquitoes, insects, Africa

Keywords: PBO, Malawi, pyrethroid, LLINs

ABS-620

Insecticide resistance profile of *Anopheles funestus* in Mopeia district, a high malaria transmission area in Central Mozambique.

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The primary vector control strategies implemented in Mozambique are indoor residual spraying (IRS) and Long-Lasting Insecticidal Nets (LLINs). IRS is implemented in high burden districts, Mopeia being one of them. The rapid emergence and spread of insecticide resistance is a major challenge to malaria control thus the need to monitor insecticide resistance to inform resistance management strategies. In this study, the phenotypic and genotype resistance of malaria vectors in Mopeia district was evaluated. This was done in the context of the BOHEMIA (Broad One-Health Endectocide-based Malaria intervention in Africa), a clinical trial evaluating the impact of ivermectin mass drug administration to humans and animals on malaria transmission. Anopheles adults and larval stages were collected from October 2021 to September 2022. Field-collected adults (F0) or F1 adults emerging from the larvae were assessed for phenotypic resistance using the WHO tube assays. The presence of metabolic resistance was assessed by observing increased susceptibility following pre-exposure to PBO. Metabolic resistance was confirmed by genotyping for CYP6P9a, CYP6P9b, L119F-GSTe2, and N4851-Ace1 insecticide resistance alleles. A total of 1349 female Anopheles mosquitoes were tested (controls included). The main malaria vector collected in the study site was *An. funestus s.s.* Phenotypic resistance to deltamethrin, bendiocarb, pirimiphos methyl and DDT was detected with 19%, 36%, 68% and 78% mortality rate respectively. Pre-exposure to PBO partially restored susceptibility to deltamethrin with mortality rate of 80%. Malaria vectors in Mopeia show resistance to multiple insecticides highlighting the need to adopt new compounds for insecticide-based vector control interventions. The partial restoration of susceptibility by PBO suggests resistance is being driven by various mechanisms including the involvement of metabolic adaptations in the mosquito.

Keywords: *Anopheles funestus*, insecticide resistance

ABS-263

Evaluation of the durability of long-lasting insecticidal nets in Djoumouna from Brazzaville Congo

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Evaluation of the durability of long-lasting insecticidal nets is used to guide the choice of LLINS, to plan the frequency of campaigns and to identify practices that influence their durability. The objective of this study was to assess the durability of LLINS distributed during the mass campaign in November 2019. The study was conducted in the village of Djoumouna, 24 km south of Brazzaville in August 2021. LLINS were collected from households to determine their physical durability and chemical durability on pyrethroid-susceptible and

pyrethroid-resistant populations of *An. gambiae s.s.* In this study, 33 LLINS were sampled. Assessment of the physical integrity of these LLINS showed that 12.1% (4/33) of the LLINS had no holes, while 87.9% (29/33) had holes. According to WHO standards, the calculation of the proportional hole index (pHI) allowed the LLINs to be divided into three categories: for a pHI between 0 and 64, 27.3% of the LLINS were in good condition, for a pHI between 65 and 642, 27.3% of the LLINS were repairable, and at a pHI of 643 and above, 45.5% of the LLINS were torn. Bioassays showed that LLINS were effective on the Kisumu strain and ineffective on the field strains. This study showed that more than half of the LLINS were found to have holes in them less than 2 years after distribution, although they retained sufficient insecticidal activity.

Keywords: LLINS, proportional hole index, pyrethroids, malaria, Congo

Parallel Turbo Talks Session 7: Vector surveillance: surveillance systems, community-based surveillance, epidemiology, disease control programs and global health

ABS-317

Blood-meal sources and malaria positivity rates of primary and secondary vectors in a malaria endemic area of Western province, Zambia.

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In Zambia, malaria remains a life -threatening public health problem. The primary vector control interventions are long-lasting insecticide-treated nets and indoor residual spraying. Dominant vector species in Western Zambia is *An. funestus s.s*, and potential secondary vectors. Enhanced entomological surveillance is required to understand, effectively select suitable and sustainable vector control strategies. This study was part of a study conducted to confirm primary vectors in the region and estimate corresponding rates of feeding from prototype attractive sugar bait stations. Mosquito collections were done in two districts (Nkeyema and Kaoma), February -

March 2020. Households were randomly selected for each night's collection and sampled overnight from both indoors and outdoors using CDC UV Light Traps. Anopheles mosquitoes were morphologically identified and classified based on abdominal status, unfed or fed. Representative subsample was selected for PCR species identification, blood-meal analysis, and ELISA sporozoite detection. A total of 144,550 Anopheles mosquitoes were collected, 7, 129 subsamples were selected for further analysis. The most abundant species was *An. funestus s.l.* (31%), followed by *An. squamosus* (20%) with 2% of *An. gambiae s.l.* The least was *An. gibbinsi* with less than 1%. For sporozoite detection, *An. funestus s.s* had a sporozoite rate of 3.0% accounting for 94.3% of all positive mosquitoes. *Anopheles arabiensis* and *An. squamosus* were also found with sporozoites. The most common blood-meal source was human (44%), while cow (32%) and goat (23%) were also common. Twelve species of anopheles mosquitoes were identified, indicating high species diversity which might complicate malaria control and elimination efforts in the area. Most sporozoite-positive mosquitoes were *An. funestus s.s.* Interestingly, *An. squamosus* was found with *P. falciparum* sporozoites. The HBI varied substantially by species.

Keywords: vector species, entomological surveillance, sporozoite rate, prototype attractive sugar bait stations

ABS-358

Investigating factors associated with vectors densities, composition and biting pattern across different setting of tanzania to inform control strategies.

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Major malaria interventions, such as ITNs and IRS, are becoming less effective due to changes in mosquito behavior and insecticide resistance. In Tanzania's northern, western, and southern regions, where malaria still caused significant child mortality, complimentary approaches are still needed to address the problem. This study aims to determine malaria vectors species abundance, and investigate their biting patterns, to inform complementary malaria vector control strategies. The present study utilized mosquito electrocuting trap (MET) to collect Anopheline mosquitoes from 32 districts in Tanzania. Zero-inflated mixed-effect regression model were used to determine mosquito abundance and biting patterns. Independent variables such as windows screening, eaves opening, roof type, livestock, land use were fitted in the model to assess the associated risk of mosquito abundance. A study found that rice farms (OR=0.18, p=0.0003), cooking outdoors (OR=0.45, p=0.0012), and absence/partial window screens (p=0.042 and OR=4.2, p=0.015) were significant predictors of mosquito abundance in primary malaria vectors. *An. gambiae* had higher outdoor (35.6%) than indoor (23.5%) abundance, while *An. funestus* had higher indoor (75.4%) than outdoor (63.0%) abundance. *An. funestus* bites indoors during early morning and night (0300-0400 hrs), while *An. gambiae* bites at night (2100-2200 hrs) and midnight (2300-0000 hrs). *An. funestus* tends to bite outdoors

around midnight (2300-0000 hrs), while *An. gambiae* bites outdoors during the night (0100-0200 hrs). Malaria transmission risk persists outdoors during communal gatherings and activities like cooking and storytelling, particularly in low-income rural households. Complementary interventions that target outdoor-biting mosquitoes are needed to augment the effectiveness of ITNs, with a focus on low-income families.

Keywords: malaria, biting paterns, mosquito abundance, Tanzania

ABS-479

Increasing capacity for evaluating transgenic mosquitoes as a population replacement strategy in malaria-endemic settings

Fatuma Juma Matwewe (Ifakara Health Institute) *

Current malaria vector control interventions have proven ineffective, and there is still a significant morbidity and mortality from these diseases. Genetic control methods are gaining popularity as viable alternatives for suppressing and replacing vector populations through the release of mosquitoes carrying a lethal gene or disease-resistant mosquitoes, although there is limited capacity in malaria-endemic settings. Therefore, there is a need of increasing capacity for evaluating transgenic mosquitoes in malaria-endemic settings. We have established a mobile, portable, containment level 3-laboratory at the Ifakara Health institute (IHI), Bagamoyo-Kingani site. The established facility will support the testing of some transgenic effectors on strains of major malaria vectors in endemic areas. The process will involve producing laboratory *An. gambiae s.s.* mosquitoes carrying somatic effector traits that make these mosquitoes refractory to Plasmodium infection. The efficacy of these effector genes will be assessed through a series of mosquito feeding assays (MFAs). Gametocytes are the transmissible stage of malaria parasites from human to mosquitoes. The MFAs will involve deliberate exposure of gametocytemic blood to mosquitoes under controlled conditions to assess for malaria oocyst and sporozoite infections. The research findings will lay the foundation for using transgenic mosquitoes carrying antimalarial effectors and the evaluation of transmission blocking interventions. We were successful in producing transient larvae, but the research is ongoing, and we hope to have final results by August 2023. Developing transgenic technologies in endemic and low-resource settings will largely contribute towards knowledge and skills transfer to local scientists.

Keywords: vector control, gene drive, transgenic mosquitoes, transmission blocking intervention, malaria

ABS-502

Circulation of mosquito-borne alphaviruses and orthobunyaviruses in two geographically distinct Ecozones of Kenya

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Arboviruses are emerging vector-borne pathogens of public health importance, associated with increasing frequency of outbreaks in Africa. We conducted mosquito surveillance in three geographically distinct ecozones: Garissa (Ijara subcounty), Baringo (Marigat subcounty) and Nakuru (Naivasha subcounty) to assess the extent of arbovirus circulation and identify potential vector targets for control. Mosquitoes were collected using CO_2-baited CDC light traps during the short and long rain seasons. In Ijara, sampling was conducted in Sangailu, Ijara and Kotile; Marigat (Ngambo and Salabani), and Naivasha (Mai-Mahiu). Mosquitoes were morphologically identified to species, pooled, homogenized, and inoculated in Vero cells. Cultures that showed cytopathogenic effects were harvested and viruses identified by RT-PCR, and sequencing. A total of N=171,152 mosquitoes were collected from Ijara, n=123,425 (72%), Marigat, n=41,177 (24%) and Mai Mahiu, n=6,550 (4%). The most predominant species in Ijara was *Ae. tricholabis*, n=53,834 (44%), *Cx. antenattus* n=21,700 (53%), in Marigat and *Cx. zombaensis*, n=2,109 (32%), in Mai Mahiu. Out of 9,306 pools screened, 73 viruses were isolates from Ijara (68/6946), and Marigat (5/1,998); and identified into genus Alphavirus n=47 (Ndumu, n=14, Semlikiforest, n=6, Sindbis, n=1; Orthobunyavirus n=24 (Bunyamwera, n=23, Ngari, n=1; and Flavivirus n=2 (West Nile virus, n=2). Highest being *Ae. ochraceus*, n=18, *Ae. mcintoshi*, n=16, and *Ae. tricholabis* n=15. No virus was isolated from Mai Mahiu mosquito samples. There is high circulation of mosquito-borne arboviruses of public health importance, in the two pastoral ecozones. This could be responsible for the many febrile cases of unknown origin frequently reported in the two regions. These highlight the presence of diverse viruses in circulation and potential species. This underscores the need for continued surveillance and introduction of measures addressing vector control in the respective areas.

Keywords: arboviruses, emerging diseases, surveillance

ABS-653

Exposure to malaria vector bites in relation to human sleeping patterns in rural Malawi

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Malaria vectors commonly bite people indoors at night. Insecticide-treated nets (ITNs) exploit this to protect individuals while asleep. However, mosquito behaviors such as increased outdoor biting may result in gaps in protection for ITN users. Likewise, human outdoor

activity during late evening or early morning can result in exposure to mosquito bites and malaria risk. We assessed people's sleeping and waking up time and location in relation to mosquito biting profiles to quantify exposure to malaria vector biting risk. Host-seeking mosquitoes were sampled using human landing catch. From September 2020 through February 2021, mosquitoes were collected every hour from 6pm to 10am both indoors and outdoors at study sites in two rural districts of southern Malawi. A questionnaire was also administered to household heads to record self-reported sleeping and waking up times. A total of 1,501 Anopheles mosquitoes were collected consisting of 80% *An. gambiae s.l.* (13% indoors and 67% outdoors), 14% *An. funestus s.l.* (10% indoors and 4% outdoors) and 6% other anopheline species (6 indoors and 80 outdoors). The majority of participants (84%, n=26,672) reported going to sleep within an hour or two after sunset, between 6-8PM. In contrast, 16% of participants reported being awake during the same period during which 4% of vectors were caught biting. Likewise, 49% (n=26,674) of respondents woke up at sunrise or within an hour after sunrise (5-6 AM), followed by 44% (n=26,674) who woke up one to three hours after sunrise (6-8AM). During the same periods, 21% of vectors were caught biting. We conclude that while a good proportion of study participants reported being indoors when 75% (n=1126) of mosquito bites took place, 25% (n=375) of bites occurred when nearly 93% of people were already awake and thus potentially exposed to bites. The results suggest that many people were either outdoors, or not under an ITN while Anopheles vectors were biting thus exposed to malaria risk.

Keywords: outdoor biting, ITNs, malaria risk, human behaviour

ABS-580

Malaria vaccine information in Africa: an analysis of the quality and engagement of TikTok videos

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Ninety-five (95%) percent of the malaria deaths occur in Africa, but the introduction of the malaria vaccine offers hope. However, misinformation poses a significant barrier to the vaccine uptake. With 1 billion active users monthly, TikTok is an increasingly popular platform for health communication, but the quality and engagement of malaria vaccine-related videos remains largely unexplored. Therefore, this study aimed to assess the engagement and quality of malaria vaccine related TikTok videos in Africa. We conducted a comprehensive search on TikTok using keywords '*malaria*', '*vaccine*', and '*Africa*' for videos posted between 2021-2023. All the identified videos were screened using the eligibility criteria. The quality of the videos that met the established criteria was evaluated using the DISCERN health information assessment tool. The DISCERN assessment tool evaluates health information materials for reliability, quality of the information, and overall rating of the information. The engagement of the videos was explored using the number of views, likes, comments, and shares of each video. Data analysis was conducted using descriptive analysis tools. Our findings revealed that out of the

nine (9) eligible videos in 5 African countries, 77.8% were entirely focused on the malaria vaccine. The average number of views was 10,994, and the mean values of likes, comments, and shares were 580.2, 30.1, and 72.4, respectively. The mean score on the DISCERN quality assessment tool was 40.1 out of 80, indicating fair quality. Based on our findings, there is a need to improve the content quality of the TikTok videos. Also, health professionals and policymakers need to work with social media creators to ensure that TikTok videos provide appropriate information to contribute to the fight against malaria

Keywords: malaria, malaria vaccine, misinformation, Africa

ABS-552

How much does outdoor biting contribute towards malaria burden?

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Malaria vector indoor interventions such as indoor residual spraying and insecticide treated nets have been the main drivers of the reduction of the global malaria burden since the beginning of the millennium. The stalling of this trend has in part been attributed to outdoor malaria transmission which is only indirectly controlled by these interventions. The contribution that outdoor biting makes to actual malaria cases has rarely been quantified based on epidemiological and entomological field data. The Bioko island malaria elimination program has implemented intensive malaria control interventions over the past two decades, accompanied by rigorous entomological and epidemiological surveillance. Using prevalence of infection and behavioral data from annual cross sectional household surveys, and in- and outdoor human landing catch data from entomological surveillance, this study assessed the contribution made by outdoor biting to malaria infection prevalence, allowing for confounding factors such as bed net use, age, and socioeconomic status, among others. About half of respondents were exposed to high numbers of bites received outdoors (>2.6 bites per night) before they went indoors for the night, more than doubling their risk of infection compared to those receiving fewer bites outdoors. Indoor biting also contributed to infection risk, but the levels of indoor biting were substantially lower, and the relationship with infection risk was weaker. Residual transmission through outdoor biting substantially increased risk for malaria infection and constitutes a barrier to malaria elimination. Early peak biting times of malaria vector mosquitoes result in many more individuals being unavoidably exposed to infectious bites

against which there are currently no effective means of protection. There is an urgent need for new classes of vector control tools that reduce the risk of malaria infection posed by outdoor biting.

Keywords: malaria; outdoor biting; parasite infection; residual transmission

ABS-610

Development of Malaria Pf/Pan antigen detection kit in Kenya; towards the realization of local manufacture of medical devices

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Malaria is a global health concern with 219 million cases and 409,000 deaths reported in 2019 by WHO. Most cases occurred in Sub-Saharan Africa, specifically Kenya with 3.5 million cases and 10,500 deaths. Prompt and accurate malaria diagnosis is crucial for control and elimination. While microscopy is the recommended diagnostic method, it has limitations in low-resource settings. Rapid Diagnostic Tests (RDTs) have been developed as an alternative to microscopy. In Kenya, the demand for malaria RDTs is estimated at 4 million tests per year. This study aimed to develop a locally produced Malaria Pf/Pan rapid diagnostic kit using pHRP II and pLDH antigens. Anti-pHRP II and anti-pLDH monoclonal antibodies were conjugated to 20nM colloidal Gold suspension, dried using a lyophilizer, and coated onto a nitrocellulose membrane with a spraying machine. The conjugates were then blocked and dried. The kit's performance was evaluated using positive and negative malaria samples, with 27 positive and 22 negative samples tested. Out of 27 positive malaria samples, all tested positive overall, 89% for Pf, and 100% for Pan. All 22 negative samples tested negative. The kit demonstrated a sensitivity of 100% overall, 89% for Pf, and 100% for Pan. The specificity was 100%. The study successfully developed a prototype of a Pf/Pan malaria detection kit with 100% sensitivity and specificity. Further optimization is required to determine the optimal protein dilution for cost-effective production and to consider the use of proteins circulating in Kenya, accounting for mutations in HRP II/III proteins. The study successfully produced a prototype of a malaria Pf/Pan antigen rapid detection kit, requiring further evaluation.

Keyword: Malaria, Antigen, Rapid Kits, Pf, Pan

ABS-119

In silico design of molecular model to study the SIFamide gene function in *Anopheles gambiae* olfactory system, in a perspective of genetic control of the vector.

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Despite decades of control effort, malaria still cause a public health problem. Fortunately, the main vector of the disease *Anopheles gambiae* (*An. gambiae*) has a weakness: it uses its sense of olfaction to target the human host on which feeds. Several genes including SIFamide regulate this behaviour in the vector. The overall objective of this study is to develop in-silico strategies to access the function of the SIFamide in An. gambiae. For this purpose, the EnsemblMetazoa database was used to identify the orthologue in An. gambiae. Then, tools such as BLAST-NCBI, CD-Search, FlyAtlas2 and MozAtlas was used to confirm this orthologue using Drosophila melanogaster as reference. Also, a knockout model was generated in silico for the orthologue by using CRISPR-Cas9 technology with the CHOPCHOP and Benchling tools. The orthologue identified is AGAP007056. The similarity and identity percentages between the protein and nucleotide sequences demonstrate the conservation of the gene in insects. Similar expression pattern of the gene was shown in *An. gambiae* and *Drosophila melanogaster* tissues but appears to be more expressed in the male than female. This could be explained by the fact that the male feeds exclusively on nectar and needs a regular supply of sugar for its survival. Otherwise, the absence of a protein domain could be due to a lack of annotation or that the gene really doesn't have a domain that has remained conserved through evolution. For the knockout technology, the gRNA has 20 bp in size and an efficiency score of 66.62%. It targets a conserved region of exon 2 and [%GC] = 65. The plasmid used for homology repair contains basis features such as a green fluorescent protein flanked by homology arms (1500 bp) immediately upstream and downstream of the Cas 9 cleavage site. Better understanding the phenotype associated to SIFamide expression will allow us to select this trait in a gene drive approach or other strategies targeting the same process in the vector.

Keywords: *Anopheles gambiae, Drosophila melanogaster*, knockout, CRISPR-Cas9, gene drive

ABS-96

The malaria transmission-blocking symbiont, Microsporidia MB, exhibits an environment-modulated interaction with *Anopheles arabiensis* at the Ahero irrigation scheme, Kenya

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In the rice-growing Ahero Irrigation Scheme in western Kenya, the tropical warm and humid climate as well as massive irrigation water bodies provide an ideal breeding ground for malaria-transmitting mosquitoes. It was against this backdrop that a Plasmodium transmission-blocking endosymbiont, Microsporidia MB, was recently discovered in the *Anopheles arabiensis* mosquito species. This study aimed at understanding the environmental factors at the scheme that influence the relatively high prevalence of *An. arabiensis* with the symbiont in the region. We conducted a correlational analysis using data recorded by an on-site weather station against the prevalence of the symbiont, as well as using calculated indices for water, bare soil, and vegetation cover at the scheme over a consistent sampling period of 18 months. The relative humidity and rainfall in the sampling zone were found to have a significant positive correlation with Microsporidia MB prevalence, whereas the ambient air temperatures had a negative correlation with the same. The rice planting and growth seasons were significantly associated with higher symbiont prevalence values as evaluated using normalized difference vegetation and water indices. However, during the dry and fallow seasons where higher indices of bare soil were recorded, the symbiont prevalence was found to decrease albeit not significantly. In order of magnitude, the symbiont prevalence was affected more by relative humidity followed by rainfall, water cover, temperature, vegetation, and bare soil respectively. All recorded correlations were subtle and indicated an interplay of multiple environmental factors influencing the host-symbiont interactions. These findings provide insights relevant to the timing of releases during the dissemination of Microsporidia MB-infected mosquitoes as a novel strategy for fighting malaria.

Keywords: malaria-transmission blocking, Microsporidia MB, environmental factors, *Anopheles arabiensis*

ABS-379

Understanding the role of the antennae in the mosquito behavioural response to insecticide-treated bed nets

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Insecticide-treated bed nets (ITNs) are the most effective means of malaria control in Africa, but resistance to pyrethroids could threaten their efficacy. While the molecular mechanisms driving resistance are well-characterised, little is understood on how mosquitoes detect, interact and respond to pyrethroids on ITNs and how resistance affects these responses. This work aims at investigating the molecular

basis of behavioural responses at the ITN surface and the potential involvement of the mosquito antennae in these processes. Firstly, to determine which resistance mechanism affects behaviour, transgenic mosquito lines carrying discreet genetic modifications involved in pyrethroid resistance (overexpression of CYP6P3, SAP2, GSTe2, and kdr L1014F), were exposed to a permethrin net in a cone assay and their behaviour recorded on video. Secondly, to determine how resistance and pyrethroid exposure affects gene expression in the antennae, RNA-seq analysis was performed on the antennae transcriptome of *An. gambiae* Kisumu (susceptible), Tiassalé (pyrethroid resistant), Tiassalé after exposure to permethrin. Video cone assays showed that the resistant lines overexpressing single resistance genes behaved similarly to the susceptible controls, showing elevated total movement when exposed to the permethrin net compared to the untreated net. However, mosquitoes carrying the kdr mutation showed comparable total movement when exposed to either net type. RNA-seq analysis of the antennal transcriptome generated a list of candidate genes that were differentially expressed in the resistant strain as well as after exposure to permethrin. This work provides the first comparative behavioural assessment of genetically defined resistant mosquitoes at the net interface as well as the first antennal transcriptome database in insecticide resistant and susceptible *An. gambiae.*

Keywords: mosquito, behaviour, antennae, video cone test, transcriptome

ABS-472

Testing configurations of attractive toxic sugar bait (ATSB) stations in Mali, West Africa, for improving the control of malaria parasite transmission by vector mosquitoes and minimizing their effect on non-target insects

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Application methods for attractive toxic sweet baits (ATSBs) need to be improved for widespread use, and the effects on non-target organisms (NTOs) need to be evaluated. The objectives of this study were to determine, at the village level, the effect of different bait station configurations to achieve a daily feeding rate of the Anopheles vector <25% for both males and females and minimize the effect on non-target organisms. Dyes were added to the attractive sugar bait stations (without toxins) to mark mosquitoes feeding on the baits, and UV CDC light traps were used to monitor the marked mosquitoes. A different set of traps was used to capture the dye labeled NTOs. Eight villages were selected for the experiments. The use of 2 and 3 stations per house resulted in feeding rates above the target of 25%. There was no statistical difference in the percentage of marked mosquitoes between two and three stations. There was no difference in feeding

of *An. gambiae s.l.* when stations were hung at 1.0 and 1.8 m. The ASB stations at 1.8 m above ground level were fed on by three of the seven insect orders monitored. The orders monitored were: Hymenoptera, Lepidoptera, Coleoptera, Diptera, Hemiptera, Neuroptera and Orthoptera. The use of one or two stations significantly reduced the percentage of NTOs fed by bait compared to the three stations with the highest feeding rates. The percentages were as follows 6.84 ± 2.03% Brachycera, followed by wasps (Hymenoptera: Vespidae) 5.32 ± 2.27%, and Rhopalocera 2.22 ± 1.79%. Hanging the optimal number of stations per house for mosquito capture (two) at 1.8 m above ground limited the non-target groups to Brachycera, Chironomidae, Noctuoidea, Rhopalocera, parasitic wasps, and wasps (Hymenoptera). The goal of marking a quarter of the total Anopheles population per day was achieved by using 2 bait stations at 1.8 m height above the ground and minimizing the effect on non-targets.

Keywords: ASB; ATSB; *Anopheles gambiae s.l.*; Diptera; Hymenoptera; Lepidoptera; Non-target organisms (NTOs).

ABS-526

Assessing the readiness and Feasibility of Larval Source Management in Rural Districts in Tanzania

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Larval Source Management (LSM) has been adopted as a supplementary vector control measure to be used alongside Long-Lasting Insecticidal Nets (LLINs) and Indoor Residual Spray (IRS) to facilitate malaria control and elimination in Tanzania. Its effectiveness in malaria reduction depends highly on its' implementation coverage including when, how and where it is conducted. A country's will and readiness financially, technically, and socially contribute significantly to the effectiveness of LSM as a complementary tool for malaria reduction. This study aims to assess the country's readiness and feasibility of implementing LSM in two rural districts and its effectiveness in malaria control and elimination. Qualitative approaches such as key informant interviews, in-depth interviews, observations, and desk review will be used to explore and assess the extent at which the country is prepared for the implementation of LSM, financially, technically and socially in two rural districts. The study will also include the assessment of role and contribution of stakeholders in LSM implementation. It is anticipated that, the findings of the study will provide an insight on the extent at which the country is prepared for the implementation of LSM in-terms of how it is coordinated from the national level to the village level, contribution of stakeholder in facilitating the implementation of LSM, financial investment, technical know-how and how the implementation is done on the ground. These findings will help to assess the strengths, weaknesses and identify areas of improvement to facilitate the effectiveness of intervention in malaria reduction and elimination. Understanding the weaknesses for implementation of LSM will provide the insight on aspects to be invested to facilitate sound contribution of LSM in malaria control efforts not only in rural, but also in urban areas and beyond.

Keywords: malaria, larval source management

ABS-539

Scaling Up LSM, Evaluating A Pilot Larval Source Management (LSM) Program; A Vector Control Intervention In Mining and Surrounding Communities in North-Western Province of Zambia.

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Multiple malaria prevention strategies have become essential especially in malaria endemic regions. First Quantum mineral in partnership with Ministry of Health Zambia piloted larval source management. This study assesses the pilot LSM program to ascertain the feasibility, viability, and sustainability as a malaria control method to inform scaling up. The LSM was conducted in three phases - July, August and October 2022. Mosquito breeding habitats were identified and treated with Vectobac WDG a biological larvicide with *Bacillus thuringiesis subsp. israelensis, strain AM 65-52*. In each of the phases, larviciding was done prior to determination of larval density in the 113 breeding sites using standard scoop collection method. Data was collected from all 113 breeding in all rounds. Statistical analysis included descriptive, chi-square and trend analysis. Ponds (30%) and ditches (28%) were the predominant breeding sites. Only 62% of the water pools larvicided were permanent breeding habitats, 78% were active breeding habitants, 33% had vegetation cover, 31% had turbid water and 32% had clean water. Further, 42% of breeding sites had a mixture of anopheles larva and culex larva. There was a statistical significance (p= 0.007) reduction in larva presence between rounds. and a statistically significant association between round of larviciding and larvae classification (P=0.002), larva presence (P<0.001), larva stage (P<0.001). Lessons learnt and areas of improvement include inadequate identification of aquatic habitats, weak monitoring systems, lack of consistency in implementation among communities and weak data quality control systems. Integrating larval control is cardinal to malaria control approaches and could be crucial for malaria elimination. Considering key parameters and potential impediments during planning and implementation of LSM is cardinal in achieving a successful and sustained LSM intervention.

Keywords: First Quantum mineral LSM program, Zambia, Vectobac, *Bacillus thuringiesis,* larviciding

ABS-211

Leveraging on geospatial modelling for inferences on ecological relationship among mosquitoes, tsetse flies and ticks bionomics along the Kenyan coast

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Geospatially mapped data show continuous variables at different spatial locations. Hot and cold spots tend to carry a lot of data and poorly represented, respectively. Geospatial relationship among mosquitoes, tsetse flies and ticks in different sites within the same ecosystem along the Kenyan coast is not well understood. The current effort set to investigate the geospatial relationship among these vectors in Lamu County along the Kenyan coast. Mosquito and tsetse fly surveys were done using recommended traps while engorged ticks were hand-picked from domestic animals in May -June 2014. Geospatial data, latitude and longitude of the ecology of the vectors were recorded. The vector samples were pricked a bit with a pin on integuments and were transported in alcohol to Pwani University laboratory. The samples were put under -20◦C after sample morphological identification was done using established keys. Regression models with spatially correlated errors were used to determine the relationship of geospatial effects of the ecology on the vectors. Generalized least square error was used to determined geospatial correlation among the locations towards random correlation on the vectors. ANOVA test was used to determine significance differences. The best model was settled through variogram, spherical correlation and rational quadratic spatial models in R. Geospatial ecology of the mosquitoes, tsetse flies and ticks had effects on the population bionomics coupled with significant differences ($p<0.05$). Further, sample variogram increased with distance illustrating the expected geospatial correlation while rational quadratic model had lower AIC values, thus preferred, relative to spherical model. The results suggest that geospatial ecology influence bionomics of these vectors and the best model can inform target ecology for vector surveillance, prevention, control and preparedness towards respective vector-borne diseases.

Keywords: geospatial modelling, mosquitoes, tsetse flies, ticks, bionomics, variogram, surveillance, disease preparedness, control

ABS-277

Species diversity, blood meal sources and infection rates of Anopheles mosquitoes in rural and urban settings in southwest Ethiopia: an implication for malaria control

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Understanding the mosquito species composition, blood meal sources, and infection rates in various settings is critical for developing and deploying tailored malaria interventions. Malaria mosquito species composition, sporozoite infection rate, and blood meal sources were examined in two malaria-endemic rural and one urban settings in Gamo Zone, southwest Ethiopia. Fifty households for Center for Disease Control and Prevention (CDC) light trap and ten for prokopack were randomly selected in Arba Minch town for monthly collection from April

to November 2022. Twenty houses for CDC light traps and ten for Pyrethrum Spray Catches (PSC) were randomly selected for bimonthly mosquito collection in two rural villages from October 2019 to February 2020. Blood meal sources identification and circumsporozoite proteins (CSPs) tests were done using an enzyme-linked immunosorbent assay (ELISA). Speciation of *An. gambiae* complex and *An. funestus* group was done by polymerase chain reaction. Three Anopheles species were documented in urban setting, while 14 were found in rural areas. Only *An. arabiensis* tested positive for *P. falciparum* CSP in rural and *P. vivax* CSP in urban areas. *P. falciparum* CSP was 0.5% (1/190: 95% CI: 0.01-2.9) and it was 0.13% (1/985: 0.003-0.56) for *P. vivax*. In rural settings, 15.2% (22/145; 95% CI: 9.8-22.1) of freshly fed Anopheles mosquitoes had human blood in their gut, 58% (84/145; 95% CI: 49.5-66.1) had bovine blood, and 16.6% (24/145; 95% CI: 10.9-23.6) had mixed blood in their gut. 50% (91/182; 95% CI: 42.5–57.5) of urban Anopheles mosquitoes tested for blood meal sources had human blood, while only 1.1% (2/182; 95% CI: 0.1-3.9) had bovine blood, and 50% (89/182; 95% CI: 41.4-56.4) were negative for both antibodies. *An. arabiensis* is playing a primary role in malaria transmission in both settings. Humans are highly exposed to malaria mosquitoes in urban settings, hence protection should be taken.

Keywords: Anopheles species; blood meal sources; Gamo zone, rural setting, urban setting

ABS-224

Perceptions and practices of rural communities regarding dracunculiasis behavior change education in Chad

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A crippling disease, dracunculiasis has been rampant in Chad for several decades despite institutional mobilizations. In 2010, 16 human cases were reported and more than 1000 dogs were infected in 2016. The number of infections in dogs has continued to increase, from 27 in 2012 to 55 in 2013, 113 in 2014, 503 in 2015, 1011 in 2016, 1040 in 2018. In 2019, 47 human cases. 1508 infestations in 2020 and 767 in 2021. The communication and education interventions of the National Guinea Worm Eradication Program are clearly hampered by various community beliefs and practices that contrast with the desired expectations. In light of these observed dysfunctions between official sensitization strategies and unpromoted community practices, this paper aims to conduct an in-depth analysis of rural communities' perceptions and practices regarding behavior change education for guinea worm disease control. The data analyzed were collected in November 2019 and February 2021 to interviews, direct observations, life stories. A total of 40 individual interviews were conducted in the endemic villages: Baîngara, Matabono, Nguerbéti and Ngara in the Bousso health district. Two theories were capitalized: Rosentock's Behaviour health model (1974) and the theory of social representations (Jodelet, 1989). The results show that rural communities neglect the instructions given despite the different channels of awareness mobilized. Cultural practices hinder the fight against dracunculiasis in rural Chad. The burial of fish casings to prevent animal infections was not respected by several households. The results show that the lack of understanding of community practices by outreach workers limits the process of stopping guinea worm transmission. Cultural practices hinder the control of Guinea worm disease in rural Chad. The burial of fish guts to prevent animal infections was not respected by several households.

Keywords: perceptions and practices, rural communities, education, behavior change, dracunculiasis

ABS-422

IDX - An AI based imaging and identification tool for Vector Identification with a prototype algorithm for select African species

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Vector surveillance, the monitoring of abundance, distribution, and diversity of mosquito species, is a critical step in assessing vector-borne disease risk. Morphological inspection of specimens remains a challenging task of the surveillance process. In many vector control programs, human expertise is responsible for species identification to guide important intervention or research strategies. Accurate data gathering poses a challenge given mosquitos' fine morphological differences and evolving mosquito populations. Several technical modalities have been explored for their potential to improve data accuracy and quality throughout the vector surveillance workflow. Applied deep learning convolutional neural networks (CNNs) for image recognition have shown promise, demonstrating the capability to visually differentiate between mosquito species in controlled optical scenarios and with limited mosquito species datasets. We developed IDX, an imaging device integrated with CNN software trained on a large dataset of both colony and wild vector images. The system allows for rapid training and deployment of CNN algorithms for operational use by vector management and research programs. We currently have 8 functional devices in Africa, with partners from Ghana, Kenya, Ethiopia, and Tanzania. Testing has demonstrated 91.7% mean species identification accuracy (F1-score) for 8 mosquito species (including *Anopheles stephensi*), and 93.5% on 11 tick species tested in a dataset gathered using 20 IDX devices. An unknown species detection algorithm was also successfully applied to this dataset (92.7% F1-score) flagging species not in our database. These advancements represent a step towards a practical system for rapid training, expansion, and deployment of automated species identification capabilities in operational vector surveillance programs across the African continent. IDX will be demonstrated at the meeting so bring your specimens!

Keywords: CNNs, morphology, computer vision, vectors

ABS-426

Mapping the abundance of *Anopheles gambiae* across Africa

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Maps of vector distributions have proven vital in guiding control efforts. Modern vector maps often predict a relative probability of presence. This is useful, but the quantity most useful to control is abundance of the vector — and this is much harder to estimate. We also know that probability of presence and abundance may not always be strongly correlated, so the utility of presence maps is limited. To better advise control efforts, we have developed a new method to map the abundance of the dominant malaria vector *Anopheles gambiae ss* across Africa at a 5km resolution. We developed a semi-mechanistic 'Demographic Species Distribution Model' to estimate the abundance of *An. gambiae* in space and time. The method builds on traditional niche mapping methods, by modelling how the species' life history traits vary with environmental covariates, but still enables fitting of the model to spatial datasets of mosquito occurrence and

abundance in trapping. It can then predict the expected number of mosquitoes that would be caught in each 5km cell and trap type, rather than simply presence or absence of the species. In providing estimates of abundance of *An. gambiae* across the landscape, the model provides greater discrimination across space than predictions of presence (which are more uniform over the landscape). The results are preliminary at the time of writing (March 2023) however we expect this study to be completed at the time of presentation (September 2023). Maps of abundance and suitability of different life stages in time and space can provide valuable insights for malaria control activities - allowing tailoring of activities towards areas they are likely to have the most impact. We believe this method will have great application for the prediction of malaria vectors and within the Vector Atlas we hope to model other species in future.

Keywords: *Anopheles gambiae*; modelling; distribution; vector

ABS-495

"How can you refuse when someone is helping you?" Community perception, acceptability, and support for establishing and sustaining 'women champions in vector control' group at the community level in Mwanza, Tanzania

Basiliana Emidi (National Institute for Medical Research, Tanzania)*

Vector-borne diseases (VBDs) are endemic in sub-Saharan Africa (SSA) and exert pressure on the public health systems of most countries in this region. Women are key change agents in the efforts to combat VBDs. Involving them in the VBDs control and management efforts increases the levels of community acceptance and compliance. This pilot study—funded through the 'mid-career women in vector control excellence award'—aimed to assess the community perception, acceptability, and support for establishing 'women champions in vector control' groups at community level. Five cross-sectional focused group discussions (FGDs) and eight in-depth interviews (IDIs) were conducted with purposively selected adult and young men, adult and young women, and community leaders in Mwagagala village, Misungwi district, in Mwanza region, Tanzania. Discussions and interviews were digitally recorded, transcribed, and synthesized to obtain key themes related to the objectives of the study. The study findings revealed that most of the respondents had a positive perception towards and accepted the idea of establishing and sustaining the 'women champions in vector control' groups at the community level. Most respondents agreed that these groups of women would help educate people on the importance of keeping their environment clean. Women have a unique ability to pass such information passionately and persuasively to other people. A few respondents, however, were skeptical of this initiative. They believed that women occupy a subordinate social position in society—with little or no privilege and authority—thus making it hard for them to participate in public activities. Most respondents also indicated that the community would support and sustain this group of women through the provision of transport, allowances, and food. Communities accept and support the idea of establishing and sustaining 'women champions in vector control' groups to eliminate VBDs.

Keywords: women champion in vector control, participation, perception, support, community, Mwanza, Tanzania

ABS-500

Harnessing data science and machine learning to unveil mechanisms that characterize vectors of diseases

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Data science (DS) is a growing field that integrates analytics, methods, and systems to discover and extract insights from large amounts of data to improve decision-making. Machine Learning (ML) algorithms are computer programs that mimic human intelligence and cognition to solve complex problems. Arthropod vectors are key drivers of vector-borne disease risk explaining why large datasets relating to diverse aspects of their biology and ecology have been collected over the years. However, the data remains fragmented and held in disparate sources and of little value for deep and holistic analytics. Understanding the dynamics and patterns of disease risk as well as outbreak occurrence requires knowledge of the vectors involved and how their distribution has changed over the years impacted by global environmental and climatic changes. Herein, we provide a roadmap for mobilizing past and current vector data with focus on malaria vectors in a common data model (CDM) for establishing a vector data hub and platform. We describe the vector data workflow that includes standardized and interchangeable formats that make them accessible for direct application of modelling, DS and ML algorithms and tools for knowledge discovery to facilitate disease risk assessment and mapping, and integration in development planning. The vector data hub provide i) a comprehensive updated occurrence, bionomic, abundance and insecticide resistance (IR) datasets spatially linked to the MAP's parasite rate surfaces; ii) advanced expertise in spatial analyses, modelling and mapping; iii) enhanced understanding of the intricacies, value and limitations of vector data; and iv) improve knowledge of vector behavior and the underlying mechanisms of insecticide resistance. Consequently, the data hub will generate actionable products that feed into vector control programmes providing demonstrable results on the ground.

Keywords: common data model, data hub, data platform, data pipeline, analytics.

ABS-609

Field studies on epidemiologically important aspects of the reproductive biology of female *Anopheles funestus* in southeastern Tanzania

Mohamed Jumanne (Ifakara Health Institute)*; Najat F Kahamba (Ifakara Health Institute); Fredros Okumu (Ifakara Health Institute)

The reproductive biology of female mosquitoes is intimately coupled to their parasite transmission potentials. This study examines the reproductive biology of female *Anopheles funestus,* the predominant malaria vector in southeastern Tanzania, focusing on factors crucial to malaria parasite acquisition and transmission. The study was conducted in two southeast Tanzanian villages from May 2022 to January 2023, where female *An. funestus* were dissected to determine parous rates, biological age, gonotrophic discordance, oviposition interval, insemination rates, and monthly variations in wing length. Then, daily survival probabilities of the biting population were estimated using ovarian and mid-gut dissection methods. A total of 1768 *An. funestus* females were dissected from May 2022 to January 2023. There was significant variation in parous rates throughout the year, with the lowest rate occurring in May and the highest rate in December. The oldest females were those that had completed four gonotrophic cycles. The insemination rate was high at 0.94, and small-sized, long-lived mosquitoes predominated during the dry season. Multiple blood meals were required for 69% of females to lay their first batch of eggs (pre-gravidity), and 13% of parous females exhibited signs of multiple blood meals within a single egg-laying cycle. The daily survival probability ranged from 0.77 in May to 0.95 in December, with an estimated overall mean daily survival probability of 0.89 ± 0.03. These findings underscore the significance of a comprehensive strategy for controlling malaria vectors that considers the seasonal fluctuations in biological, behavioural, and environmental factors essential to parasite acquisition and transmission. Additionally, targeting interventions towards the few long-lived female vectors during extended dry seasons could decrease their population and lower malaria transmission rates.

Keywords: *Anopheles funestus*, reproductive biology, pre-gravid rate, gonotrophic discordance, biological age, oviposition interval

ABS-174

Feasibility and community acceptance of insecticide treated eave nets and insecticide treated window screens in Tanzania.

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Institute); Jason Moore (Swiss Tropical and Public Health Institute); Ole Skovmand (MCC47); Rune Bosselmann (Vegro Aps); Sarah J Moore (Ifakara Health Institute); John Bradley (London School of Hygiene & Tropical Medicine)

Long-lasting insecticidal nets (LLINs) and targeted indoor residual spray (IRS) are used extensively in Tanzania and have significantly reduced malaria mortality and morbidity across the country. However, malaria remains a public health concern, calling for the development of supplementary intervention tools. This study aimed to understand community perceptions on the installation of insecticide treated eave nets (ITENs) and windows screens (ITEWs) for full house screening against mosquitoes. Fourteen In-Depth Interviews (IDIs) with local carpenters who installed the intervention in 440 households and six Focus Group Discussions (FGDs) with community members in both the treatment (with intervention) and control (without) arms were conducted to gain understanding of feasibility and community perceptions of the intervention against malaria in three villages at Chalinze district in Tanzania. Only two carpenters reported to get nasal congestion and a headache after the working with the intervention on day 1 and related it to the chemicals on the netting. However, none of the community members experienced any adverse effects after the intervention was installed in their houses. Community members reported the intervention reduced mosquito abundance in their houses and also protected them from insects, lizards and snakes. Due to an observed reduction in malaria incidences in their households, some residents reported stopping sleeping under LLINs. A willingness to buy the netting if sold at an affordable price range of TZS 1000-6000 (≤ USD 2.50) per square meter was also expressed among community members. Community feasibility studies provide insights to barriers and facilitators to the adoption of new interventions tools. Therefore, appropriate social behavioral change communication strategies can be developed prior to the deployment of newer vector control tools to ensure synergy with existing interventions.

Keywords: community perceptions, malaria, new tools

POSTER ABSTRACTS

Poster Abstracts Day 1

ABS-4

Analysis of Plasmodium falciparum Resistance to Chloroquine in Côte d'Ivoire after 20 years: High Prevalence of Wild Strains

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Malaria is a major public health problem worldwide, especially in Africa, where antimalarial drug-resistant strains are spreading. In Côte d'Ivoire, Dihydro-artemisinine Piperaquine (DHA-PPQ) has been included in the policy for simple malaria management, but key mutations of the pfcrt gene are being studied to determine the mutation points that modulate *Plasmodium falciparum* resistance to Piperaquine. Genomic DNA from 158 patients from the five study sites with *P.falciparum* malaria was extracted using Chelex 5% tween. Conventional PCR amplification of the pfcrt gene was followed by Sanger sequencing of the amplificates on the Sanger sequencing platform of the CRCHU of Quebec (Canada). Comparison of different proportions was carried out using Rstudio software version 4.1.3. Analysis of individual alleles showed a prevalence of wild strain alleles over mutant alleles at all study sites. The K76T mutation was found at relatively low prevalences at the sites: 4.5% (1/22) in Bouaké; 10% (2/20) in Yamoussoukro; 18.5% (4/20) in Ayame; 20% (5/27) in Man and 34.8% (24/69) in Anonkoua-koute. Analysis of the distribution of the wild strain haplotype (CVMNK) of the pfcrt gene showed a high proportion (55-80% prevalence) compared to mutant strain haplotypes (1-20% prevalence). The high prevalence of the CVMNK haplotype across all sentinel sites supports the potential for regained sensitivity to CQ in the treatment of simple malaria. Therefore, continued molecular surveillance and in vitro analysis of pfcrt gene polymorphism mutations is highly recommended.

Keywords: Chloroquine, CVMNK Haplotype, *Plasmodium falciparum*, Côte d'Ivoire.

ABS- 7

Tsetse Flies Infected with Trypanosomes in Three Active Human African Trypanosomiasis Foci of the Republic of Congo

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Human African trypanosomiasis (HAT) is a neglected tropical disease still endemic in the Republic of Congo. Despite the continuous detection of HAT cases in the country, there is still not enough data on trypanosome infections in tsetse flies, trypanosome species and tsetse flies' species distribution in endemic foci. The present study was intended to fill this gap and improve understanding of trypanosome circulation in three active foci in the centre and south of Congo. Pyramid traps were set in various places in villages to collect tsetse flies both during the rainy and dry seasons. Once collected, tsetse flies were identified using morphological keys. DNA extracted from flies was processed by PCR for species identification and for detection of trypanosome presence. A total of 1291 tsetse flies were collected. The average apparent density of flies per day was 0.043 in Mpouya, 0.73 in Ngabé and 2.79 in Loudima. *Glossina fuscipes quazensis* was the predominant tsetse fly collected in Ngabé and Mpouya, while *Glossina palpalis palpalis* was the only tsetse fly found in Loudima. A total of

224 (17.7%) flies were detected infected by trypanosomes; 100 (7.91%) by Trypanosoma congolense savannah, 22 (1.74%) by *Trypanosoma congolense* forest, 15 (1.19%) by *Trypanosoma vivax*, 83 (6.56%) by *Trypanosoma Brucei (S.L.)* and 2 (0.16%) undetermined species. No T *Trypanosoma brucei gambiense* was found. Loudima recorded the highest number of infected tsetse flies. The study provided updated information onthe distribution of tsetse fly populations as well as on Trypanosoma species circulating in tsetse flies in the different active HAT foci in Congo. These data suggested a high risk of potential transmission of animal trypanosomes in these foci, thus stressing the need for active surveillance in this endemic area.

Keywords: Transmission; tsetse flies; HAT; Republic of Congo

ABS- 13

Comparative study on the persistence of the essential oil of Clausena anisata (Rutaceae) and Hyptis suaveolens (Lamiaceae) for individual protection against mosquitoes (Diptera: Culicidae)

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Chemical insecticides and repellents are intensively used to control mosquitoes. DEET (N, N-diethyl-3-methylbenzamide) is one of the most well-known chemical repellents. DEET is effective against many different blood-sucking arthropods and is generally safe for topical use if applied as recommended, although serious adverse effects have been reported mainly with pregnant women and children. Concern about the deleterious effects associated with chemical insecticides has revived interest to explore plants as a source of natural insecticides and repellents. We evaluated the persistence of repellent effect of the concentrations of 1,50%; 3%; 4,5% and 6% of *Clausena anisata* essential oil and that of *Hyptis suaveolens* against the mosquito *Culex quinquefasciatus*, two hours after application. For each concentration of the essential oils, at least 12 replicates were performed. Informed consent volunteers were used; one foot (of each) treated 2 hours previously is placed in a cage containing 25 female mosquitoes aged at least 10 days. The number of mosquitoes landing and biting on the treated volunteer during a 15 minutes was recorded .The results showed that the repellent effect of essential oils persists two hours after application and increases with increasing concentration. At a concentration of 6%, the repellency rates recorded are 88,99% and 87,58% respectively for *C. anisata* and *H. suaveolens* oil. The percentage of mosquitoes taking blood recorded for this 6% concentration is 2,36% and 2,7% respectively for *C. anisata* and *H. suaveolens* oil. We can therefore conclude that two hours after application, the repellent effects of the two oils are similar at 6% concentration.

Keywords: Mosquitoes, Vectors, Essential oils, Repellents, Vector control.

ABS-16

Permethrin resistance progression in generations of *Anopheles Gambiae* (Kisumu) adults exposed to minimal sub-lethal concentrations

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This study was designed to investigate baseline Permethrin resistance response progression in susceptible *A. gambiae* (Kisumu) over generations by: (i) determining the lowest sub-lethal insecticide concentrations (LSLCs); (ii) comparing resistance statuses of LSLC exposed and unexposed adults; Established, insectary-reared, and fully susceptible strains of Kisumu populations were sourced, reared, and exposed for mortality assay and LSLCs determination at the adult stage. Various exposure concentrations were achieved by a slight modification of the Centre for Disease Control (CDC) protocol. Information obtained was calculated as means, and percentages and expressed in tables and charts using SPSS 16.0. The study revealed that:(i)The Kisumu population was fully susceptible to Permethrin and demonstrated reduced susceptibility at very low concentrations. The LSLCs of Permethrin with mortality rates comparable to unexposed susceptible Kisumu strains were 0.2µg and 0.4µg per CDC bottle, i.e., LSLC 1 and LSLC 2, respectively; (ii)Kisumu adult population exposed persistently to LSLC 2 did not survive beyond f0 generation while the LSLC 1 exposure lasted five generations (f0 to f4) during which resistance statuses were consistently below 1.00±0.82 (4.0%) after 1 hour; This study concluded that resistance development in *A. gambiae* rates 2.51% per generation until it blew at the 220th generation with a huge disadvantage in the life cycle and fecundity of the vector.

Keywords: Insecticide, Resistance, Vecctor control

ABS- 20

Modelling the influence of temperature and rainfall on malaria incidence in four endemic provinces of Zambia using semiparametric Poisson regression

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Although malaria morbidity and mortality are greatly reduced globally owing to great control efforts, the disease remains the main contributor. In Zambia, all provinces are malaria endemic. However, the transmission intensities vary mainly depending on environmental factors as they interact with the vectors. Generally in Africa, possibly due to the varying perspectives and methods used, there is variation on the relative importance of malaria risk determinants. In Zambia, the role climatic factors play on malaria case rates has not been determined in combination of space and time using robust methods in modelling. This is critical considering the reversal in malaria reduction after the year 2010 and the variation by transmission zones. Using a geoadditive or structured additive semiparametric Poisson regression model, we determined the influence of climatic factors on malaria incidence in four endemic provinces of Zambia. We demonstrate a strong positive association between malaria incidence and precipitation as well as minimum temperature. The risk of malaria was 95% lower in Lusaka (ARR = 0.05, 95% CI = 0.04–0.06) and 68% lower in the Western Province (ARR = 0.31, 95% CI = 0.25–0.41) compared to Luapula Province. North-western Province did not vary from Luapula Province. The effects of geographical region are clearly demonstrated by the unique behaviour and effects of minimum and maximum temperatures in the four provinces. Environmental factors such as landscape in urbanised places may also be playing a role.

Keywords: Eco-environmental, Climate, Malaria Incidence, Zambia

ABS- 23

Molecular identification of Trypanosoma brucei gambiense in naturally infected pigs, dogs and small ruminants confirms domestic animals as potential reservoirs for sleeping sickness in Chad Joël Vourchakbé, Zebaze Arnol Auvaker Tiofack, Tagueu Sartrien K

Vourchakbe Joel Vourchakbé (University teacher-researcher)*

Human African trypanosomiasis (HAT) has been targeted for zero transmission to humans by 2030. Animal reservoirs of gambiense-HAT could jeopardize these elimination goals. This study was undertaken to identify potential host reservoirs for *Trypanosoma brucei gambiense* by detecting its natural infections in domestic animals of Chadian HAT foci. Blood samples were collected from 267 goats, 181 sheep, 154 dogs, and 67 pigs. Rapid diagnostic test (RDT) and capillary tube centrifugation (CTC) were performed to search for trypanosomes. DNA was extracted from the buffy coat, and trypanosomes of the subgenus Trypanozoon as well as T. b. gambiense were identified by PCR. Of 669 blood samples, 19.4% were positive by RDT and 9.0% by CTC. PCR revealed 150 animals (22.4%) with

trypanosomes belonging to Trypanozoon, including 18 (12%) *T. b. gambiense*. This trypanosome was found in all investigated animal species and all HAT foci. Between animal species or villages, no significant differences were observed in the number of animals harboring *T. b. gambiense* DNA. Pigs, dogs, sheep and goats appeared to be potential reservoir hosts for *T. b. gambiense* in Chad. The identification of *T. b. gambiense* in all animal species of all HAT foci suggests that these animals should be considered when designing new control strategies for sustainable elimination of HAT. Investigations aiming to decrypt their specific role in each epidemiological setting are important to achieve zero transmission of HAT.

Key words: Animal reservoir, *Trypanosoma brucei gambiense*, Sleeping sickness, Domestic animals.

ABS- 26

Generational and biochemical changes involved during the selection process of pyrethroid resistant *An. gambiae* and *An. arabiensis* populations

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The three major vectors of malaria in Western Kenya are Anopheles gambiae, An. arabiensis and An. funestus. Insecticide resistance has been widely reported in Africa threatening insecticide-based malaria vectors control efforts. This study aimed at investigating the genetic and metabolic changes that occur during the selection process of resistant Anopheles gambiae and Anopheles arabiensis from western. Cohorts of 50 male and 50 female mosquitoes in each experiment from Ahero and Bungoma were exposed to diagnostic dosages of 0.05% of Deltamethrin treated papers in WHO tube bioassays for 1hr and mortality scored 24hrs post exposure. Male and female survivors were pulled and maintained under standard insectary condition to produce the next generation. The process was repeated for subsequent generations until there was 100% mortality. Biochemical assays were performed on susceptible and resistant mosquitoes preserved after WHO tube bioassays. Genotyping was done on the susceptible and resistant mosquitoes after the WHO tube bioassays using Real-Time Polymerase Chain Reaction. There was steady increase in the mosquito mortality with 100% mortality in fifth and third generations for Bungoma and Ahero mosquitoes respectively. Enzymatic activity was high in the first generation of resistant mosquitoes from Bungoma but the levels decreased drastically in the subsequent generations. The frequency of the homozygous ss (L1014s) allele was high in the first generation of Kabula mosquito populations but reduced in the subsequent generations. There were phenotypic, genotypic and metabolic changes within different mosquito generations. There is also an urgent need for development and deployment of non-pyrethroid based vector control tools in malaria endemic regions.

Keywords: *Anopheles gambiae, Anophelese arabiensis*, Malaria, Insecticide resistance, pyrethroids, deltamethrin

ABS- 30

Investigating The association between vector abundance and vector-borne diseases in Sub-Saharan Africa: a secondary data analysis

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In Sub-Saharan Africa, vector-borne diseases such as malaria, dengue fever, and Zika virus remain a major public health concern. Vector abundance is a critical factor that determines the transmission dynamics of these diseases. This study aims to investigate the association

between vector abundance and the prevalence of vector-borne diseases in Sub-Saharan Africa using secondary data from the VectorNet database covering the period from 2010 to 2020. We will use a cross-sectional study design and logistic regression models to analyze data on vector abundance and the prevalence of vector-borne diseases. The study population will include all individuals residing in Sub-Saharan Africa, and we will adjust for potential confounding factors such as age, sex, and socioeconomic status. Preliminary analysis suggests that there is a significant positive association between vector abundance and the prevalence of vector-borne diseases, particularly malaria, dengue fever, and Zika virus, in areas with high vector abundance compared to those with low vector abundance. These findings highlight the crucial role of vector abundance in the transmission of vector-borne diseases in Sub-Saharan Africa. Therefore, targeted vector control strategies need to be implemented to alleviate the burden of these diseases in the region. Public health authorities should prioritize resource allocation to areas with high vector abundance to reduce the transmission of vector-borne diseases. This study provides important evidence that can guide policies and programs aimed at controlling and preventing vector-borne diseases in Sub-Saharan Africa.

Keywords: Sub-Saharan Africa, Vector-Borne Diseases, Malaria, Dengue Fever, Zika Virus, Vector Abundance, Transmission Dynamics, Preval

ABS- 36

Larvicidal activities and synergistic effects of essential oils against Anopheles funestus and Culex quinquefasciatus (Diptera: Culicidae) from Kisumu, Kenya

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Rapid development of resistance in vector mosquitoes to synthetic insecticides is a major challenge for malarial control. The use of plant derived essential oils (EOs) is an attractive strategy in controlling mosquito populations because they are environmentally safe and may have a lower chance of developing resistance. This study assessed the larvicidal activities of EOs *from Lantana camara, Lippia multiflora, Lippia chevaleri and Cymbopogon schoenanthus* and their mixtures against *Anopheles funestus* and *Culex quinquefasciatus.* Third to four instar larvae were tested using a world health organization (WHO) modified protocol to evaluate larval mortality 24 h after exposure to EOs and their binary combinations. *Culex quinquefasciatus* larvae were susceptible to EOs more than *An. funestus*. For *Cx. quinquefasciatus*, the EOs lethal concentrations at 50% mortality (LCs50) from *C. schoenanthus*, *L. multiflora, L. camara, L. chevaleri* were 23.32, 27.24, 38.54

and 54.11 ppm, respectively. Whereas for *An*. *funestus* the EOs LCs50 were 120.5, 67.5, 49.21, and 105.74 ppm, respectively. Synergistic effects were observed using EOs from *C. schoenanthus + L. multiflora* (LC50= 44.05 ppm) on *An. funestus* while *L. camara* +*L. chevalier* (LC50=33.16 ppm), *L. chevaleri* + *C. schoenanthus* (LC50= 12.08 ppm) and *L. multiflora* + *L. chevaleri* (LC50=20.61 ppm) were synergistic for *Cx. quinquefasciatus*. These results indicate the potential for local plants derived EOs and their binary combinations as botanical larvicides. The EOs could be used as future eco-friendly agents to control these vectors.

Keywords: *Anopheles funestus, Culex quinquefasciatus*, larvicidal, essential oils, combinations

ABS- 51

Preliminary study on the distribution of lymphatic filariasis in Gabon

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Lymphatic Filariasis (LF) is recognized as endemic in Central Africa including Gabon, where no study has formally demonstrated it. Only the descriptions of a few clinical cases allow us to suspect it. In order to help understand this disease and enable the country to commit to the elimination goal assigned by the World Health Organization, it is essential to assess the level of prevalence, the geographical distribution of the disease and identify transmission foci in Gabon. Thus, an epidemiological survey was undertaken with the aim of mapping the distribution of LF in Gabon for the implementation of a mass distribution of drugs at the scale of the territory. Intravenous blood was collected from children aged 5 to 14 between 2014 and 2015 in the 18 health departments (HDs) of 7 provinces of the country, for the detection of the presence of antigens of *Wuchereria bancrofti* at the using Filariasis Test Strips (FTS). A total of 2466 children were surveyed, of whom 28 (1%) were FTS positive. All DS surveyed are endemic to LF with prevalence ranging from 0.5% (Zadié, Ogooué Ivindo) to 3.45% (Ndjouoro-Agnili, Haut Ogooué). Similarly, 15 HDs have antigenemia prevalences ranging from 0.5% to 1.8% and 3 HDs have prevalences greater than 2% (from 2.4% to 3.4%). Our survey made it possible to assess the circulation of *Wuchereria bancrofti* at the national level. However, the method used may prove to be limited by cross-reactions with other parasites (Loa loa). Thus, it would be wise to refine these results on the basis of the STAG strategy as recommended by the WHO to confirm the existence or not of the transmission of this disease in the now suspected foci.

Keywords: Lymphatic filariasis, Cartography, Prevalence, Gabon

ABS- 52

"Fighting against malaria is everyone's concern": A randomised control trial assessing the role of incentives for encouraging local communities to recording and upload mosquito sound using Mozzwear application

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Current malaria surveillance methodologies are considered too expensive to scale within resource limited settings, hence new technologies and approaches are necessary to maximize data collection and ultimately design new malaria control tools. Effective mosquito surveillance can be enhanced through the utilization of digital technologies and the engagement of citizens for real time data collection. This study details follow-up research on the use of the HumBug acoustic sensor that uses a mobile phone application (MozzWear) for detecting and identifying wild, host-seeking mosquitoes using the sound made when they fly. The sensor captures these flight tones when the mosquitoes enter houses, attracted to people sleeping under modified mosquito nets (HumBug Nets) during the night. In our previous study, citizens were provided with airtime incentives to encourage participation in recording and uploading mosquito sounds. Here we describe a comparative study conducted in four villages in rural Tanzania . Participants were randomised into two groups; 1) control group: no incentive provided; and 2) Incentive group: airtime credit was provided to participants. Both groups were provided with HumBug smartphones running the MozzWear app plus adapted mosquito bed nets ('HumBug Nets') to hold the phones during recording and asked to record and upload mosquito flight tone data once per week for a period of four months. Experience survey was administered to participants in both groups to assess their experience of participating in this study. The results indicate that participants were willing to record and upload mosquito flight tone data even without receiving an incentive. Their feedback suggested that fighting against malaria was more important and was everyone's concern in rural Tanzania.This study demonstrates that intrinsic motivation had a strong influence on participation in the study, even without incentives, citizens were still willing to participate in the study

Keywords: Mosquito surveillance, mozziewear application, citizen science, Community, randomised controlled trial.

ABS- 65

Effect of different concentrations of Sodium Bicarbonate (Nahco3) on mosquito larvae

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Mosquitoes are considered by the World health organization (WHO) as world's deadliest animal because life threatening diseases such as, malaria, dengue, chikungunya, encephalitis, yellow fever, zika and filariasis, transmitted by mosquito vectors. The mosquito-borne diseases have potential for very serious and rapid spread, irrespective of boarders with socio-economic and public health consequences. Sodium bicarbonate, is a naturally occurring substance that is present in all living things, which maintain the pH balance. It has been used as an efficient and cost-effective fungicide and insecticide. The research aimed to identify the species of mosquitos found the study area and to determine the effect of sodium bicarbonate on the larvae of the mosquito**.** The study was carried out at Auyo rice farm in Jigawa state. Larvae were collected by systematic dipping of ladel, they were brought to the laboratory and separated using Pasteur pipette, based the morphology and resting habits of the larvae. Identification was completed when the adults emerged. Solutions of sodium bicarbonate at different concentrations were prepared and ten larvae each of mosquito species were added and observed over a period of 10hours. Mosquitos were identified as Anopheles gambiae, Anopheles pharoensis and *Culex quinequefasciatus*. No observed mortality at 1hr for all the species, at 2hour 90% mortality was observed in the *culex quinquefasciatus*, while for the Anophelese 70% mortality was observed at 3hrs and 100% mortality was seen in the culex at the 3hr. While a gradual mortality was recorded for the Anopheles species over a period of 8 hours where 100% mortality was observed in all the experimental sets, except one with the least concentration of 0.5g/ 200mLs which survived for 10hrs and the experiment was terminated. *A. gambiae, A. pharoensis and C. quinequefasciatus* were identified in the area. Sodium bicarbonate was effective on mosquito larvae.

Keywords: *Anopheles gambae, Anopheles Culex quinquafascratus*, Mosquito larvae and Sodium bicarbonate

ABS- 66

Malaria prevalence among different age groups and gender in subsistence crop farming and fishing communities in greater Kamuli District, Uganda: Implications for Control

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Malaria remains a major health threat in Uganda. This study aimed at comparing the malaria prevalence rates among different age groups and gender between subsistence crop farming and fishing communities in greater Kamuli district, Uganda. Malariometric surveys covering 519 people (224 adults and 295 children) living in 70 households in Nabwigulu crop farming communities and Bukungu fish landing site were carried out using Rapid Diagnostic Tests.Overall, 25.1% (130 out of 519) of the people screened in the two sites combined had malaria. Malaria burden was found to be higher among the subsistence farming community (46%) compared to the fishing community (26.3%). Generally, males had the same risk of malaria infection as females among the fishing communities, while in the subsistence farming communities, males (26.7%) had higher malaria prevalence than females (18.3%). The prevalence (58.3%) of malaria among school-going children (6 to 11 years) in the subsistence farming community was similar to that of <5 years old (53.8%). Malaria prevalence was lowest among children 12 to 17 years (17.6%). Children under five years apparently had the highest malaria prevalence in the fishing community (43.3%). Overall, adults (>18 years) had a malaria prevalence of 47.4%. Malaria transmission risk factors include poor cultivation and fishing-related activities, poor housing, and the lack of collective malaria control and prevention efforts among the communities were responsible for the high malaria burden. Livelihood-related factors in the study area played a big role in malaria transmission among the different age groups and gender. Community sensitizations on malaria transmission risk factors are recommended, while safety measures against malaria risk should be considered for all age groups and gender in both livelihoods.

Keywords: Malaria, Age, Gender, Subsistence Farming, Fishing

ABS- 70

IK Smart Light: A new tool to deliver more efficient and smart indoor residual spraying

Iñigo Garmendia (GOIZPER S.COOP)*

Indoor residual spraying (IRS) is an effective tool but training IRS teams and insuring efficient and effective spraying of communities is limited by technical and logistical challenges. IVCC and Goizper Group, working with IRS implementers, have developed a new tool, the IK Smart Light. The device provides immediate feedback to spray operators to help them deliver accurate target dosage of insecticide. It also assists supervisors and program managers to train spray operators more efficiently and each device collects data during use which allows to monitor spray applications in real time. The spray data can be uploaded to the cloud and visualized remotely to alert managers about potential problems immediately. Prototypes were piloted in Mozambique (2022-2023) and Ghana (2021-2022) and supervisors' feedback

clearly expressed that, that tool is a “game changer” in helping them improve spraying performance and manage more efficient and effective programs in the future.

Keywords: Indoor residual spraying, efficient, smart, spraying quality, monitoring, supervision, training

ABS- 71

Larval source management in Tanga an epitome for escalation in Tanzania

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Malaria is heinous life threatening disease whose eradication can be achieved through Integrated Mosquito Vector program. Eradicating mosquitoes transmitted diseases could make Africa become socially and economically prosperous. Vulnerable community could be protected from malaria by controlling aquatic stages of mosquitoes if cost effective and scalable implementation systems can be conceived and implemented. A large scale biolarviciding implementation is ongoing in Tanga City Council, Handeni District Council and Lushoto District Council in Tanga Region employing modestly paid Community Owned Resource Persons (CORPs), Ward Executive Officers, Village Executive Officers and Hamlet leaders. Each larval habitat is visited once per week and mosquito trapping per each house is done once per week. We have conspicuously demonstrated the applicability, effectiveness and efficaciousness of mosquito biolarviciding for malaria control to hamlet level. The population of both aquatic and adult stages of Culicine and Anopheline mosquitoes are significantly reduced, suggesting that biolarviciding contribute to malaria reduction. Community exhibited outstanding level of acceptability and participation in biolarviciding intervention. When integrated with other interventions biolarviciding is an effective tool in reducing malaria transmission.

Keywords: Anophelene

ABS- 86

Vertical and horizontal transmission of Microsporidia MB in *Anopheles arabiensis*: Effect on life history traits

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Microsporidia MB is a naturally occurring symbiont in Anopheles arabiensis that inhibits the development of Plasmodium without causing any fitness consequences. These characteristics provide Microsporidia MB advantage over other transmission blocking strategies such as sterile insect techniques and genetically modified mosquitoes. Microsporidia MB is transmitted vertically, from mother to offspring, and horizontally through mating. However, in depth understanding of Microsporidia MB transmission patterns is required for mass production of mosquitoes, a pre-requisite for mosquito release, and for robust estimates from theoretical models on Microsporidia MB spread in the natural populations following release. Iso-female lines originating from field collected Microsporidia MB - infected and uninfected females were compared for various life history traits from the egg to adult stage. Bioassays were conducted on first filial generation mosquitoes to determine the effect of diet type and quantity on Microsporidia MB prevalence and density. Microsporidia MB - infected and uninfected males were compared individually and in groups for mating competitiveness. Larval development time of Microsporidia MB -infected *An. arabiensis* is shorter compared to uninfected mosquitoes. Diet type and quantity influences the density of Microsporidia MB. Microsporidia MB -infected adults have a higher mating rate compared to uninfected mosquitoes. In general, Microsporidia MB -infection has no negative effect on the development of An. arabiensis mosquitoes. Microsporidia MB -infection is influenced by diet type and quantity. Diet can, therefore, be manipulated to rear highly infected mosquitoes. Microsporidia MB is inherently able to spread in mosquito population due to higher mating rate making it a promising candidate for malaria transmission blocking strategy.

Keywords: Microsporidia MB, Transmission blocking, malaria, mosquito releases

ABS-88

Chikungunya (Togaviridae) and dengue 2 (Flaviviridae) viruses detected from Aedes aegypti mosquitoes in Burkina Faso by qRT-PCR technique: Preliminary results and perspective for molecular characterization of arbovirus circulation in vector populations

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In 2016, an entomological study was carried out in a railway transect between Banfora and Ouagadougou, Burkina Faso. The objective was to assess the risk factors of arbovirus outbreaks, including vector-borne infection status within representative regions of the country. *Aedes aegypti* mosquitoes were collected at the larval stage from their natural rearing habitats in four study sites when estimating the main larval index, then reared until adult stage and kept in RNAlater for the detection of arbovirus RNA. In the laboratory, mosquito samples were tested for dengue virus (DENV) and Chikungunya virus (CHIKV) using a real-time qRT-PCR stage. A DENV-2 positive pool was detected in Ouagadougou with a minimum infection rate (MIR) of 16.67 and other sixCHIKV-positive pools with a MIR of 66.67 in Ouagadougou, Banfora, and Boromo. This qRT-PCR approach, if validated with various samples also comprising wild blood-fed adults, is a useful tool for arbovirus circulation and disease monitoring in Burkina Faso.

Keywords: arboviruses, dengue, Chikungunya, molecular biology, qRT-PCR, Aedes aegypti, Burkina Faso

ABS- 91

Identification of insecticide resistance mutations and Plasmodium falciparum prevalence in *Anopheles gambiae* and *Anopheles funestus* in Eastern DR Congo

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Malaria vector control in the DRC is plagued by several major challenges, including recent widespread emergence of insecticide resistance among Anopheles mosquitoes. Across provinces, insecticide resistance has been reported. However investigation of molecular resistance mechanisms among Anopheles vector has been more limited. This study assessed *P. falciparum* infection prevalence and the frequency of 11 published insecticide resistance mutations among *An. gambiae sl*. and *An. funestus sl.,* collected from areas of pyrethroid resistance. Adult *An. gambiae sl*. and *An. funestus sl*. were collected from three sites, Tchonka, Tushunguti and Kibali. PCR-screening for the presence of resistance mutations was performed to provide additional information on the frequency of insecticide resistance mechanisms. A subset of eight individual An. gambiae sl. each from Tchonka, Tushunguti and Kibali and *An. funestus* sl. from Tchonka and Tushunguti were identified to species level by PCR; all were determined to be *An. gambiae ss.* and *An. funestus ss*. *P. falciparum* infection rate was 11.04% and 10.94% among *An. funestus* sl. and *An. gambiae sl.* L1014F-kdr and L1014S-kdr were present in 75.9% and 56.7% of *An. gambiae sl*. screened, with some individuals harbouring both resistant alleles. Across the three study sites, L43F-CYP4J5 allele frequency ranged from 0.42 to 0.52, with evidence for ongoing selection. G119S-ace1 was also identified in all sites but at lower levels. A triple mutant haplotype

CYP6P4-I236M, partial Zanzibar-like and CYP6AA1, was present at high frequencies. In *An. funestus sl*. cis-regulatory polymorphisms in CYP6P9a and CYP6P9b were detected, with allele frequencies ranging from 0.82 to 0.98 and 0.65 to 0.83, respectively. L119F-GSTe2 was not detected in any individual tested. Several new candidate markers (CYP4J5, G119S-ace1, the triple mutant, CYP6P9a and CYP6P9b) were identified, which are diagnostic of resistance to major insecticide classes.

Keywords: Insecticide-Resistance-Mutaions- Anopheles-Vectors

ABS- 93

Evidence of High-altitude windborne migrating mosquitoes infected with pathogens

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Windborne mosquitoes have been collected at high-altitudes (40-290 m above ground over the Sahel using sticky nets attached to tethered helium-filled balloons. The high diversity of mosquito species at altitude, the predominance of gravid females indicating that they took at least one blood meal prior to their migration, and their abundance during the rainy season suggest that windborne mosquitoes at altitude are a key driver in the spread of mosquito borne pathogens (MBPs). Indeed, epidemiologists inferred that windborne vectors spread arboviruses, plasmodia, and even filariae over hundreds of kilometers. However, until now there was no empirical evidence demonstrating that wind borne mosquitoes are implicated in the spread of pathogen. Here, we analyzed the infection status of mosquitoes collected at altitude over different ecozones between Mali and Ghana by targeted pathogens qPCR followed by sanger sequencing as well as by metagenomics. Our results revealed high overall infection rates with plasmodium: 6.9%, with 2.8% thoracic infection. These parasites consisted of 14 avian Plasmodium species, including the widespread P*. relictum, P. vaughani* and *P. matutinum* and additional two hemosporidian species which are vectored by biting midges. The pan-filaria screen revealed nematode infection of avian and

mammalian (caprine-antelope) filariids. RT-qPCR revealed infection with alphaviruses (including West Nile virus) and flaviviruses. A metagenomic analysis of 48 individual mosquitoes enriched in qPCR positive samples revealed the presence a zoonotic human pathogen—M'Poko virus among nearly 50 insect-specific viruses. Additionally, this metagenomics data detected other non-mosquito borne pathogens. This study provides the first direct evidence of the spread of MBPs by windborne mosquitoes and suggests that aerial sampling would be valuable component of broad disease surveillance, informing about the sources and destinations of migrating pathogens and vectors.

Keywords: High altitude mosquito, disease surveillance, pathogens spreading

ABS- 106

Entomological Parameters of Malaria Vectors in Anambra State, southeast Nigeria

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Adequate knowledge of entomological parameters within a defined geographic endemic area is basic for effective planning of malaria vector control for malaria elimination. The study investigated indoor resting density (IRD), human biting rate (HBR), blood meal source (BMS), human blood index (HBI), sporozoite rate (SR) and entomological inoculation rate (EIR) of malaria vectors in Awka North, Awka South and Njikoka Local Government Areas in Anambra State, southeast Nigeria. Pyrethrum spray collection (PSC), Centre for Disease Control (CDC) light trap, and human landing catch (HLC) techniques were used for collection of indoor and outdoor malaria vectors. Mosquitoes collected were sorted according to species and sex; and identified using standard morphological and molecular techniques. Chi-square test was used for data analysis. A total of 2,870 Anopheles mosquitoes were collected, male 1949 (67.9%) and female 921 (32.1%). All female species identified morphologically belong to the *Anopheles gambiae s. l.* complex. From the molecular and siblings species separation, *Anopheles gambiae* recorded the highest abundance of 54.2% and *Anopheles coluzzii* the least abundance of 45.8%. The IRD was found to be 1.40 per man per night with an average HBR of 5.05. The blood meal source showed that human blood source was the highest number 46.2%, followed by goat blood source 32.7%, and combination of human and goat blood was the least 21.2%. The result also showed a HBI of 0.51. The test for the presence of circumsporozoite protein (CSP) of *Plasmodium falciparum* shows that none of the malaria vectors was positive for sporozoite; thus, the EIR could not be determined and compared among the study population. The allopatric breeding of the two sibling species of *Anopheles gambiae and Anopheles coluzzii* reported in this study is probably the second of such report in Nigeria and therefore has huge implications for malaria vector control and malaria control in Anambra State, Nigeria.

Keywords: Entomological parameters, blood meal source, malaria vectors, malaria control, Anambra State

ABS- 107

The contribution of biolarviciding in reducing Malaria incidences in Tanzania

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Larval source management has been reported to be the most effective way to control mosquito vectors, but most of African countries for years have focused their resources on using the indoor residual sprays, long lasting insecticidal treated nets and effective treatment of Malaria. The laboratory and semi-field trials that have been conducted in Tanga-Tanzania using biolarvicides has been a promising intervention in reducing malaria and arboviral diseases through showing high mortality of *An. Gambiae* complex, *Cx. quinquefasciatus* and *Ae. aegypti* larvae. The tested larva found to be more susceptible, Lethal concentration values that caused 50% and 95% mortalities of test larvae (LC50 and LC95) showed that *An. gambiae* complex and *Cx. quinquefasciatus* tested were highly susceptible to Bti and Bs under laboratory conditions. Also, larvae of *Ae. aegypti* were found to be highly susceptible to Bti, with LC95 value as low as 0.052 mg/l. Nevertheless, *Ae. aegypti* larvae were found to be not susceptible to Bs under experimental doses of laboratory settings. In semi-field experiments, all experimental dosages for Bti resulted 91.0–100% larval mortality within 24 h whereas Bs resulted in 96.8–100% larval mortality within the same time-frame. The results tell Bs had a more prolonged residual activity, with pupal reductions range of 55.7–100% for 9 days at all application rates while the corresponding pupal reduction with Bti was 15.4–100% for 5 days, this explains the fact that Bti has fast insecticidal effect within a very short time while BS has a long-lasting insecticidal effect. Due to the low residual activity of Bti and Bs tested at laboratory and semi-field level, weekly application at a maximum label rate would be appropriate to reduce mosquito larvae in natural larval habitats and ultimately reduce mosquito-borne diseases such as Malaria and arboviral diseases.

Keywords: Larval Source Management, Biolarvicides

ABS- 110

Diversity of Rift Valley Fever virus mosquito vectors (diptera, culicidae) in cattle parks in Côte d'Ivoire

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Over the last two decades, we have witnessed a significant increase in vector-borne diseases due to climate variations that lead to environmental changes favoring the development and adaptation of vectors. This study was carried out to improve knowledge of the diversity of mosquito vectors involved in the transmission of Rift Valley Fever virus in Côte d'Ivoire. An entomological survey was conducted in the five areas of Côte d'Ivoire; north, east, west, center and south. Mosquitos were trapped using light traps set at ten cattles parks installed at 6:00 to 6:00 am once per area during four consecutive days. Ecological indices were calculated to characterize the different populations of Rift Valley Fever virus mosquito vectors. Molecular diagnosis of Rift Valley Fever virus was carried out by real-time RT-PCR with specific primers. Ecological indices were calculated to characterize the different populations of Rift Valley Fever mosquito vectors. A total of 5196 adults mosquitoes belonging to seven species: Aedes aegypti (3.89%), *Anopheles gambiae* (3.08%), *Anopheles zienani* (0.21%), *Culex cinereus* (6.6%), *Culex quinquefasciatus* (84.43%), *Culex nebulosis* (2.67%) and *Mansonia africanus* (0.19%) were collected. Comparison of abundances and indices species diversity indicated that *Culex quinquefasciatus* (84.43%) was significant most dominant and constant in all area samplings. Sites (cattles parks) were not diverse and throughout sampling. Rift Valley Fever virus was successfully detected in three mosquitos species; *Aedes aegypti*, *Culex cinereus* and *Culex quinquefasciatus*. In terms of mosquitos species diversity, the site are similar to each. This study was successfully detected Rift Valley fever virus from three mosquitoes species; *Aedes aegypti*, *Culex cinereus* and *Culex quinquefasciatus*. *Culex quinquefasciatus* represents the most abundant and constant mosquitos species in all study site.

Keywords: Mosquitos vectors, Ecology, Rift Valley Fever Virus, Zoonotic infections

ABS- 124

Risk Factors Associated with Anemia among school-age pupils in Tanzania; A case study of Pwani, Geita and Arusha regions

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Anemia is a condition in which the number of red blood cells or the hemoglobin concentration in the blood is lower than normal and has been considered to be a health concern in developing countries like Tanzania. Primary school pupils are the most endangered groups of

anemia. Anemia has a negative impact on one's well-being, rational growth, educational attainment, and job production if left untreated. This study aimed to determine risk factors associated with anemia among public school-age pupils aged 5 – 19 years in Tanzania. The study was cross-sectional that involved 2,292 pupils from the selected regions. It used secondary data from a school malaria and nutrition survey conducted between August and October 2019 among public primary school pupils (5 to 19 years) in Tanzania. Binary and Multinomial logistic regression models were used to assess the possible association of independent and outcome variables. Anemia was higher (33%) among school-age pupils aged 15 – 19 years (COR=1.35, 95% CL: 1.11, 2.12). compared to the pupils aged 5 – 9 years. Among school-age pupils who were anemic (COR=1.67, 95%CL: 1.23, 2.27) most of them had malaria infection. Mild anemia was less common among pupils living in urban areas (COR= 0.57, 95% CL: 0.41, 0.80) compared to a rural area. Therefore, malaria-positive, rural residents and elderly children (15 to 19 years) were among the major risk factors associated with anemia among public school-age pupils in the study area. Malaria-positive, rural residents and elderly age group of pupils (5 to 19 years) were among the major factors associated with anemia among public primary school pupils in the study area.

Keywords: Anemia, school-age pupils, malaria, Tanzania.

ABS- 128

Larviciding intervention targeting malaria vectors also affects Culex mosquito distribution in the city of Yaoundé, Cameroon.

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Although Culex species are considered to be equally affected by control measures targeting malaria vectors, there are still not enough evidences of the impact of interventions such as larviciding on these mosquito species distribution. The present study assessed the impact of a larviciding trial targeting malaria vectors on Culex mosquito species in the city of Yaoundé. A cluster randomized trial comparing thirteen treated clusters and thirteen untreated clusters was implemented. Data were collected at baseline and during larviciding intervention, from March 2017 to November 2020. The microbial larvicide VectoMax G was applied once every 2 weeks in intervention areas. Adult mosquitoes were collected using CDC light traps in both intervention and non-intervention areas and compared between arms. Globally, larviciding intervention was associated with 69% reduction in aquatic habitats with Culex larvae and 36.65% reduction of adult Culex densities in houses. Adult Culex densities were reduced both indoor (35.26%) and outdoor (42,37%). No change in the

composition of Culex species was recorded. The study suggested a high impact of larviciding on Culex mosquito species distribution. The impact of the intervention could be improved if typical Culex breeding habitats including pit latrines were targeted.

Keywords: larviciding, Culex, *Bacillus thuringiensis*, *Bacillus sphaericus*, Yaoundé.

ABS- 141

Adult mosquito predation and potential impact on the sterile insect technique

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The sterile insect technique is a promising environmentally friendly method for mosquito control. This technique involves releasing laboratory-produced sterile males into a target field site, and its effectiveness may be affected by the extent of adult mosquito predation. Sterile males undergo several treatments. Therefore, it is vital to understand which treatments are essential in minimizing the risks of predation once released. The present study investigates the predation propensity of four mantis species (*Phyllocrania paradoxa*, *Hymenopus coronatus, Blepharopsis mendica, Deroplatys desiccata*) and two gecko species (*Phelsuma standingi, P. laticauda*) on adult *Aedes aegypti, Ae. albopictus* and *Anopheles arabiensis* mosquitoes in a laboratory setting. First, any inherent predation preferences regarding mosquito species and sex were evaluated. Subsequently, the effects of chilling, marking, and irradiation, on predation rates were assessed. The selected predators effectively preyed on all mosquito species regardless of the treatment. Predation propensity varied over days for the same individuals and between predator individuals. Overall, there was no impact of laboratory treatments of sterile males on the relative risk of predation by the test predators, unless purposely exposed to double the required sterilizing irradiation dose. Our study has increased the cohort of known adult mosquito predators. It provided basic information about predation and factors that may influence the predation risk of laboratory-produced sterile males. Standardized predation trials may lead to additional quality control tools for irradiated mosquitoes. Further investigations need to be enhanced by comparing, at least under semi-field conditions, the vulnerability of laboratory-produced mosquitoes and their field-collected counterparts to wild predators.

Keywords: Adult mosquito predation, Aedes, Anopheles, Mantis, Gecko, Sterile insect technique

ABS- 164

Exploring phytoplankton management for controlling the malaria vector Anopheles gambiae in Benin

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Because *Anopheles gambiae* larvae typically live in aquatic habitats with strong sunlight exposure and dense phytoplankton populations, phytoplankton management is one possible tool for controlling the mosquito. Phytoplankton deserve particular attention because they are a primary food source for mosquito larvae. The relationship between different species of phytoplankton and *Anopheles gambiae* mosquito larvae was studied in order to improve malaria control. *Anopheles gambiae* larval habitat was surveyed by sampling phytoplankton at 51 sites. The deleterious effect of Scenedesmus quadricauda on third instar larvae was evaluated in the laboratory. 27 phytoplankton species were encountered in the field survey. Anopheles gambiae larvae had a positive association with high densities of Spirogyra (Pearson chi-square = 25.56, $P < 0.0001$) and a negative association with high densities of green algae (Elakotothrix, Coelastrum, Ankystrodesmus, Chlorella, Kirchneriella, Selanastrum, and Scenedesmus) and cyanobacteria (Oscillatoria, and Nostoc). Laboratory bioassays revealed that *S. quadricauda* is indigestible and toxic to *An. gambiae* larvae that ingest it. The larval mortality was 100% when larvae ingested only S. quadricauda and 85.6% if larvae were exposed to a mixture of *S. quadricauda* and cat food. The findings of this study indicate that phytoplankton management with *S. quadricauda* or other green algae offers a possible way to eliminate An. gambiae production. Complementary studies are needed to investigate the deleterious effect of these algae on *An. gambiae* under semi-natural and natural conditions.

Keywords: *Anopheles gambiae*, *Scenedesmus quadricauda,* Mosquito control, Malaria, Phytoplankton, Toxic algae

ABS-171

Experimental Hut and Field Evaluations of the Thermacell® based Metofluthrin Spatial Repellent against Pyrethroid Resistant Anopheles Funestus in Siaya, western Kenya.

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Spatial repellents (SR) are undergoing epidemiological evaluations with the aim of complementing current vector control tools This study conducted experimental hut and small-scale field trials between Oct 2022 and Jan 2023 to evaluate the protective efficacy of Thermacell® based metofluthrin SR against pyrethroid resistant Anopheles funestus in Siaya County, western, Kenya.Phase 1 of the study was conducted in the "Dala Suna" experimental huts located around Lake Kanyaboli, Siaya County, Kenya. The SR product emanator included a cartridge containing metofluthrin attached to liquefied petroleum gas (LPG) cylinder and included two experiments: one to evaluate whether fire from the LPG cylinder increased mosquito density indoor and the second to evaluate the effect of 2, 4 and 12-hour emanation periods had on indoor density and biting rates. Experiment 2 was further modified to include an hour's emanation between 0500-0600HRS the next morning. The second phase: was a field evaluation of an outdoor emanation of the SR product using human landing catches outdoors with volunteers sitting at 5ft, 10ft and 20ft from the emanator. Measured outcomes were deterrence, percentage feeding inhibition, mortality and mosquito landing rates.The SR had an 87.7% deterrence rate and knockdown of 95.5% of *Anopheles funestus* coming into the huts. Cooking with LPG cooker increased mosquito densities indoors by 51%. The 12-hour emanation period reduced Anopheles landing rate indoor by 99.3%. Using 5ft as reference, outdoor mean hourly biting rate were significantly lower than at 20ft (0.33 RR = 9.766(5.351-17.822) P<0.001) but were not significantly different from 10ft (0.025 RR=0.79 (0.349-1.79) P=0.573). SRs almost completely blocked biting indoors, led to 10X lower biting rates within 10ft of the emanator outdoors, the first product to demonstrate such potential. The use of LPG in house could increase exposure to Anopheles mosquito bites.

Keywords: *Anopheles funestus*, LLINs, IRS, Insecticides Resistance Management, Spatial repellent

ABS- 179

Trophic preferences of Anopheles coluzzii: what implications for malaria vector control in Benin?

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The main objective of the present study was to assess the preferences in terms of vertebrate hosts of *Anopheles coluzzii*. Adult mosquitoes were collected through pyrethrum spray catches, and human landing catches in two communes in Benin: Malanville, a pastoral area, and Porto-Novo, a non-pastoral area. Molecular species identification was performed through PCR within the Anopheles gambiae complex. Blood meal origin and *P. falciparum* sporozoite rate (SR) were determined using ELISA blood meal and circumsporozoite protein tests, respectively. Overall, 97% of females of *An. gambiae s.l*. were *An. coluzzii,* with biting behaviour more pronounced outdoors in Malanville, the pastoral area. The main vertebrate hosts on which females *An. coluzzii* blood fed were goats (44%), followed by humans (24.29%), bovines (22%), and pigs (1.4%). Our results also showed that single-host blood meals (human: 24.29%, or animal: 68%) were mostly observed compared to mixed blood meals (8.58%). The human biting rate (HBR) and P. falciparum SR of An. coluzzii were 66.25 bites/man/night and 0.77%, respectively. However, in the non-pastoral area (Porto-novo), 93.98% of samples were *An. coluzzii*. The latter blood-fed mostly (86.84%) on humans, with an estimated HBR of 21.53 b/m/n and SR of 5.81%. In terms of trophic preference*, An. coluzzii* was overall opportunistic. The high zoophagy observed in the pastoral area could be due to the strong presence of animals in human dwellings. Thus, pastoralism associated with a pronounced zoophagy in vectors, could therefore be considered an indirect strategy for controlling malaria transmission to humans. Our results also suggest that, in pastoral areas, household-level malaria interventions involving the application of insecticides to cattle, may be effective, if implemented in combination with the use of long lasting insecticidal nets.

Keywords: Trophic preference, *Anopheles coluzzii*, biting rate, blood-feeding behaviour, pastoralim, malaria

ABS- 185

Application of Vector Control Optimization Model (VCOM) on eave ribbons for malaria vector control in Kilombero Valley, Tanzania

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Despite significant progress against malaria, the use of two core interventions, namely insecticide-treated nets (ITNs) and indoor residual spraying (IRS), are becoming increasingly vulnerable due to insecticide resistance and outdoor biting by mosquitoes. Thus, for effective control, there is a critical need to complement the existing interventions that are currently in use with the new designed ones. Using the

Kilombero Valley as a case study, the Vector Control Optimization Model (VCOM) was adapted and extended to simulate the impact of adding eave ribbons treated with spatial repellent (ER) as supplementary intervention in an area of high ITN coverage. Simulation was conducted to assess the impact of varying coverage of this supplementary intervention on the entomological inoculation rates (EIR) generated by two common vectors in Kilombero, Anopheles arabiensis and *Anopheles funestus.* Finally, the impact of introducing this intervention on the combined EIR from *An. arabiensis* and *An. funestus* was assessed to identify scenarios in which values fell below 1; the likely threshold required for malaria interruption. ER was predicted to substantially reduce the EIR in Kilombero valley when combined with 80% ITN coverage. However, the nature of the impact varied notably between vector species. ER was predicted to have a much larger effect on transmission mediated by *An. funestus* than *An. arabiensis*. Additionally, in the situation where EIR from both *An. arabiensis* and *An. funestus* was combined, substantial coverage of this supplementary intervention was predicted to lower EIR to below one. Despite the significant impact ER in combination with ITNs on one of the two vectors *(An. funestus* or *An. arabiensis*), this intervention is insufficient when combined with ITNs to reduce the EIR to below one in settings like Kilombero Valley where both species contribute to malaria transmission.

Keywords: Eave ribbon, *Anopheles funestus, Anopheles arabiensis*, Kilombero Valley, malaria

ABS- 186

The distance-density relation to inform larval source management: How far into sugar irrigation schemes do malaria mosquitoes breed?

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While agricultural production is expanding in low –and middle-income countries, the vast majority of arable land is too dry for rainfed agriculture. Supplemental irrigation overcomes the insufficient water supply by rainfall, and increases crop yields and food production and ensures reduced crop failures. While large-scale irrigated farming systems may enhance local economies and even food security, they also create and sustain suitable mosquito breeding habitats when proper drainage systems are absent or poorly maintained. This can lead to persistent malaria transmission year-round, as mosquitoes can reproduce independent of rainfall. We conducted a study in Manhiça

district, southern Mozambique, to characterize mosquito breeding habitats from the village periphery into an irrigated sugarcane plantation. In transects spanning over 5 kilometres each, and which included areas with local small-scale farming, a river, floodplains and a swamp, we assessed how the abundance and species diversity of the immature mosquito population changes across those different environments, and over time and space. We characterized which breeding types contribute and sustain malaria mosquitoes throughout the year. We will present the outcome of this study, which will provide novel information on larval ecology in southern Mozambique, and can guide targeted larval source management (e.g., through aerial spraying or teams on the ground) in an area with persistent malaria transmission despite the use of other frontline vector control interventions.

Keywords: Mosquito breeding habitats, irrigated plantation

ABS- 187

Susceptibility status of Culex mosquitoes to selected insecticides at public university in Tanzania

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The study aimed to assess mosquitoes' susceptibility status against pyrethroids (deltamethrin), carbamates (bendiocarb), and organophosphates (pirimiphos-methyl) at the public University in Tanzania. The WHO-recommended discriminating concentrations (%) of deltamethrin (0.05%), bendiocarb (0.1%), pirimiphos-methyl (0.25), and permethrin (0.75%) were used on batches of 2400 Culex mosquitoes (1:1 male to female ratio) collected in various at campus and 440 reared mosquito ((1:1 male to female ratio) to detect knock-down and mortality rates. The abundance of culex mosquitoes captured at the campus was 7413 of which 6135(85.19%) and 1098 (14.81%) were males and females respectively. The 24-hour mean mortality rates of adult culex mosquitoes against three insecticides across the campus ranged from 7.5% - 17.5% for deltamethrin, 15 – 25% for bendiocarb, and 5- 15% for pirimiphos-methyl. The mean mortality of reared culex mosquitoes was 5, 12.5 and 5 for deltamethrin, bendiocarb, and pirimiphos-methyl respectively. All reared and collected mosquitoes recorded mortality rates below 90%. to deltamethrin (0.05%), bendiocarb (0.1%), pirimiphos-methyl (0.25), and permethrin (0.75%). The mean knockdown time (KDT50) of the adult mosquitoes collected on campus was elevated, ranging from 21.9-74.7, 28.1-to 52.8, and 44.4-176.4 minutes for deltamethrin, bendiocarb, and pirimiphos-methyl respectively. Results further revealed that both reared and female culex mosquitoes were more resistant to all insecticides tested than their counterparts. Culex mosquitoes collected during the survey were resistant to all insecticides tested. Hence, various methods including environmental modifications and the use of other potential insecticides are recommended to reduce culex mosquitoes in the area.

Keywords: culex mosquito, insecticide, susceptibility

ABS- 197

Preliminary morphological identification of indoor mosquitoes in the northern regions of Namibia

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Indoor mosquitoes in northern Namibia covering six regions, were examined to determine the types and numbers of the probable vectors of malaria, geospatially. The regions varied in malaria endemicity and geographical outlook. A total of 1141 mosquitoes were collected, through a pyrethrum spray and collect approach. Culex spp, was the most common and prevalent in all the regions. *An. gambiae* complex species (An. gambiae s.l.) was predominant in Kunene and lesser in Kavango. The different types of species found in order of prevalence were: Culex spp. (74.1%), An. gambiae complex (23.8%), An. squamosus/cydippis (1.3%), *An. rhodensiensis* (0.17%), An. ardensis (0.17%) and the rest (*An. salbai, An. tenebrosus, An. maculipalpis,* and *Aedes* species) at (0.08%) each. Most of the female Culex species (75.2%) had fed on human blood, contrasting approximately 50% of the *An. gambiae* complex that had fed. *An. gambiae* complex was prevalent in the more arid and steppe environments, whereas Culex species appeared adapted to both arid, steppe and vegetated areas. We conclude that indoor mosquitoes in the sampled areas are largely Culex species. Considering that Culex species also transmit arboviruses, this calls for further interrogation.

Keywords: Namibia, Malaria vectors, culicine mosquitoes, anopheline mosquitoes

ABS- 201

An efficient mosquito marking with transstadial persistence

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Various techniques have been used for marking adult Anopheles mosquitoes to monitor key determinates of their vectorial capacity including population size, dispersal, survival, ecology and behaviour. These techniques, however, have negative impacts on the mosquito fitness (e.g. fluorescent dusting) or are short-lived. Here we report a uranine-based mosquito marking technique with transstadial

persistence. We maintained different stages of Anopheles gambiae (Ifakara strain) larvae in uranine solution at 0.5mg/ml, 0.25, 0.125 or pure water on fish-flake until pupation and determined pupation date and rate, fluorescence intensity, rate of adult emergence. Resulting adults were examined for visibility and persistence of fluorescence, fecundity, fertility and survival. Uranine at 0.25mg/ml on L3 showed has no adverse effect on the larvae development and on the performance of pupae or resulting adults. This dose resulted in a significantly high fluorescence intensity which persisted throughout the mosquito lifetime. This study demonstrated that uranine treatment of mosquito larvae is a simple and safe marking strategy with transstadial persistence of the fluorescence at a visible intensity, thus the best mosquito marking tool yet.

Keywords: Uranine, transstadial persistance, marking

ABS- 212

Prevalence of Schistosomiasis among school going children in Homabay County,Kenya.

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Schistosomiasis is caused predominantly by two species; Schistosoma mansoni which is responsible for intestinal schistosomiasis and Schistosoma haemotobium which causes urinary schistosomiasis. It is often associated with many factors which correlate significantly with the spread of diseases. The factors include low socioeconomic status, lack of clean water supply, Lack of basic infrastructure, relatively low quality of housing and poor environmental sanitation. We assessed the prevalence of schistosomiasis among school children in Homabay County, Kenya. A cross sectional study was conducted from January 2022 to November 2022. Study participants were randomly selected from two primary schools at the study area. A total of 200 children aged between 6& 17 years (120 females and 80 males) were voluntarily enrolled. All the study participants were requested to provide both urine and stool samples by using dry, clean well labelled plastic containers. Consequently, all the samples were then examined for *S.manoni, S.haematobium*. Among the participants, 120 (60%) were females and 80(40%) were males .Majority 136(68%) were aged between 10-13 years whereas those aged 6-9 and 14-17 comprised 22(11%) and 10 (5%) of each group, respectively. The prevalence rates of *S. haematobium* was 22.9% .The analysis indicated that males and females were equally infected (50%) each. With regard to age, children aged between 10-13 years were the most infected with an infection rate of 88.9% compared with other age groups. School age children are among the high risk groups for *S. haematobium* and *S. mansoni* infections. Additionally, hygiene and playing in contaminated water could also increase the risk of infection.

Keywords*: S.mansoni, S.haematobium*

ABS- 213

Determination of the residual efficacy of micro-encapsulated pirimiphos-methyl (Actellic® 300CS) for IRS in Ethiopia

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The aim of this trial was to assess the persistence of Actellic® 300CS (30% pirimiphos-methyl) by spraying different wall surfaces (mud, dung, paint, cement, and iron sheet) to determine its residuality. Actellic® 300CS was diluted according in 7.5 L of water and applied using a compression sprayer fitted with a CF valve to deliver 30ml/ m2 with a consequent target dose of 1gr a.i. /m2. Ten experimental huts were treated at Sekoru, Ethiopia. The interior diameter of the huts was 2.5-3.5m and the height of the walls was between 2 and 3m. Each type of wall in a single hut was demarcated and labeled as mud, dung, painted, cement and iron sheet. In each hut, a minimum of 3 cones were fixed to walls at different heights (top, middle, bottom) of the indoor walls to evaluate the persistence of insecticide at different heights. The trial ran from November 2021 to July 2022 with monthly tests being carried out. Ten susceptible *An. arabiensis* were exposed for 30min in each cone assay (n=3 on each of the 5 surfaces) and then monitored daily for up to 120h in an untreated wooden box with sugar water, covered with moist towels. Propoxur was used as control in the same trial set up. There was no significant difference between the different heights of the wall surfaces for both products. The trial results, revealed that the residual efficacy of Actellic 300CS extends up to eight months in all treated wall surface types (> 80% mortality w/i 5 days). Results showed that Actellic 300 CS had better mortality after 24h and longer lasting residuality than Propoxur . Due to the widespread resistance against carbamates Actellic 300 CS is a proven tool for resistance management in IRS.

Keywords: Actellic 300CS

ABS- 226

Current insecticide resistance status of *Anopheles gambiae s.l* in Nord Ubangi, DR of Congo

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Malaria continues to represent a major public health challenge in the Democratic Republic of the Congo (DRC). Insecticide resistance is one of the primary threats to sustaining the global reduction in malaria morbidity and mortality. The threat posed by insecticide resistance in DRC is significant in DRC where vector control long-lasting insecticide treated bed nets (LLINs) are the core intervention. Monitoring

of the insecticide resistance status of local vector species is an important aspect of the factors required to inform control strategies and assess their effectivenes .The phenotypic resistance of *An. gambiae s.l*. was assessed using WHO susceptibility bioassays. Adult F1 *An. gambiae s.l.* were reared from larval collections conducted at 4 sites within Bili Health Zone, from October to November 2018. 125 female Anopheles which age varies from 3 to 5 days were tested with different insecticides and fifty for the control. Mortality was calculeted 24hours post expositition. *An. gambiae* s.l. was the principle malaria vector collected during larval prospection activities. *An. gambiae s.l.* were susceptible to carbamate insecticide (bendiocarb, 100%), organophosphate insecticides (malathion and pirimiphos-methyl), but resistant to the pyrethroid (mortality less than 95%) insecticides (permethrin and deltamethrin). Deltamethrin mortality demonstrated spatial variations between different sites. Overall, this activity confirmed resistance to pyrethroids in *An. gambiae s.l*. in selected locations in Nord Ubangi, DRC. These results highlight the necessity of routine insecticide resistance monitoring to inform the epidemiological analysis and operational decision-making for malaria vector control in DRC. Additional phentotypic and molecular testing methods should be conducted to describe the underlying mechanisms and intensity of resistance to inform insecticide resistance management and decision-making.

Keywords: Insecticide resistance-*Anopheles gambiae s.l*- Nord Ubangi-RD Congo

ABS- 247

Effects of sample preservation methods and duration of storage on the performance of mid-infrared spectroscopy for predicting the age of malaria vectors

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Monitoring the biological attributes of mosquitoes is critical for understanding pathogen transmission and estimating the impacts of vector control interventions. Infrared spectroscopy and machine learning techniques are increasingly being tested for this purpose, and can accurately predict the age, species, blood-meal sources, and pathogen infections in mosquitoes. The techniques are still in early-stage development, and there are no standardized procedures for handling mosquito samples. We, therefore, assessed the effects of different preservation methods and storage duration on the performance of mid-infrared spectroscopy for age-grading malaria-transmitting mosquitoes. Laboratory-reared *Anopheles arabiensis* (N=3,681) were collected as 5 or 17-day olds, killed with ethanol then preserved using either silica desiccant at 5°C, freezing at -20°C, or absolute ethanol at room temperatures. For each preservation method, the

mosquitoes were divided into three groups and stored for 1, 4 or 8 weeks, then scanned using an attenuated total reflection-Fourier transform infrared spectrometer on the mid-infrared wavelengths. Supervised machine learning classifiers were trained with the infrared spectra, and used to predict the mosquito ages. Support vector machine (SVM) was the best performing classifier. The classification of mosquito ages was most accurate when the training samples and samples being tested (test samples) were preserved the same way or stored for equal durations. However, when the test and training samples were handled differently, the classification accuracies declined significantly. When using mid-infrared spectroscopy and supervised machine learning to age-grade mosquitoes, the highest accuracies are achieved when the training and test samples are preserved the same way and stored for the same durations. Protocols for infrared-based entomological studies should therefore emphasize standardized sample-handling procedures for greater accuracy.

Keywords: Malaria vectors, infrared spectroscopy, machine learning, preservation, storage

ABS- 248

Endectocides to complement the malaria vector control toolkit: expected and unexpected side-effects of ivermectin on malaria vectors

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Mass treatment of livestock and/or humans with ivermectin is a promising complementary malaria vector control strategy that requires, however, repeated treatments to cover the high transmission season. To overcome this, a long-acting ivermectin formulation is currently under development and its potential to release mosquitocidal concentrations of ivermectin for more than one month is under evaluation as part of the impact project. Although broader use of ivermectin can pose some anticipated challenges (i.e. potential environmental contamination and effects on non-target organisms, risk of inducing resistance in livestock or human parasites), other side-effects such as the selection of ivermectin resistance in malaria vectors through physiological or behavioral modifications appear to be less obvious. The aim of this review was to decipher how resistance to ivermectin could be selected in malaria vectors and propose a research agenda

to study and manage this phenomenon if it appears. We searched electronic databases (PubMed, Web of Science and Google Scholar) using search terms that include ivermectin resistance in hematophagous arthropods. Data were extracted and summarized in terms of resistance mechanism. Target site mutations and metabolic resistance were the main mechanisms by which hematophagous arthropods survive exposure to ivermectin. In the malaria vector *An. gambiae*, mutations in the glutamate-gated chloride channels and an increase of P450 enzymes have been associated with ivermectine resistance. Based on these data and on-going studies as part of the impact project, we proposed a research and development agenda for ivermectin resistance management. Anticipating the research on physiological or behavioral resistance to ivermectin in mosquitoes will facilitate the development of effective resistance-management plans and enable preparedness for monitoring and evaluating this strategy after its implementation.

Keywords: Malaria; Mass Drug Administration; residual transmission; Ivermectin resistance; Anopheles

ABS- 260

System dynamics model for malaria vectors interactions and strength of insecticide resistance under the influence of climate

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Malaria is a major public health problem over the world, but particularly in sub-Saharan Africa. The extent and intensity of malaria transmission are directly related to the anopheline mosquito vectors that carry it from person to person. Their distribution, intrinsic behavior, and ability to resist the current insecticides used in their control determine the level of malaria transmission where temperature and rainfall are the key climate factors that play a significant role. Hence, determining the mosquito vectors' interactions and their forces of insecticide resistance patterns in heterogeneous environments are very critical for the control of malaria vectors. The objective of this study was to develop and evaluate a model that represents the evolution of the complex/subgroup of *Anopheles gambiae* and *Anopheles*

funestus species using system thinking and system dynamics approach to analyze the population dynamics of these multi-species systems and unveil the strength of resistance of each species to the different used insecticides in single and multi-species communities under the influence of temperature and rainfall. The study came out with a multi-species system model that explains how malaria mosquito vectors population dynamics are influenced by species interactions mostly at their immature stages and predict the evolution of individual species in the whole system under changing temperature and rainfall. The results also suggest that the mechanism of insecticide resistance formation and development increases under a warming climate and may vary in either single- or multi-species communities of anopheline mosquito species. Overall, the model adequately captures dynamics at different levels of the mosquito vectors system for the complex network interactions and continuous feedback effects and provides comprehensive information for effective malaria disease scourge management.

Keywords: Causal loops diagram, stocks and flows diagram, mosquito vectors, system behaviour, temperature, rainfall

ABS-261

Secondary bacterial infections and antibiotic resistance from lesions of tungiasis patients in western, kenya

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Tungiasis is a parasitic disease caused by the female sand flea *Tunga penetrans*. Secondary infection of the lesions caused by this flea is common in endemic communities. This study sought to shed light on the bacterial pathogens causing secondary infections in tungiasis lesions and their susceptibility profiles to commonly prescribed antibiotics. Participants were recruited with the help of Community Health Workers. Swabs were taken from lesions which showed signs of secondary infection. Identification of suspected bacteria colonies was done by colony morphology, Gram staining, and biochemical tests. The Kirby Bauer disc diffusion test was used to determine the drug susceptibility profiles. Out of 37 participants, from whom swabs were collected, specimen were positive in 29 and 8 had no growth. From these, 10 different strains of bacteria were isolated. Two were Gram positive bacteria and they were, *Staphylocccus epidermidis* (38.3%) and *Staphylococcus aureus* (21.3%). Eight were Gram negative namely *Enterobacter cloacae* (8.5%), *Proteus species* (8.5%), Klebsiellla species (6.4%), *Aeromonas sobria* (4.3%), Citrobacter species (4.3%), *Proteus mirabillis*(4.3%), *Enterobacter amnigenus* (2.1%) and *Klebsiella pneumoniae* -2.1%). The methicillin resistant *S. aureus* (MRSA) isolated were also resistant to clindamycin, kanamycin,

erythromycin, nalidixic acid, trimethorprim sulfamethoxazole and tetracycline. All the Gram negative and Gram positive bacteria isolates were sensitive to gentamicin and norfloxacin drugs. Results from this study confirms the presence of resistant bacteria in tungiasis lesions hence highlighting the significance of secondary infection of the lesions in endemic communties. This therefore suggests that antimicrobial susceptibility testing may be considered to guide in identification of appropriate antibiotics and treatment therapy among tungiasis patients.

Keywords: Tungiasis, *Tunga penetrans*, Neglected Tropical Diseases, Secondary infection, Antibiotic resistance

ABS- 266

Investigation of antibiotic prescription at a public primary healthcare facility in Burkina Faso and of potential effects on malaria transmission

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The spread of resistance to antibiotics today represents a serious public health problem in the world, particularly in countries with limited resources. In Africa, the problem is more serious due to inappropriate self-medication and irrational prescriptions in health centers. For example, bacterial infections are the leading cause of death among children under 5 years of age, who are also particularly vulnerable to malaria. However, a majority of children suffering with viral or parasitic diseases are often treated with antibiotics. Moreover, previous studies showed that antibiotics ingested by the mosquito during the blood meal negatively impact their bacterial microbiome. In this study, a retrospective survey on the proportion and frequency of antibiotics prescribed to patients at public primary healthcare of Pè, a peri-urban locality in west of Burkina Faso was conducted over a period of four years. At least one antibiotic was prescribed during 43% of the healthcare appointments and children aged 0 to 15 years were most concerned. Amoxicillin (33%) and cotrimoxazole (40%) were the most frequently prescribed. The most common diagnosis was malaria (50%), trauma cases (41%) and respiratory tract infectious (17%). Inappropriate treatment can accelerate the appearance of resistant bacteria. In addition, amoxicillin and cotrimoxazole significantly affect the mosquito microbiota, a known barrier against Plasmodium parasite transmission. Hence, it is important to also consider potential effects of antibiotics on parasite transmission by the mosquito to assess the benefit-risk balance of antibiotic use, in order to choose the right drugs and to use them optimally.

Keywords: antibiotics, drug resistance, malaria transmission

ABS- 270

The Asian Tiger Mosquito invasion story in forest of Central Africa and potential consequences in a One Health perspective

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The hypothesis of an invasion of forest environments of *Ae. albopictus* implies it has the ability to colonize forest ecosystems, including access to potential breeding sites, or feeding on wild reservoirs of arboviruses. The aim of our study was to demonstrate the potential of *Ae. albopictus* of invading wild forest habitats, and determine its degree of penetration in forest compartments from anthropo-sylvatic edges. To do this, in the Lopé national park, Gabon, we monitored Aedes albopictus populations from 2014 to 2018 in anthropogenic and sylvatic compartments using ovitraps, BG-sentinel and Human landing catches. In addition, in a punctual survey we deployed during 5 days three networks of 30 to 40 ovitraps in three forest sites close to human habitations, over distances varying from 0 to 175m from edges towards deepest parts of the forest blocks. We also carried out larval surveys in natural and artificial water collections in the village and within the sylvan part of the park. We observed that Ae. albopictus can lastingly persist in sylvatic ecosystem regardless the magnitude of human presence, and that its establishment in forest does not alter its propensity to bite humans. Our results showed that there is a continuum of colonization of the forest area, showing that *Ae. albopictus* has the ability to colonize the interior of forests. However, a modeling of the colonization dynamics showed that its level of colonization decreases progressively with the distance from the anthropo-sylvatic forest edges. Larval prospections revealed that in the sylvan areas of the park, Ae. albopictus is more likely to colonize forest groves and galleries, known as circulation hub of animal reservoirs, and where it may act as bridge vector of zoonotic viruses between those forest areas and anthropogenic compartments.

Keywords: One Health; Zoonotic viruses; *Aedes albopictus*; Forest invasion; Central Africa

ABS- 279

Assessment of the bacterial communities associated with Anopheles gambiae larval habitats in Southern Ghana

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Mosquito breeding habitats is an ecosystem that comprises of a complex, intimately associated micro-organisms. Understanding the bacterial community structure, and its dynamics on mosquito larval productivity is a pre-requisite for comprehending mosquito habitat selection for oviposition. This study aimed to determine bacteria communities associated with Anopheles larval habitats, and correlate their prevalence to the absence or presence of mosquito larvae. Sequencing of the 16S rRNA using Oxford Nanopore's MinION platform was used to identify and compare the bacterial communities in Anopheles positive breeding habitats (productive and semi-productive habitats) and negative habitats (non-productive) from Southern Ghana. A total of 12 bacterial taxa were identified in all the samples (larvae and water) tested. Significantly, mosquito positive breeding habitats (productive and semi-productive) had more bacterial diversity compared to mosquito negative habitats (non- productive). Comparisons of bacterial composition revealed that Epsilonproteobacteria was more common ($P < 0.05$) in unproductive habitats, Gammaproteobacteria, Actinobacteria and Sphingobacteria were more common ($P < 0.05$) in productive habitats, and Gammaproteobacteria, Betaproteobacteria, and Alphaproteobacteria were the most abundant bacterial class in Anopheles larvae. Only two taxa, belonging to the phyla Gammaproteobacteria and Betaproteobacteria were common to both larvae and mosquito positive breeding habitats. These results suggest a higher bacteria composition may play a role in Anopheles mosquitoes' attractiveness to a breeding habitat. These findings contribute to the understanding of which bacteria, directly or indirectly, can be linked to absence or presence of mosquitoes' larvae in breeding habitats, and set the basis for the identification of specific bacterial taxa that could be harnessed for vector control in the future.

Keywords: bacteria, breeding habitat, mosquito larvae, *Anopheles gambiae* larvae, 16S rRNA, Ghana

ABS- 304

Abstract Title: Risk factors related to Buruli ulcer in the Akonolinga Health District in Cameroon

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Buruli ulcer (UB), the third mycobacterial disease, behind tuberculosis and leprosy, is a disease that is characterized by large ulcers of the skin caused by a type of mycobacterium (called *Mycobacterium ulcerans*) that can cause permanent disability. It occurs mainly in West and Central Africa. However, the exact mode of transmission remains unknown. Due to the nature of the disease and its stigma, it is difficult to determine the exact contributing factors of the disease. The objective of this study is to determine the risk factors related to Buruli ulcer in the social homes of the populations of the Akonolinga Health District for good management of the disease. Methods: The data collected to the social homes of the populations were codified and recorded on an input mask developed on the CSPro4.1 software, then exported to data analysis software, value of 5% (0.05) was chosen as the threshold, we used the logistic regression model to analyze the risk factors

of Buruli ulcer as well as the specific test of independence of Chi 2, which tests the association between two qualitative variables. Results: No significant association between the age of the individual and UB infection, on the other hand 26.3% of Catholic households have UB compared to 24.6% in Protestant families. 30.6% of cases in households with fewer than 5 people, while this proportion is 23.0 in households with 5 to 10 people and 31.3% in those with more than 10 people. The type of soil material significantly influences Buruli ulcer infection. Fishing and laundry in or near swampy areas and artificial lakes are 33 and 54 times more likely to catch UB, respectively, and those who bathe are 55 times more likely to be infected with the disease. Conclusion: This study shows that the presence of swampy areas, backwaters near households frequented by residents, fishing, laundry, bathing and doing field work are illustrated as characteristics of significant influences of Buruli ulcer infection.
Keywords: Buruli ulcer, risk factors, infection.

ABS- 310

Merozoite surface protein 2 polymorphism of *Plasmodium falciparum* isolates in selected malarious area, Northwest Ethiopia, 2022

Agenagnew Ashagre Gelew (Woldia University)*

Plasmodium falciparum's genetic diversity provides the parasite with many effective immune evasion and drug resistance mechanisms, which lead to the inactivation of antimalarial drugs. This phenomenon makes it a major problem to eradicate malaria globally. This study aims to assess MSP2 polymorphism in P. falciparum isolates from Northwest Ethiopia. A cross-sectional study was conducted to assess MSP2 polymorphism in *P. falciparum* isolates in selected malarious area, Northwest Ethiopia, from April to June 2021. A convenience sampling technique was used to select a total of 150 study participants. Capillary blood samples were collected for the preparation of blood film and dried blood spots for molecular genotyping. MSP2 allele frequency and MOI were computed. The Spearman's rank correlation coefficients were used to assess the association between MOI and parasite densities and age. P value < 0.05 was Statistical significance. Polymorphism analysis was done on 126 P. falciparum isolates within the allelic families of MSP2. There were 38 different MSP2 alleles, of which 20 correspond to the IC/3D7 and 18 to the FC27 allelic family. The majority of the isolates contained multiple infections, and the mean MOI was 3.46. There was no statistically significant difference in the MOI by age of patients (P = 0.646). However, a statistically significant correlation was found between parasite densities and MOI (P= 0.046). The heterozygosity index for MSP2 was 0.948. This study has shown that *P. falciparum* isolates contain multiple genotypes with a high MOI, suggesting the presence of extensive genetic diversity and mixed-strain infections in Northwestern Ethiopia. This could reflect both the endemicity and high level of malaria

transmission intensity that requires more effort to control malaria transmission in the study area. Moreover governmental and non-governmental stakeholders must work together to control malaria transmission.

Keywords: MSP2, *Plasmodium falciparum*, Gondar, Northwest, Ethiopia, Polymorphism

ABS- 318

Efficacy of ReMoa Tri adulticide against African malaria vectors: Susceptible *Anopheles gambiae* and resistant *Anopheles arabiensis*

Dismas Simwela Kamande (Ifakara Health Institute)*; Silas Majambere (Valent BioScience LLC); Sarah J Moore (Ifakara Health Institute); Banugopan Kesavaraju (Valent BioScience LLC)

Space spray intervention uses ultra low volume (ULV) droplets to control outdoor adult vector populations. Newly formulated adulticides are needed to combat malaria vectors, specifically exophilic species. ReMoa Tri adulticide is formulated using pyrethroid, abamectin and fatty acid targeting resistant vectors. Here, the efficacy of ReMoa Tri was evaluated in a small-scale field trial against susceptible and resistant African malaria vectors. A block randomized in 2x4 grid design set in the 100m swatch with mosquito cages set at a distance interval of 25, 50, 75, and 100m as described in WHO guidelines. The mixture of ReMoa Tri adulticide (solute and solvent) prepared at a ratio of 2:1, the fontan® Portastar S ULV backpack sprayer was used to deliver a droplet size with volume median diameter (VMD) 12 to 24 µm. The trial was conducted at dusk when the wind speed was 3-10 kilometers per hour (kph) with 5kph optimal wind speed. The technician was spraying while walking across the spray line at 3.5 kph. All 3 replicates of the spray were conducted on the same night. ReMoa Tri induced 100% KD60 and 100% M24 against susceptible and knockdown-resistant *An. gambiae s.s*. (Kisumu KDR strain) in all replicates at each of the 25,50,75, and 100 meters distances. For strong metabolic resistant *An. arabiensis*, ReMoa Tri induce 100% KD60 and 100% M24 at each 25, 50, and 75m except for 100m where optimal mortality is achieved at 48 hours. During the application, acceptable outdoor weather conditions were recorded with average temperature at 24.7, humidity at 81.1 %, wind speed 5km/h and spraying with a walking speed of 3.5 km/h. The ReMoa Tri adulticide induce optimal knockdown after 60 minutes and optimal mortality by 24 hours against susceptible and knockdown-resistant *An. gambiae s.s.* while with resistant *An. arabiensis* optimal mortality was achieved at 48 hours.

Keywords: Space spray, Malaria, vector-borne diseases, droplet size, weather conditions, Adulticide, ReMoa Tri

ABS- 320

Long-acting formulation of Ivermectin for effective malaria control: insights from an age-structured modelling study.

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Controlling malaria consists of either killing the parasite within the human host or reducing the vector population. These two approaches have allowed to decrease the number of deaths by almost 40% during the 2 past decades. However, a stagnation since 2015 followed by an increase in the last years, highlight the limits of available tools. One of the known limits is the vector tolerance to insecticides. A complementary approach under scrutinity is treating host with Ivermectin (IVM) that render the blood meal toxic for mosquitoes. Several studies have modelled the impact of mass drug administration (MDA) of oral ivermectin to human populations and have evidenced a promising effect in reducing malaria prevalence. However, the mosquitocidal effect of a single oral IVM dose (150-200 µg/kg) is relatively short-lived, requiring multiple MDA to significantly decrease malaria prevalence. We have developped an original mathematical model to investigate the effects of a Long-Acting Ivermectin Formulation (LAIF) on malaria transmission. This population model considers multiple continuous structural variables: humans age, time since infection, and time post-IVM administration for both humans and vectors. Such an approach allows targeting a specific human class by excluding children under five years and women of childbearing age. Furthermore, the time post-IVM administration was required to properly capture the longitudinal dynamics of both IVM systemic concentrations in the human bloodstream, and IVM effects on mosquitoes' life span after a blood meal on LAIF-treated human. These last parameters were estimated from in vivo experiments. The long-lasting insecticide treated net and MDA coverage associated to different malaria transmission profiles were used as baselines to evaluate the added value of using LAIF in realistic life conditions. The detailed effect of the LAIF on the reduction of malaria prevalence will be presented during the conference.

Keywords: malaria, modelling, epidemiology, long-acting ivermectin

ABS-337

Residual efficacy of Sylando® 240SC at 250mg m2 on mud, wood and cement measured by a modified tunnel test, Tanzania

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Alternative classes of insecticides for indoor residual spray (IRS) are needed to combat insecticide resistance and control vector-borne disease. Chlorfenapyr under the name Sylando® 240SC has been repurposed for use in IRS and applied as a treatment at a rate of 250 mg/m2. The aim of the study is to evaluate the efficacy and residual activity of Sylando ®240SC on relevant substrates (mud, cement, and wood). The evaluation is conducted in the modified tunnel with a rabbit host in I-ACT (Ifakara ambient chamber test), Tanzania. A total of 12 min huts were used for this evaluation. Six mini-huts (2 per substrate) were sprayed with Sylando ®240SC, 3 huts for SumiShield® IRS (positive control) and 3 huts sprayed with water (negative control). Three pyrethroid resistant mosquito strains including 1) *Anopheles arabiensis* (Kingani), 2) *Anopheles funestus* (FUMOZ) and 3) *Culex quinquefasciatus* (Bagamoyo); and two pyrethroid susceptible strains 4) *Anopheles gambiae s.s*. (Ifakara) and 5) *Aedes aegypti* (Bagamoyo) were used. For each substrate, five replicates of 20 mosquitoes per strain per mini-hut were exposed overnight at one-week post-spraying, and then monthly for up to 12 months. The study is ongoing and here we present data for the six months. In Sylando®240SC, *An. arabiensis* mortality at 168hrs post spray is ranging from 98.1%(95%CI:96.0-100) in mud to 100% in wood substrate. Whilst in SumiShield®, it ranges from 99.9% (95%CI: 97.0- 100) in wood to 100% in the mud substrate. Equivalence was seen between Sumishield® and Sylando® on all substrates with all strains. Based on six months results, Sylando®240SC was equivalent to SumiShield® IRS. Therefore, Sylando®240SC is a potential candidate insecticide formulation for IRS for malaria control. In addition, a new bioassay for evaluating pro-insecticides has been developed.

Keywords: Sylando®, Chlorfenapyr, IRS,SumiShield®

ABS-340

Life-history attributes of juvenile *Anopheles gambiae s.s.* in central Uganda; implications for malaria control interventions.

Charles Batume (Uganda Virus Research Institute)*

Malaria is among the leading causes of death in Uganda, and *Anopheles gambiae sensu stricto* (s.s.) is the predominant vector. Although current vector control interventions have greatly reduced the malaria burden, the disease persists. There is a need to develop novel interventions to supplement current malaria control efforts if we are to eliminate the disease. In order to evaluate new tools for vector control, it is essential to characterize vector populations. In this study we achieved this by assessing the life history parameters of Juvenile *An. gambiae s.s* mosquito populations under laboratory and semi-field conditions. The study was conducted between July to December 2017 to cater for the seasons in the semi field settings at Kibuye and Kayonjo villages in central Uganda. Ten replicates of rearing dishes comprising 30 first instar larvae each were profiled for various life-history attributes (egg hatching, larval development time, larval survivorship, pupae weight and pupation rate) for each of semi field and laboratory setting. Multivariate analysis of variance was used to determine differences in averages for each life history attribute between lab and semi field setting. All life-history attributes were similar for the two sites under laboratory conditions. However, the similarities or differences between field and laboratory development were parameter-specific. Whereas, larval survivorship and pupation rate were similar in the field within seasons and laboratory in colonies from both sites, in the semi-field settings, pupae weight was similar across seasons and laboratory in colonies from both sites. In addition, the average larval development time during the wet season was longer than that of the laboratory for both sites. Baseline Information about Juvenile stages of *An gambiae s.s* can aid in design, development and evaluating efficacy of malaria control interventions.

Keywords: Life history attributes, Interventions, evaluating efficacy, Juvenile stages.

ABS-347

Proof of principle of Interior Inesfly paint 5A IGR in Uganda

Charles N.A Ntege (NMCD)*

Widespread resistance of main malaria vector Anopheles gambiae to Pyrethroids reported in many African countries and operational drawbacks to current IRS methods suggest the convenience of exploring new products, approaches for vector control. Insecticide paint Inesfly 5A IGR™, containing two organophosphates, chlorpyrifos and diazinon and one insect growth regulator pyriproxyfen was piloted for 12 months in Mwera Prison. Mosquito larvae were collected from the nearby breeding sites and reared by the VCO for one week. Three-day female Anopheles mosquitoes exposed. Control used Kisumu. Two sleeping rooms selected, named intervention rooms. The outer surface of the rooms used as control surface. Cone wall bioassays were conducted on both the control and intervention surface. Knockdown was recorded every 10 minutes of exposure and mortality after 24 hours. Six cones were used in the intervention rooms while 2 were used for control. All prisoners in the facility were tested for malaria using mRDTs, their results kept at Mwera Health Center IV.

Prisoners found with the parasite were treated with antimalarial. Total knock down of the exposed mosquitoes was achieved after 30minute of exposure and mortality was realized after 24 hours. Malaria cases reduced tremendously in the prison after painting the 2 sleeping rooms of the prison. Other insects like bed burgs also disappeared from the prison. There was no malaria in the prison during the period of study as prisoners were tested every 3 months. Conclusion: Inesfly paint knocked *Anopheles gambiae* malaria vectors in half an hour. Mortality was recorded at 24 hours. It is potentially recommended to be used as an additional tool in malaria control and elimination in Uganda. Recommendation: More survey to be conducted as this was on a small scale.

Keywords: *Anopheles gambiae*, mRDT

ABS-360

Harnessing mosquito symbionts for malaria transmission blocking

Jeremy K Herren (ICIPE)*

The recently discovered Anopheles symbiont, Microsporidia MB, is maternally inherited and 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 developing a strategy for transmission blocking by vector population replacement. We used fluorescence confocal microscopy and qPCR to investigate the characteristics and efficiencies of Microsporidia MB transmission between *Anopheles arabiensis* mosquitoes. The patterns of Microsporidia MB localization over the development of *Anopheles arabiensis* were investigated by confocal microscopy and qPCR. We show that Microsporidia has high rates of vertical transmission (70-80%) and can be also transmitted paternally and sexually and also find Microsporidia MB accumulation in tissues linked to transmission routes, specifically the germ line.

Keywords: Transmission blocking, symbiont, malaria, anopheles, microsporidia

ABS-369

Semi-field colonization of a multiple-resistant strain of *Anopheles gambiae s.l* for testing Long Lasting Insecticidal Nets (LLINs) in Accra, Ghana.

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Laboratory colonization and maintenance of malaria vectors plays an essential role for research, development and testing malaria vector control tools. The process is faced with challenges such as potential loss of resistance phenotypes. The objective of this study was to colonize and maintain a field collected, pyrethroid resistant *Anopheles gambiae s.l.,* suitable for testing pyrethroid-PBO and pyrethroid-chlorfenapyr LLINs. Larvae of *An. gambiae s.l* mosquitoes were collected from a vegetable farm, with pyrethroid mortality <20%. Adults raised were blood fed and allowed to lay eggs for laboratory colonization. The target was to maintain a laboratory colony with resistance to pyrethroids at <60% mortality. Over the colonization period, field larvae were periodically sampled and added to the colonized population and raised in field water to maintain resistance threshold. WHO susceptibility testing was used to assess resistance status, molecular assays were used to determine VGSC-L1014F, Ace-1 (G119S) frequencies and metabolic mechanisms of the colony at every five generations. Different methods of maintaining target resistance profiles through the generations were tested. Rearing in field water and periodic augmentation with field collected larvae were found to be the optimal method. The method overcame additional colonization challenges including low blood feeding and fecundity rates. Mortality was maintained at <60% for 17 generations after which it increased to 71%. A significant increase in mortality was seen for pyrethroids after pre-exposure to PBO. High VGSC-L1014F frequencies were consistently maintained, though Ace-1 frequencies and enzyme activity fluctuated. This study has shown that periodic introduction of larvae from the field and rearing in field water may help maintain resistance in *Anopheles gambiae* mosquitoes.

Keywords: Mosquito colonization, LLINs, Insecticide Resistance

ABS-371

Efficacy of two long-acting insecticide-treated nets of new generation IG2 and Permanet3 against a population of *Anopheles gambiae s.l.* in Benin resistant to pyrethroids.

kefilath Badirou (CREC)*

WHO recommends the alternative use of LLINs that contain several active ingredients for the management of insecticide resistance. In this study a Mild impregnated with a pyrethrinoid Alphacypermethrin and a pyrol-based insecticide Chlorphenapyr (IG2) and a Mild impregnated with a pyrethroid and a synergist PBO (Permanet 3) were evaluated with a population of *An. Gambiae S.S* resistant to pyrethroids from Ifangni in Benin. WHO tube and CDC bottle sensitivity tests, as well as PBO impregnated papers, were used to assess the level of resistance to Alphacypermethrin and Chlorphenapyr and the effect of PBO. WHO tube tests revealed that the population of *An. Gambiae S.S* from the locality of Ifangni in Benin has an R+++ resistance level to Alphacypermethrin and sensitive to Chlorphenapyr. The results of the cone tests showed that IG2 unwashed has a mortality rate after 24 hours of 71% compared to 32% after 24 hours for unwashed Interceptor. With the unwashed Permanet 3 mosquito net the mortality rate is 100%. The results of the tunnel tests revealed that the inhibition induced by unwashed IG2 83% compared to 77% with Interceptor. With Permanet3, the coupon of the side incorporating the synergist has an inhibition rate of 94% against 31% with the face containing only pyrethroid. The addition of chlorphenapyr (pyrol-based insecticide) as well as Synergist (PBO) to pyrethroids improved the effectiveness of the IG2 and Permanet 3 mosquito net against Interceptor.

Keywords: LLINs, Efficacy, Chlorphenapyr MILDs, Effficacy- Résistance-Insecticide-Clorphenapyr-Alphacyperméthrine-synergiste-PBOe

ABS-380

A One Health approach for integrated vector control: proof of principle from a cluster randomized livestock-centred trial in western and coastal Kenya

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Integrated strategies for vector control that utilize biological tools with unique modes of action could counter increasing insecticide-resistance in vector populations and reduce negative impact on the users and environment. Laboratory and field experiments with a commercial fungus-based veterinary product (TickOff®) indicated potential impact on survival of biting arthropods including,

mosquitoes, ticks and biting flies, when applied on cattle. Community-based and co-produced field trials were implemented in 16 villages in two locations, comprising of i)vector surveillance in cattle-keeping and non-cattle keeping homesteads ii)fortnightly spraying of cattle in half the villages after a baseline year; and iii)assessment of safety of the agent on cattle following regular application. A cluster randomized before and after trial design was used. Mosquito vector populations were monitored using cattle-baited traps, light traps both outdoors and indoors, Aedes gravid traps and tsetse traps in 320 sentinel households. A 12-months baseline was followed by a 12-months intervention in half the villages. Results: The entomological sampling is ongoing and will be concluded in June 2023. Preliminary data indicates that malaria vector populations were higher indoors, both in cattle-keeping and non-cattle keeping homes, than outdoors. Cattle-keeping homes had higher numbers of mostly zoophilic mosquitoes. The impact of the intervention will be presented based on completed data analysis. Initial cattle health indicators did not show any adverse effects of the control agent on cattle. Initial community feedback indicates disappointment with the slow acting biological agent especially for tick control. Conclusion: While a One health approach to malaria vector control would be desirable, initial feedback suggests a lack of an intersectoral working structure and absence of shared resources. Furthermore, the slow-action of biological tools might affect acceptance.

Keywords: One Health, biological control, cattle-targeted, malaria, vector control

ABS-382

Mapping the distribution of invertebrate non target organism in three villages in western Burkina Faso prior the implementation of genetic control tool against malaria vectors

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Mosquito control programs are challenged by mosquito-borne diseases such as malaria, insecticide resistance, and environmental impact on non-target organisms. To address this situation, Target Malaria consortium is in the process of developing a genetic tool that will control malaria mosquitoes Anopheles and that may have little or no impact on non-target organisms. A census or mapping of all non-target organisms in the breeding sites is therefore necessary at this time at our study sites. The objective of our study is to obtain information on the presence of non-target organisms sharing the same larval habitat and, where possible, their ecological relationships with the target mosquito species. Larval habitats sampling was conducted during our monthly field surveys started in 2017 and is still ongoing at our Souroukoudingan and Bana sites in western Burkina. Sampling consisted of collecting with a sieve any living organism

from about twenty larval habitats and keeping them in 90% alcohol. Identification (Jean-Luc Gattolliat) then allowed us to determine the order and family of each invertebrate collected. After identification, results showed that the different larval habitats sampled were composed of several orders and families at all sites. The Holometabole Coleoptera order and Dytiscidaes family were the most represented while the Paurometabole Odonata order and Anisoptera Libellulidae family were the least represented at both sites. These results could constitute a mapping of all non-target organisms existing on our sites currently and could inform us on a probable impact of the use of genetic control.

Keywords: Non-target organism, genetic control, Order, Family, malaria

ABS-384

Distribution of ticks and zoonotic tick-borne pathogens of livestock in the Upper East Region of Ghana

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Zoonotic diseases have been reported in neighbouring countries and coupled with the trade of livestock across borders, there is an increased risk of zoonotic disease outbreaks. This study focused on tick species within selected sites in the Kassena-Nankana Districts in Ghana and determined infectious pathogens that are of zoonotic and veterinary importance in livestock. Ticks and dry blood spots (DBS) were collected from livestock across 11 sites from February to December 2020 and screened for tick-borne pathogens using RT-PCR, conventional PCR, sanger and whole-genome sequencing. The ticks were identified using morphological keys and a molecular method that targets the mitochondrial 16S rRNA gene of ticks. The data obtained was analyzed by Stata version 13. A total of 1,550 ticks were collected from 448 livestock with *Amblyomma variegatum* (62.98%) as the predominant tick species. Furthermore, Rhipicephalus (Boophilus) microplus were molecularly identified for the first time in Ghana, suggesting a risk to livestock production. From the 491 tick pools screened, the pathogens identified in ticks were CCHFV (0.41%), *Rickettsia africae* (39.72%), *Rickettsia aeschlimannii* (14.66%), *Coxiella burnetii* (3.67%), *Babesia sp. Lintan* (2.04%), *Theileria orientalis* (3.05%), *Theileria parva* (1.43%), *Babesia sp. Xinjiang* (0.20%),

Babesia bovis (0.41%), *Ehrlichia canis* (4.27%), *Ehrlichia minasensis* (1.63%), Anaplasma capra (0.81%) and *Anaplasma marginale* (0.20%). Furthermore, pathogens detected in livestock were Rickettsia spp (3.26%), Babesia sp. Lintan (8.70%), Theileria orientalis (2.17%), Theileria parva (0.36%), *Anaplasma capra* (18.48%), *Anaplasma phagocytophilum* (1.81%), *Anaplasma marginale* (3.26%) and *Anaplasma ovis* (7.25%). There is a high risk of zoonotic disease transmission in the area, especially Rickettsia, requiring the development of strategies to mitigate the threat in the country.

Keywords: Ticks, Livestock, Zoonotic Pathogens, Ghana

ABS-391

Designing And Parameterising Mathematical Models For The Of Novel Vector-Control Interventions Targetting Gaps In Protection To Drive Malaria Elimination Using Data From Semi-Field And Field Studies

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Often, human landing catches (HLCs) are used to assess the reduction in biting caused by new vector-control tools. However, very little is known about whether landing is a good measure of biting. To address this, semi-field studies were conducted. In one experiment, laboratory-reared mosquitoes were allowed to feed on a volunteer in the chamber, while in another experiment, a volunteer conducted human landing catches. These experiments were performed on the same night using eave ribbons impregnated with either 5, 10, 15, or 20 g of transfluthrin (6 nights each), with a control arm run in parallel for each experiment every night. We used statistical inference to fit a mathematical model that describes mosquito behaviour to the two experimental datasets. Then, we suggest an extension to the experimental framework and model design that allows the mechanisms driving differences between feeding and landing to be parameterised. Subsequently, we demonstrate how results from these models can be combined with field data to assess the potential impact of novel vector-control tools. Our findings indicate that landing underestimates the impact of vector-control tools in reducing *Plasmodium falciparum* transmission for non-resistant mosquitoes and overestimates this impact for resistant mosquitoes, particularly at the lowest and highest dosages. An explanation for this could be other intervention effects, such as sublethal incapacitation. When these

effects are considered for assessing novel vector-control tools we identify tools which reduce the ability of a mosquito population to transmit malaria comparable to LLINs or IRS. These tools also target gaps in protection, such as day-biting or outdoor-biting mosquitoes, in settings where LLINs and IRS are not suitable, for example forest-goers.

Keywords: Mathematical modelling, Bayesian inference, malaria, spatial repellents, insecticide-treated clothing

ABS-410

Metabolic resistance mechanisms involved in high pyrethroid-resistance of An. gambiae and An. coluzzii populations from the South of Senegal.

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Emergence and spread of insecticide resistance among the main malaria vectors is threatening the effectiveness of vector control interventions in Senegal. The main drivers of this resistance in the *An. gambiae* complex remains poorly characterized in Senegal. Here we characterized the main target site and metabolic resistances mechanisms among the *An. gambiae* and *An. coluzzii* populations in Senegal. Larvae and pupae of *An. gambiae s.l.* were collected and reared to adulthood for insecticides susceptibility (DDT, pyrethroids, bendiocarb and pirimiphosmethyl) and synergist assays (PBO) using the WHO test kits. TaqMan method was used for the molecular characterization of the main target site insecticide resistance mechanisms (Vgsc-1014F, Vgsc-1014S and N1575Y). RT-qPCR was performed to estimate the level of genes expression belonging to the CYP450 family. High resistance level to pyrethroids and DDT and full susceptibility to organophosphates and carbamates where observed in all sites, excepted a probable resistance to bendiocarb in Kedougou. The 1014F, 1014S, and 1575Y mutations were found in both species. Pre-exposure to PBO synergist induced a recovery of susceptibility to permethrin and deltamethrin. Subsequent analysis of genes expression level, revealed that the CYP6Z1 and CYP6Z2 genes were over-expressed in wild-resistant mosquitoes compared to the reference susceptible strain (Kisumu), suggesting that both the metabolic resistance and target site mutation are likely implicated in this pyrethroid resistance. The presence of both target-site and metabolic resistance mechanisms in highly pyrethroid-resistant populations of *An. gambiae s.l.* from Senegal threatens the effectiveness and the sustainability of the pyrethroid-based tools and interventions currently deployed in the country. PBO or Duo nets and IRS with organophosphates could be used as an alternative measure to sustain malaria control in the study area.

Keywords: Malaria; *An. coluzzii; An. gambiae*; pyrethroid; kdr; N1575Y; metabolic resistance; Senegal

ABS-419

Assessing Anopheles vector species diversity and transmission of malaria in four health districts along the borders of Côte d'Ivoire.

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Although malaria and Anopheles mosquito vectors are highly prevalent in Côte d'Ivoire, limited data are available to help understand the malaria vector density and transmission dynamics in areas bordering the country. To address this gap, the Anopheles mosquito species diversity and the transmission of malaria were assessed in four health districts along the borders of Côte d'Ivoire. From July 2016 to December 2017, monthly collection of adult Anopheles mosquitoes was done using window exit trap and pyrethrum spray methods (PSC). In each site, 15 exit traps were installed on the windows of inhabited houses and 10 bedrooms were selected for PSCs in different dwellings during 2 consecutive days. The members of the *An. gambiae* complex were identified using short interspersed nuclear element-based polymerase chain reaction. Anopheles specimens were analysed for malaria Plasmodium parasite detection using the cytochrome oxidase I gene. A total of 281 female Anopheles were collected in Aboisso, 754 in Bloléquin, 1319 in Odienné and 2443 in Ouangolodougou. *Anopheles coluzzii* predominanted in Aboisso (89.2%) and Bloléquin (92.2%), while *An. gambiae* was the major species in Odienné (96.0%) and Ouangolodougou (94.2%). The Plasmodium sporozoite infection rate *in An. gambiae s.l.* (*An. gambiae* and *An. coluzzii*) was highest in Odienné (11.0%; n = 100) followed by Bloléquin (7.8%, n = 115), Aboisso (3.1%; n = 65) and Ouangologoudou (2.5%; n = 120) while in *An. funestus s.l.*, the infection was found only in Odienné (8.7% ; n = 23) and Bloléquin (6.2% ; n = 32). No P. falciparum sporozoite was detected in *An. nili* specimens in the four health districts. Anopheles vector species diversity, abundance and Plasmodium sporozoite infection were high within the health districts along the borders of Côte d'Ivoire, resulting in high malaria transmission among the local populations.

Keywords: Malaria, Plasmodium, Anopheles, Border health district, Côte d'ivoire

ABS-427

Digitalization of entomological surveillance data collection and storage: A pathway to responsive malaria interventions in Nigeria

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Nigeria is the largest procurer of ITNs in sub-Saharan Africa. With the spread of pyrethroid resistance, the NMEP aims to select and deploy ITNs that are efficacious against local malaria vectors, which requires seamless access to entomological surveillance data. The NMEP and NIMR coordinate routine malaria entomological data collection across 31 sites in Nigeria. However, several challenges have disrupted the use of entomological data for timely decision-making on intervention selection including absence of an integrated platform to collate entomology data from partners; inability to monitor field operations to ensure quality data collection; and decentralised access to field results. To address these challenges, the NMEP and NIMR, with support from CHAI, developed a national entomological database within the National Malaria Data Repository. This represents the first-time entomological data will be collated and reported on a platform that is easily accessible to government, partners, and research institutions. Prior to digitization, field data collection tools were standardized to align entomological surveillance indicators across data sources. Paper-based field data collection forms were customized into electronic data collection tools for breeding site identification, adult surveillance, vector bionomics and insecticide resistance assays. A summary form was developed to enable entry of secondary entomological surveillance data from partners and research institutions. The indicators were configured in DHIS2, and interactive dashboards were designed to automate analysis, visualize maps of insecticide resistance, and produce quarterly bulletins for dissemination through the NMEP. The national entomological database will be rolled nationally in 2023 and analytical outputs from the database will be used by relevant stakeholders or technical working groups to inform timely recommendations on the procurement of appropriate ITN types to maximize their impact.

Keywords: Entomology database, Malaria, surveillance, vector-control, health-informatics

ABS-429

Indoor Residual Spraying: Zanzibar Experience Using Volunteers from the Military of National Services

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To ensure the success of the IRS campaign, ZAMEP in collaboration with the PMI Vector Link project, had a robust supervision system that ensured quality results were achieved. The supervision team included National supervisors from ZAMEP, the Ministry of Health (MoH) and Vector Link staff. Pre- and post-spray supervisions were conducted thoroughly, and necessary corrective actions were instituted to ensure smooth IRS implementation using nine (9) operations sites across selected Shehias which were provided by the government and were based in health facilities or in other government-owned structures. This was an essential cost-saving measure for ZAMEP since they were not charged rent for these operations site stores. Across all the operating sites, all stores were housed in government facilities. ZAMEP used 348 volunteers (JKU) students as spray operators and 6 JKU commanders as supervisors for disciplines.

The ZAMEP implemented indoor residual spraying implemented a District IRS approach to achieve its objectives and meet the targets whereby borrowed vehicles from the military (JKU) and from the Regional Commissioners' office were used to transport sprayers from the military camp to their respective IRS sites and from the sites. A discharging form was signed indicating that the site was free from any environmental risk emanating. The key project achievements highlight include Successfully sprayed 41,524/44,242 structures, achieving a coverage rate of 94%., Protected 214,901 residents, including 35,621 children old under 5 years and 6,587 pregnant women. Lesson learned is IRS using volunteers from the military of national services is possible and cost serving with high achievements.

Keywords: Indoor Residual Spraying

ABS-430

Field evaluation of the efficacy, residual activity and impact on malaria incidence of 2GARD™ and KLYPSON® 500 WG insecticides in West Nile, Uganda

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Resistance of malaria vectors to different classes of insecticides has been reported in Uganda. Identifying new indoor residual spray compounds effective against resistant vector populations is a high priority. A two-arm trial was conducted in Adjumani district to determine the efficacy of KLYPSON® 500 WG (Clothianidin 2%) and 2GARD™, (Clothianidin 0.5% + Deltamethrin 0.06%). Indoor residual spraying coverage in the two arms was 204/224 (96.2%) and 508/530 (92.2%) houses respectively. Insecticide content on walls was tested by high performance liquid chromatography. Efficacy was monitored monthly using WHO Cone Bio-Assay for 6 months after spray application. Comparison of mortality effect of the insecticides was determined by one-way analysis of variance pooled T-test. Variation of

residual effect of insecticide on wall types was determined using equivalence TOST test. Susceptibility tests were conducted for wild *Anopheles funestus* mosquitoes to permethrin 0.75%, Pirimiphos-methyl 0.25%, Bendiocarb 0.1%, KLYPSON® 500 WG and 2GARD™ using the WHO tube Assay. Impact of IRS on malaria incidence was determined from DHIS2 data from the study area. Both 2GARD™ and KLYPSON® 500 WG insecticides maintained optimal efficacy during the 6-month study period, with 100% mortality of mosquitoes by 24 hours for 2GARD™ and 72 hours for KLYPSON® 500 WG post-exposure to treated surfaces. Wild *Anopheles funestus* was 100% susceptible to both 2GARD™ and KLYPSON® 500 WG insecticides, with possible resistance to Bendiocarb and Pirimiphos-methyl, and confirmed resistance to Permethrin. Both 2GARD™ and KLYPSON® 500 WG insecticides sustained malaria incidence reduction in 39.2 Sq. Km and 202.2 Sq. Km respectively during the 6 months study period. Both 2GARD™ and KLYPSON® 500 WG are viable insecticides for malaria vector control in Africa, with preference for 2GARD™ in hyper-endemic areas.

Keywords: Efficacy, Residual activity, vector control, 2GARD™, KLYPSON® 500 WG

ABS-434

Effects of insemination and blood-feeding on locomotor activity of wild-derived females of the malaria mosquito *Anopheles coluzzii*

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Behavioural shifts in the canonical location and timing of biting have been reported in natural populations of malaria vectors following the implementation of insecticide-base vector control. These modifications increase the likelihood of human-vector contact and allow mosquitoes to avoid insecticides and promote residual malarial transmission. The biting behaviour of mosquitoes follows rhythms that are under the control of biological clocks, modulated by physiological states and environmental conditions. Here, we explore modifications of spontaneous locomotor activity expressed by mosquitoes in different physiological states to highlight phenotypic variability associated to circadian control that may contribute to explain residual malaria transmission. The F11 generation of field-collected *Anopheles coluzzii* from southwestern Burkina Faso was tested using an automated recording apparatus (LAM, TriKinetics Inc.) under LD 12:12 or DD light

regimens in laboratory-controlled conditions. Activity recordings of a test were carried out for a week with 6-day-old females belonging to four experimental treatments, representing factorial combinations of two physiological variables: insemination status (virgin vs inseminated) and gonotrophic status (glucose fed vs blood fed). Chronobiological features of rhythmicity in locomotor activity were explored using periodograms, diversity indices, and generalized linear mixed modelling. The average strength of activity, onset of activity, and acrophase were modulated by both nutritional and insemination status as well as by the light regimen. Inseminated females showed a significant excess of arrhythmic activity under DD. When rhythmicity was observed in DD, females displayed sustained activity during the subjective day. Insemination and gonotrophic status influence the underlying light and circadian control of chronobiological features of locomotor activity.

Keywords: *Anopheles coluzzii*, Field, Locomotor activity, Daily rhythms, Insemination, Blood and glucose intakes, Diversity

ABS-445

Spatio-temporal distribution of malaria cases following malaria control intervention between 2017 and 2023 in Mutasa District, Zimbabwe

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Over the last decade, the incidence of confirmed malaria has declined significantly in Mutasa District. Despite a relatively good national case reporting system, updated detailed maps of malaria distribution have not been publicly available. In this study, monthly surveillance records over the period 2017 – 2023 of malaria burden data by PfHRP2 based rapid diagnostic tests confirmed malaria parasite positive blood specimen, were used to produce maps of malaria distribution across the district. The maps show that Plasmodium falciparum malaria incidence has a marked seasonal variation and spatial heterogeneity over the district. During the peak season (April – May) the incidence is high and cases are concentrated along the north-east to south-west direction compared to fewer and heterogeneous distribution of cases in the rest of the district. The same pattern is observed during the low transmission season (July – November). This paper shows the value of spatiotemporal malaria case mapping for targeted intervention malaria risk assessment. As incidence of malaria changes over time, regular updates of these maps are necessary. In their application to national malaria control, these sub-national malaria risk can be used to prioritize and target interventions leading to a more appropriate allocation of resources and more efficient prevention and response

Keywords: Spatio distribution of malaria cases

ABS-447

A systematic literature search for asian anopheles bionomics to parameterise a mathematical model identifying key performance properties of novel vector-control tools for reducing malaria transmission

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In the Greater Mekong Subregion, situated within the WHO Southeast Asia region, multidrug-resistant Plasmodium falciparum malaria and insecticide resistance have been found, threatening elimination. The potential of tools to reduce malaria transmission likely depend of their modes of action, i.e. how they affect mosquitoes at various points of the feeding cycle, as well as the bionomics of the local vector populations. First, we perform a systematic literature search generating a dataset for the human blood index, parity rate, sac rate and resting period duration for five primary vector species in the region. To determine which of these bionomics influence the ability of mosquitoes to transmit malaria, we perform sensitivity analysis on an existing mathematical model of the mosquito feeding cycle. We then extend this sensitivity analysis to search for key performance properties (mortality while host seeking, reduction in biting, feeding inhibition, preprandial or postprandial killing) of potential new vector-control tools, increasing our understanding of how characteristics of tools affect malaria transmission. Finally, we compare how these properties reduce the vectorial capacity depending on the dynamics of the mosquito population. Significant differences were found between the bionomics of the Anopheles species. Additionally, the HBI was significantly influenced by the season, location (indoors/outdoors), trapping method and local personal protection usage, and parity rate was significantly influenced by season, location, trapping method, climate, land cover type and current insecticide control usage. These bionomics significantly influence the ability of vector-control tools to reduce the transmission of Plasmodium falciparum malaria (Future work: estimated completion date end of June). This work may help guide design of novel vector-control tools and suggest suitable use cases based of the local vector populations.

Keywords: Malaria, Anopheles, Mathematical model, Vector control

ABS-449

Local adaptation and colonization are potential factors affecting sexual competitiveness and mating choice in Anopheles coluzzii populations

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The mating behaviour of the malaria vector Anopheles gambiae complex is an important aspect of its reproduction biology. The success of mosquito release programmes based on genetic control of malaria crucially depends on competitive mating between both laboratory-reared and wild individuals, and populations from different localities. It is known that intrinsic and extrinsic factors can influence the mating success. This study addressed some of the knowledge gaps about factors influcencing mosquito mating success. In semi-field conditions, the study compared the mating success of three laboratory-reared and wild allopatric *An. coluzzii* populations originating from ecologically different locations in Burkina Faso. Overall, it was found that colonization reduced the mating competitiveness of both males and females compared to that of wild type individuals. More importly, females were more likely to mate with males of their own population of origin, be it wild or colonised, suggesting that local adaptation affected mate choice. The observations of mating behaviour of colonized and local wild populations revealed that subtle differences in behaviour lead to significant levels of population-specific mating. This is the first study to highlight the importance of local adaptation in the mating success, thereby highlighting the importance of using local strains for mass-rearing and release of *An. coluzzii* in vector control programmes.

Keywords: *Anopheles coluzzii*, Swarming, mating behavior, malaria

ABS-458

No evidence for long range male sex pheromones in two malaria mosquitoes

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Cues involved in mate seeking and recognition prevent hybridization and can be involved in speciation processes. In malaria mosquitoes, females of the two sibling species, *Anopheles gambiae* and *An. coluzzii,* often found in sympatry, mate in spatially segregated species-

specific male swarms and hybrids are rare. This suggests the existence of strong pre-mating reproductive barriers between these species. The involvement of long-range sex pheromones in mating behavior in Anopheles species have been debated in literature but to date, no study has provided strong evidence. Here, we attempted to bring to light the existence of male sex pheromones driving the assortative mating between *An. gambiae* and *An. coluzzii.* To put all the odds in our favor, we used different chemical ecology methods. First, we investigated the long-range behavioral response of females exposed to headspace of male swarms in an olfactometer. Second, we collected and analyzed volatile organic compounds (VOCs) with different methods on both laboratory-induced swarms and natural swarms. And third, we tested for an electroantennographic response of females to male swarm VOCs. We used both recently colonized mosquitoes and large experimental set-ups to ensure males produced a free swarming behavior. Behavioral analyze did not show an attraction of females to male swarms. In the chemical analyses, no specific compound was found in the swarm extracts. And in the electrophysiological analyze, female antennae did not show a detection for any specific compound in the swarm extracts. Despite all our efforts, our results support the absence of long-range sex pheromones involved in swarm detection and recognition by females in *An. gambiae* and *An. coluzzii*. This finding has an importance in ecology, evolution and control strategies of malaria vectors. Moreover, the question of how Anopheles females seek male swarms is still open.

Keywords: Anopheles, male swarm, mating behavior, mate seeking, chemical cues

ABS-464

Finding paternally and maternally deposited transcripts in Anopheles early embryos

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In recent years, a lot of progress has been made to molecularly decipher development and sex-determination in Anopheles mosquitoes. However, the molecular mechanisms driving the very early stages of embryogenesis remain poorly understood. In the first hours, the newly formed mosquito zygote genome remains transcriptionally inactive, and the early development is controlled by maternally deposited RNAs and proteins. Little is known about the transition to the transcriptionally active zygote genome, or about the potential paternal contribution of transcripts to the early embryo. Investigating these phenomena can provide fundamental insights for the understanding of the processes that drive genome activation and early embryo development. Moreover, the identification of parentally deposited transcripts is of great interest for the generation and improvement of genetic control strategies of these malaria vector

mosquitoes. Modelling data show encouraging results on the use of technologies based on the deposition of toxins in the embryos. Identification of maternally and paternally deposited transcripts would open up a range of possibilities to use their regulatory sequences in genetic control strategies where deposition of elements would be desirable either from males, from females or from both. To investigate this, we set up genetic crosses of *Anopheles gambiae* males with *Anopheles arabiensis* females and extracted the RNA from 1-hour-old embryos (zygote genome activation in Anopheles occurs around 2 hours post-oviposition). Since the aim was to find not only deposited mRNAs but also non-coding RNAs, we performed RNA sequencing with ribosomal RNA depletion. We then used markers of genetic variation between these two species to assign the paternal or maternal origin of the transcripts found in the embryos. This allowed us to identify genes that are paternally and maternally deposited in Anopheles, and to discover yet unannotated transcripts and isoforms.

Keywords: Anopheles, vector control, genetic control, mosquito biology, malaria, embryo development, RNA seq

ABS-465

Intensity of insecticide resistance in the population of the Anopheles gambiae complex that breeds in riverbeds during the dry season in Mali.

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Insecticide resistance threatens insecticide-based malaria vector control tools. Surveillance of insecticide resistance and the genetic mechanisms underlying it is essential to mitigate insecticide resistance. This study assessed the levels of insecticide resistance of *Anopheles gambiae s.l.* populations that breed in the Niger Riverbed in the Dangassa region during the long dry season*. Anopheles gambiae*

s.l. larvae were collected from larval sites created in the riverbed following water withdrawal and transported to the insectarium in Bamako and raised to the adult stage. Unfed two- to five-day-old female F0 mosquitoes were exposed to deltamethrin-impregnated paper at doses of 1X, 5X and 10X to determine resistance intensity. In addition, they were exposed to DDT, bendiocarb and pirimiphos-methyl at their respective diagnostic doses to assess their susceptibility to these insecticides. Synergistic tests were also performed to determine metabolic resistance. The populations of *An. gambiae s.l*. were fully susceptible to carbamates and organophosphates, but resistant to pyrethroids and organochlorines. The intensity of resistance to pyrethroids (deltamethrin) was very high with mortality rates of 1.0%, 71.1% and 80.3% at concentrations of 1X, 5X and 10X, respectively. Pre-exposure to piperonyl butoxide (PBO) synergist did not fully restore sensitivity to deltamethrin (mortality = 68.2%, $p < 0.0001$). The resistance of *An. gambiae s.l.* with pyrethroid insecticides is very intense. This could threaten the effectiveness of long-lasting insecticide-treated nets (LLINs) containing pyrethroids currently used for malaria vector control in Mali. This breeding population of *An. gambiae s.l*. surviving to the dry season will certainly contribute to the spread of resistant strains at the beginning of the rainy season in areas bordering the Niger River.

Keywords: *Anopheles gambiae s.l*., malaria vector, insecticide, resistance, Mali

ABS-262

Effectiveness of three long-lasting insecticidal nets (LLINs) with pyriproxyfen-pyrethroid, chlorfenapyr-pyrethroid or piperonyl butoxide-pyrethroid versus a pyrethroid-only LLIN, against malaria in Tanzania: third year results of a four-arm cluster rando

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Pyrethroid long-lasting insecticidal nets (PY-LLINs) have contributed considerably to the decline in malaria morbidity and all-cause mortality across sub-Saharan Africa. Recent reductions in malaria cases have stalled due to the widespread distribution of pyrethroid resistance in malaria vectors. In response, a new class of LLINs combining mixtures of active ingredients comprising two insecticides or a pyrethroid plus a synergist, has been developed. These nets demonstrated better effectiveness compared to standard LLINs on malaria outcomes for one or two years. In this paper, we report the performance of the 3 new dual active ingredients LLINs against malaria prevalence, vector density and malaria transmission by pyrethroid-resistant vectors, over three years of community use in Tanzania. A third year of follow-up of a four-arm cluster-randomized controlled trial of dual LLINs was conducted between 2021 and 2022 in Mwanza Region, Tanzania. Restricted randomization was used to randomly assign 84 clusters to one of the four LLIN groups to receive either standard PY-LLINs (reference), chlorfenapyr-PY LLINs, pyriproxyfen-PY LLINs or piperonyl butoxide (PBO)-PY LLINs. The primary outcome was malaria infection prevalence in children at 30- and 36-months post LLIN distribution. Analysis was done using intention-to-treat (ITT). A stronger effect was observed at 36 months in arms receiving the chlorfenapyr-PY LLINs compared to standard PY-LLINs. Significant difference was observed in the entomological inoculation rate EIR and Anopheles vector density in houses deployed with chlorfenapyr-PY LLINs relative to houses under standard LLIN arm. There was weak evidence of a difference in epidemiological and entomological outcomes in arms receiving other nets during the third year of follow up. Protective efficacy against malaria offered by chlorfenapyr-PY LLINs was still superior to standard-PY LLINs over a three-year LLIN lifespan.

Keywords: Malaria, LLINs.

ABS-22

Contributions of nitrate enrichment to larval growth indices, insecticide susceptibility and resistance enzymes profile of *Aedes aegypti* (Diptera: Culicidae) mosquito

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This study was informed by the growing need to understand the roles of agricultural farm inputs in mosquito development and resistance to insecticides. To this end, graded nitrate enrichment was assayed on Aedes aegypti to determine its effects on larval growth indices,

insecticide resistance, and enzyme profiles. Newly hatched-out larvae of Ae. aegypti were reared in graded (0, 4, 16, 64, 256, and 1024 mg/L) levels of nitrate solutions till adulthood. Entomological variables (larval growth rates, LGR, duration of development, DD, and immature survivorship, IS) were determined. Susceptibility of adult mosquitoes from the treatments to WHO insecticide-impregnated papers (Permethrin 0.05%) was evaluated following WHO protocols and analyzed for resistance enzyme profile (Esterase and Glutathione S Transferase, GST) and nutritional reserves (protein, lipid, glycogen, and glucose) following standard methods. The mosquitoes reared at 16 mg/L had the highest LGR. Nitrate enrichment affected the DD of all larval instars except first larval instars. Development was faster at lower concentrations (range = 8.28±0.31 to 8.85±1.48 days) and slower at higher concentrations (range = 10.30±0.41 to 11.18±0.59 days). Immature life-stage survivorship was high (> 95 %). Susceptibility to permethrin and enzyme levels decreased with increase in nitrate concentration. Quantities of nutritional reserves were not affected by nitrate levels. This study has revealed the contributions of nitrate enrichment on entomological attributes of epidemiological importance. The information will be vital in developing cost-effective control strategies and habitat manipulation protocols.

Keywords: Agricultural inputs, duration of development, growth rates, nutritional reserves.

ABS-135

Impacts of armed conflict for malaria prevention and elimination programs in Ethiopia: a time-series analysis

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Ethiopia has experienced several conflicts during the last several years that have negatively impacted its health systems. This study aims to assess the impact of the conflicts in Northern Ethiopia on malaria prevention and elimination efforts, as well as the malaria surveillance system. We used routine district health information system data to quantify the changes in the levels of malaria prevention and control services from 2019 to 2021. We used interrupted time-series analysis and descriptive statistics to estimate the changes in intervention levels within the conflict-affected and surrounding districts. The routine malaria surveillance data showed that the reported national

malaria cases increased by 20% from 2019 to 2021. Disruptions were found to vary across zones and districts with clear patterns by the intensity and duration of the conflict. There was a significant difference in test and incidence rates between affected areas and surrounding affected/not affected areas. While data limitations made it difficult to describe the level of disruptions to malaria prevention and elimination measures during the conflict (particularly in conflict-affected areas), these findings highlight a strong variation in the malaria incidence between conflict-affected and unaffected areas. Our study highlights the importance of peace and stability and preserving a functioning health system to sustain Ethiopia's progress toward malaria elimination targets.

Keywords: Ethiopia, conflicts, malaria-elimination,

ABS-140

Can nitrogen environments be useful in mass-irradiation of adult Aedes mosquitoes for SIT programs?

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The developmental stage of the mosquito is one of the main factors that affect its response to ionizing radiation. Irradiation of adults has been reported to have beneficial effects. However, the main challenge is to immobilize and compact a large number of adult male mosquitoes for homogenous irradiation with minimal deleterious effects on their quality. The present study investigates the use of nitrogen in the irradiation of adult Aedes albopictus and Ae. aegypti. Irradiation in nitrogen (N2) and in air after being treated with nitrogen (PreN2) were compared with irradiation in air at gamma radiation doses of 0, 55, 70, 90, 110, and 125 Gy. In both species, approximately 0% egg hatch rate was observed following doses above 55 Gy in air versus 70 Gy in PreN2 and 90 Gy in N2. Males irradiated at a high mosquito density showed similar egg hatch rates as those irradiated at a low density. Nitrogen treatments showed beneficial effects on the longevity of irradiated males for a given dose, revealing the radioprotective effect of anoxia. However, irradiation in N2 or PreN2 slightly reduced the male flight ability. Nitrogen treatment was found to be a reliable method for adult mosquito immobilization. Overall, our results demonstrated that nitrogen may be useful in adult Aedes mass irradiation. The best option seems to be PreN2 since it reduces the immobilization duration and requires a lower dose than that required in the N2 environment to achieve full sterility but with

similar effects on male quality. However, further studies are necessary to develop standardized procedures including containers, time and pressure for flushing with nitrogen, immobilization duration considering mosquito species, age, and density.

Keywords: Sterile insect technique, irradiation, Aedes aegypti, Aedes albopictus, anoxia

ABS-151

Optimizing the attractiveness of Host Decoy Traps to malaria vectors with artificial odours and visual features.

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Malaria vector surveillance tools often incorporate features of hosts that are attractive to mosquitoes. Recently developed Host Decoy Trap (HDT) combines visual, thermal, and olfactory stimuli associated with human hosts and has shown great efficacy in terms of collecting vectors. Synthetic odors and artificial carbon dioxide (CO2) could prove useful by mimicking the human odor currently used in HDTs. This study aimed to test the attractiveness of various artificial olfactory cues in HDTs to capture malaria vectors. We compared four different odor treatments in outdoor field settings in southern Benin and western Burkina Faso: (1) the standard HDT using whole natural human odor from a person, (2) HDT with artificial CO2, (3) HDT with artificial odor and (4) an HDT with artificial CO2 plus artificial odor. In both country settings, the standard HDT produced the greatest catch of An. gambiae mosquitoes. Of the HDTs baited with artificial odor sources, the most effective included carbon dioxide, either alone (Benin) or in combination with synthetic odor (Burkina Faso). The trap using synthetic human odor alone caught fewer An. gambiae s.l. than the other artificially baited traps. Both *An. coluzzii* and An. gambiae were caught by all traps, with a predominance of *An. coluzzii*. Although using odor naturally produced by a real person resulted in the greatest mosquito catch, the artificial alternatives tested here were still effective at collecting target vector species and could therefore represent a cost-effective approach for a robust integrated vector monitoring strategy. Artificial odor alone, without carbon dioxide, did not appear to be sufficient to induce landing on the HDT, despite the presence of other attractive stimuli. Sustainable methods for CO2 production for use in field monitoring of hematophagous insects should be prioritized.

Keywords: Synthetic human odor, carbon dioxide, *An. gambiae* mosquitoes, host decoy trap, malaria vector surveillance

ABS-272

Integrated vector management making emphasis in the use of biolarvicides for Malaria Control in two provinces of Angola.

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The arrival of the SARS-CoV-2 virus and the global health crisis triggered by the COVID-19 pandemic has jeopardized the strategy to fight malaria in many countries. The interruption of prevention, diagnosis, treatment, and financing services caused an increase in cases and deaths from this disease in sub-Saharan Africa in this period. However, countries where malaria is endemic made efforts to maintain services during the pandemic, such as the Republic of Angola. The objective is to show the vectorial reduction with stratified prevention actions with the use of biolarvicides and adulticides, based on an epidemiological stratification criterion in the period 2019 - 2021. Work was done in 1445 neighborhoods of Luanda and Huambo in an integrated manner with municipal health directorates. Approximately 96,000 breeding sites near communities were identified and treated. The main species collected were *Anopheles gambiae* sl, *Culex quinquefasciatus* and *Aedes aegypti* in ditches, puddles, and tanks. The biolarvicides Bactivec® and Griselesf® were applied at doses of 2 – 5 ml/m2. Significant larval reductions (≥ 90%) were achieved in the worked areas. The malaria incidence rate was not affected by the pandemic in both provinces in the 2019-2020 period; however, a comparative analysis with the year 2021 showed an increase of 50% and 200% respectively, evidencing the impact of Covid-19 on the reduction of vector prevention activities and on the disease.

Keywords: IVM, Biolarvicides, Malaria

ABS-150

Compliance of sentinel laboratories on good practices for carrying out antibiotic susceptibility tests within Burkina Faso national AMR surveillance network.

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The standardization of procedures is a best way to harmonize and strengthen the quality of laboratory-based surveillance for antimicrobial resistance. Since 2018, Burkina Faso has developed and disseminated the national manual of procedures for performing antibiotic susceptibility tests in sentinel laboratories within its national AMR surveillance network. Our study's objective was to assess these sentinel laboratories' compliance with good practices for carrying out antibiotic susceptibility tests. This cross-sectional study lasted from September 19 to 28, 2022. A technical committee has been set up to design and validate the evaluation tool, composed of four Excel sheets. Emphasis had been placed on carrying out quality controls on culture media, antibiotic disks, and compliance with the procedure for carrying out the ASTs, by the laboratories. Excel software was used for data recording, graphs and tables design. Free R software version 4.2.0 was used to perform descriptive statistics. An overall score below 80% was considered noncompliance. The participation rate of antimicrobial resistance sentinel site laboratories in the evaluation was 94.74% (18/19). Among the 18 sentinel laboratories, 83.33% (15/18) carried out at least one quality control activity on culture media, 66.67% (12/18) conducted at least one quality control activity on antibiotic disks. The results of compliance assessment of the antimicrobial susceptibility tests according to the modified Kierby Bauer method revealed that 76.47% (13/17) of the laboratories had compliance rate higher than 80%. The evaluation revealed non-conformities with the national manual of procedures for performing at the level of sentinel laboratories, particularly in the quality control component.

Keywords: Compliance, antibiotic susceptibility tests, quality control, Sentinel laboratories, Burkina Faso

ABS-198

Investigating anti-filarial potential of Microsporidia in *Anopheles gambiae* within Ahmadu Bello University, Zaria-Nigeria.

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Mosquitoes are responsible for transmitting multiple disease parasites including malaria parasites (*Plasmodium falciparum*), and filariasis parasites (*Wuchereria bancrofti*). Nigeria is regarded as the highest malaria and third filariasis endemic country with about 39.1 % of global death from malaria. *Anopheles gambiae* is one of the species of mosquitoes that spreads *P. falciparum* and *W. bancrofti* in sub-Saharan Africa. Recently, a new species of Microsporidia known as *Microsporidia MB* was discovered in Kenya and unveiled to prevent the survival of *P. falciparum* in *An. arabiensis*. Even though *An. gambiae* transmit both *P. falciparum* and *W. bancrofti* but the link between Microsporidia and *W. bancrofti* is yet to be investigated in *Anopheles gambiae*. About 914 mosquitoes were collected using an aspirator from the field and *An. gambiae* are identified with their morphological keys. The *Anopheles gambiae* were dissected for microscopic identification *of W. bancrofti* and Microsporidia with 5 % Giemsa and 2% fast grain respectively. PCR further confirmed the presence of Microsporidia MB in the Microsporidia-positive samples. SINE200 PCR was used for the identification of the siblings of the An. gambiae. A total of 124 *An. gambiae* are identified from the collected samples of mosquitoes. Molecular identification of the siblings revealed 29 % are *Anopheles colluzzii* and 57 % are *Anopheles arabiensis* in the study location. About 9.7 % and 12.1% of the *Anopheles gambiae* are infected with *W. bancrofti* and Microsporidia respectively. Interestingly, the findings revealed that Microsporidia infected *An. gambiae* do not coinfected with *W. bancrofti*. The result shows that the presence of Microsporidia in *An. gambiae* prevent the presence of *W. bancrofti* and this may serve as an avenue for unlocking the potential of Microsporidia in preventing filariasis transmission in the endemic area.

Keywords: Microsporidia*, Wuchereria bancrofti*, *Anopheles gambiae*

ABS-19

Houses improving as a supplemental intervention tool for reducing indoor vector densities and malaria prevalence in Emana, Center Cameroon.

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Improvement of typical rural houses can effectively reduce indoor vector densities and consequently malaria transmission. We assessed this supplemental control effects in a MILDA low coverage area of Centre, Cameroon. 16 houses were firstly selected based on their indoor density of resting malaria vectors. Half of them randomly chosen for eaves screens (experimental) with fiberglass coated wire mesh and half left unscreened (control). Entomological baselines were collected monthly in both groups. Outdoors and indoors adult mosquitoes were sampling for entomological data collection in each houses using human landing catch (HLC). Malaria prevalence surveys were

conducted after mosquitoes sampling in both groups. A total of 300 mosquitoes were collected over six months period using HLC in 16 houses (mean mosquitoes =18.75). Among *An. funestus*, 63.9% were unfed, 32.9% blood fed, 0.39% gravid and 1.56% half gravid females. 17.7% of *An. gambiae* were unfed and 82.2% blood fed. More indoor adult mosquitoes were collected in the control (n=74) than experimental houses (n=56). Parasitological surveys result to relatively low malaria parasite prevalence rates in screened houses compared to the control houses. Overall, malaria prevalence was 57.8% (95% CI: 0.32-0.74) n=90, with baseline prevalence rate of 58.5% (95% CI: 0.67-1.13), n=65 and 2nd follow-up survey prevalence of 42.0% (95% CI: 0.52-0.76) n=66. At all the two parasitological follow-up survey points, house screening significantly reduced the malaria prevalence by 43% ($p< 0.001$). Housing improvement has potential to reduce indoor vector densities and malaria prevalence.

Keywords: Housing improvement, Anopheles density, eaves screened, malaria prevalence, Cameroon.

ABS-22

Contributions of nitrate enrichment to larval growth indices, insecticide susceptibility and resistance enzymes profile *of Aedes aegypti* (diptera: culicidae) mosquito

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This study was informed by the growing need to understand the roles of agricultural farm inputs in mosquito development and resistance to insecticides. To this end, graded nitrate enrichment was assayed on *Aedes aegypti* to determine its effects on larval growth indices, insecticide resistance, and enzyme profiles. Newly hatched-out larvae of *Ae. aegypti* were reared in graded (0, 4, 16, 64, 256, and 1024 mg/L) levels of nitrate solutions till adulthood. Entomological variables (larval growth rates, LGR, duration of development, DD, and immature survivorship, IS) were determined. Susceptibility of adult mosquitoes from the treatments to WHO insecticide-impregnated papers (Permethrin 0.05%) was evaluated following WHO protocols, and analyzed for resistance enzyme profile (Esterase and Glutathione S Transferase, GST) and nutritional reserves (protein, lipid, glycogen, and glucose) following standard methods. The

mosquitoes reared at 16 mg/L had the highest LGR. Nitrate enrichment affected the DD of all larval instars except first larval instars. Development was faster at lower concentrations (range = 8.28±0.31 to 8.85±1.48 days) and slower at higher concentrations (range = 10.30±0.41 to 11.18±0.59 days). Immature life-stage survivorship was high (> 95 %). Susceptibility to permethrin and enzyme levels decreased with increase in nitrate concentration. Quantities of nutritional reserves were not affected by nitrate levels. This study has revealed the contributions of nitrate enrichment on entomological attributes of epidemiological importance. The information will be vital in developing cost-effective control strategies and habitat manipulation protocols.

Keywords: Agricultural inputs, Duration of development, Growth rates, Nutritional reserves

ABS-225

Impact of Climate Change on Malaria Transmission in N'Djamena/Chad

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Climate change is considered as the greatest health threat and one of the most important challenges of the century. According to WHO, Africa's vulnerability to climate change and malaria could occur 60,000 additional deaths between 2030 and 2050. In Chad, malaria is the primary reason for consultation despite the implementation of several means of prevention. The city of N'Djaména, located in the Sahel zone, undergoes three to four months of rain per year (July to October), which corresponds to the period of high density of anopheles and therefore to high malaria transmission. However, in recent years, the city has been subject to flooding, which has lengthened the transmission period, since Anopheles are observed even in the dry season. It is therefore essential to assess the impact of climate change on malaria transmission in this city in order to strengthen prevention strategies. The study was carried out in four neighborhoods selected according to whether they were affected (Walia, Toukra) or not (Gabo 2, Goudji Charaffa) by flooding. Anopheles were collected after insecticide spraying in 10 rooms per day for three consecutive days per neighborhood/month from December 2022 to March 2023.

Anopheles were captured much more in the flooded neighborhoods 511 in Walia, 495 in Toukra than in the non-flooded neighborhoods 291 in Gabo 2 and 228 in Goudji Charaffa and more than half of the Anopheles captured were either gorged, semigravid or gravid. Climate change has lengthened the duration of the malaria transmission season in N'Djamena by almost four months. This situation calls for the

national malaria control program to review its planning with respect to malaria control inputs, to strengthen the awareness of the population to adopt preventive measures, and to encourage donors to support control efforts.

Keywords: Malaria, Climate Change, Surveillance, Sahel

ABS-469

Insecticide resistance status of *Anopheles gambiae sensu lato* at different districts of Uganda

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Vector control is a key intervention to achieve remarkable decline and sustaining the gains in malaria control. Uganda has in the last decade scaled up population level malaria vector control interventions notably, insecticidal treated nets (ITNs) and Indoor Residual Spraying (IRS). These interventions are threatened by emerging and spreading insecticide resistance in Ugandan malaria vectors. This study investigated insecticide susceptibility, resistance intensity, and oxidase detoxification in *Anopheles gambiae* sensu lato to commonly used public health insecticides in 17 Ugandan districts. The susceptibility status of *An. gambiae* to pyrethroids, organophosphates, neonicotinoids, pyrroles and carbamates was determined using the WHO (World Health Organization) bottle bioassay and WHO test kits. Presence of oxidative enzyme detoxification mechanisms were determined by pre-exposing mosquitoes to piperonyl butoxide followed with exposure to discriminating doses of pyrethroids coated bottles and WHO test kits. Resistance intensity was investigated using serial dosages of 1×, 5× and 10× the diagnostic dose and scored at 24 hours' post-exposure to determine the magnitude of resistance to these insecticides. Testing occurred in 17 districts of Uganda in 2021 and 2022. There is confirmed resistance to pyrethroids across all districts and high-intensity resistance to pyrethroids in most districts where tests were conducted. PBO synergist bioassays fully or partially restored susceptibility to pyrethroids in some districts. Susceptibility to Clothianidin, Chlorfenapyr and Pirimiphos-methyl was noted across all districts tested. Resistance to bendiocarb seems to be emerging. Widespread resistance to pyrethroid insecticides imparts deployment of dual AI nets and PBO nets based on vector susceptibility status to pyrethroids in 17 districts. For IRS, clothianidin-based products may be used in rotation with Actellic 300CS.

Keywords: Insecticide resistance Uganda

ABS-532

Association of 410L, 1016I and 1534C kdr mutations with pyrethroid resistance in Aedes aegypti from Ouagadougou, Burkina Faso, and development of a one-step multiplex PCR method for the simultaneous detection of 1534C and 1016I kdr mutations

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Since 2000, Burkina Faso has experienced regular dengue cases and outbreaks, making dengue an increasingly important health concern for the country. Previous studies in Burkina Faso reported that resistance of Aedes aegypti to pyrethroid insecticides was associated with the F1534C and V1016I kdr mutations. The current study reports high resistance of Ae. aegypti populations to pyrethroid insecticides, likely supported by mutations in the voltage-gated sodium channel, here evidenced by genotyping the kdr SNPs V410L, V1016I and F1534C. We also describe a new multiplex PCR-based diagnostic of F1534C and V1016I kdr SNPs. Larvae of Ae. aegypti were collected from three health districts of Ouagadougou in 2018. The resistance status of Ae. aegypti to permethrin (15 µg/ml) and deltamethrin (10 µg/ml) was tested using bottles, and to malathion (5%) using WHO tube tests. All bioassays used 1-h exposure and mortality recorded 24 h post-exposure. Bioassay results were interpreted according to WHO thresholds for resistance diagnosis. The kdr mutations were screened using AS-PCR and TaqMan methods in exposed and non-exposed Aedes mosquitoes. Females mosquitoes from all health districts were resistant to permethrin and deltamethrin (<20% mortality) but were fully susceptible to 5% malathion. The F1534C and V1016I kdr mutations were successfully detected using a newly-developed multiplex PCR in perfect agreement with TaqMan method. The 1534C/1016I/410L haplotype was correlated with permethrin resistance but not with deltamethrin resistance, however, the test power was limited by a low frequency of dead individuals in deltamethrin exposure. Resistance to pyrethroid insecticides is associated with kdr mutant haplotypes, while the absence of substantial resistance to malathion suggests that it remains a viable option for dengue vector control in Ouagadougou.

Keywords: *Aedes aegypti*, pyrethroids, resistance, malathion, multiplex PCR, kdr, Burkina Faso, dengue

ABS-483

Natural Microsporidia MB infection in field-collected Anopheles species in different agro-ecological areas and land use in Kenya

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Recent studies in Kenya have shown that Microsporidia MB, a vertically transmitted endosymbiont in mosquitoes, interrupts the development of Plasmodium in *Anopheles arabiensis* to block its transmission. However, these studies have been conducted using *An. arabiensis* sampled in two areas of Kenya where large-scale rice irrigation is practiced and characterized by humid and semi-humid climates. However, malaria is transmitted by a wide variety of *Anopheles* in areas of different climates and land use practices. In this study we investigated whether Microsporidia MB occurs in Anopheles species in irrigated and non-irrigated sites located in different agro-ecological zones in Kenya. In May-June 2022, transect sampling was used to sample Anopheles larvae and adults in irrigated and non-irrigated sites in humid, semi-arid and arid agro-ecological zones in Kenya to investigate the occurrence of Microsporidia MB in Anopheles in these areas. Microsporidia MB was found in both larvae and adult *An. gambiae* s.s., *An. arabiensis*, and *An. funestus* s.s. sampled in all the three agro-ecological sites. Microsporidia MB also occurred in adult *An. pharoensis* in humid agro-ecological sites. In adult Anopheles, the occurrence of Microsporidia MB was higher in semi-arid than in humid and dry agro-ecological zones while in larvae it was higher in the humid than the semi-arid and arid climates. In all the three agro-ecological zones there was a higher occurrence of Microsporidia MB in Anopheles sampled in irrigated sites than non-irrigated sites. Results show that Microsporidia MB naturally occurs in a variety of Anopheles species in different agro-ecological areas and land use practice. Findings suggest that the novel strategy of using Microsporidia MB would be suitable as a complementary tool of malaria control in different agro-ecological settings. Studies to compare the occurrence of Microsporidia MB in rainy and dry seasons are required.

Keywords: Anopheles, Microsporidia MB, Agro-ecological zone

ABS-486

New application technology for vector control in Kenya. Experience in the operational use of drones for the application of biolarvicides on breeding sites at Busia county.

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The control of the primary stages of Malaria vectors in Africa represents a challenge due to his presence in large breeding sites, such as rice fields, swamps and stagnant waters in bushes and flooded areas near communities. Busia is the leading county in Malaria infections in Kenya at 39% prevalence. The End Malaria Council Kenya (EMC) has rolled out the use of Biolarvicides drone sprays in effort to combat

Malaria in Busia county, using an approved drone operator company to conduct the applications. With the goal of conducting larviciding of the large breeding sites (BS), and aiming to validate the spraying of these, applications with the Agras T20 drone model were carried out on 2022 and 2023 characterization of the BS was conducted to collect Anopheles larvae and to define the Biolarvicides dose to apply. Additionally, calibrations of the drone's operational parameters were carried out. All the BS identified as positive were treated (60), ranging from 2-10 ml/m2 of active surface. More than 5,2 km2 of active surface were spreayed with the biolarvicides, achieving significant reduction of the larval populations (97,3% average). The results are important to validate the applications by using the drone Agras T20. The mortality at the treated BS, the easy operation and handling, as well as the capacity to cover large extensions reducing operational complications and time while reaching hard access BS, is evidence of the potential of this technology for LSM.

Keywords: Drone, biolarvicides, Malaria, breeding sites

ABS-491

Creating geospatial disease heat maps using routine HMIS data and DHIS2

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DHIS2 is a software application that works with country's Health Management Information System (HMIS) to provide effective mechanism to collect, aggregate and disseminate routine HMIS data in a country. DHIS2 application is used in over 73 countries worldwide and with more additional countries continuing to adapt broadly. Despite it's broad use and potential, some researchers have questioned quality of the data coming from the DHIS2 database, in particular in relation to data incompleteness, implausible values due to data entry errors, and duplicates records. In this paper, we use DHIS2 data to create geospatial disease heat maps for Tanzania mainland and assessed its quality relative to other empirical studies. We downloaded data from the DHIS2 OPD dataset containing data element names and values. We grouped the data and values by health outcome categories. We limited the data between the period 2015 to 2019 and calculated total number of disease diagnoses for each of the defined health outcome category per 1000 population per year and by average. We assigned a semi-quantitative measure of (none)/low/medium/high to each calculated value using quartile (equal counts) method from QGIS (QGIS 3.4, 2020) and created geospatial disease heat maps to represent council-level variation for each health outcome category. The result shows that there is heterogeneity from disease group indicators across different councils in the Tanzania mainland. Of interest, the distribution of malaria diagnoses across Tanzania mainland shows a high-density of malaria along the north-west and south-east. This similar to that of Malaria Indicator Survey 2017 and other empirical studies. This exploratory analysis reveal that DHIS2 data has potential to contribute to scientific research and empirical studies. We urge for more collaboration between MoH and public heath researchers to further promote its use

Keywords: routine HMIS, DHIS2, disease reporting, spatial data

ABS-492

Efficacy and persistence of Spinosad (Natular DT) against wild *Aedes aegypti* larvae in Port Sudan, Eastern Sudan

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The mosquito *Aedes aegypti* is the primary vector of dengue fever Chikungunya, Zika viruses, which are responsible for high human morbidity and mortality. In 2022-2023, dengue fever is became the most important Aedes borne disease and represents a major public health problem in Sudan. The dengue disease and its vector are widely and rapidly spread to new areas subsequently has been found in many States of Sudan including Khartoum State. Vector control remains the principal method to combat dengue fever. New tools safer for humans in addition to conventional larvicides and adulticides are becoming increasingly important for control of dengue vector and mitigation of dengue transmission. In a semi-field study, spinosad tablet formulation potency was tested against *Aedes aegypti* larvae in earthen Jars filled with fresh water in comparison to an untreated control. Cohorts of late third instars of *Aedes aegypti* were introduced into these containers on weekly basis. Mortality was recorded after 48 h following exposure of *Aedes* mosquito larvae to spinosad. The late effect of spinosad on adult emergence was monitored weekly and up to eight weeks. The mortality in treated *Aedes aegypti* larvae during the evaluation period was 100% from week 1 up to week 5, 99.9%, 93.6%, 90.7% in week 6,7, 8 respectively. This is the first experiment to evaluate the efficacy of spinosad in Sudan. Spinosad proved highly effective and showed significant larvicidal activity (> 90.0%) and persist against *Aedes aegypti* mosquitoes for up to 60 days; hence, the candidate mosquitoes were considered susceptible. Spinosad is a promising larvicide and may be used as part of larval source management programmes for reducing mosquito density and combating dengue fever.

Keywords: *Aedes aegypti*, dengue fever, larvicide, mosquito control, Sudan

ABS-505

Vector-borne diseases in dog in a One Health context in Morocco: Study of the vector population and transmitted pathogens - preliminary results

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Vector-borne canine diseases are caused by a range of infectious agents transmitted by blood-sucking arthropods, including mosquitoes, ticks, Culicoides and sandflies. In addition to their veterinary importance, some of these pathogens are of major public health concern and can even cause serious and potentially fatal diseases in humans. However, they are still underestimated and rarely studied in Morocco. This preliminary study focused on the sampling of arthropod vectors in dog shelters in four Moroccan regions (Rabat-Salé-Kénitra, Casablanca-Settat, Fès-Meknès and Béni Mellal-Khénifra) using specific traps: mini-CDC-light traps coupled with a CO2 source for mosquitoes, mini-CDC-incandescent light trap and castor oil-based sticky papers for sandflies and Onderstepoort type trap with UV light for Culicoides ; the collection of ticks was directly made from the dogs of the shelters. In parallel, blood samples were taken from 228 dogs. The study lasted from March to November 2022. All collected specimens were morphologically identified and stored at -80°C for further detection of pathogens using molecular analysis. A total of 10754 ticks belonging to the species *Rhipicephalus sanguineus (sensu lato)* were collected from 500 dogs, of which 52% were adults, 35% nymphs and 13% larvae. A total of 2316 individuals belonging to the genus Culicoides (14 species), 569 individuals of mosquitoes (3 species) and 475 individuals of sandflies (10 species) were collected and identified morphologically. *Culicoides imicola* constituted 54.8% of the total collection, *Culex pipiens* represented 95.9% of the species collected and *Sergentomyia minuta* (32.9%) and *Phlebotomus sergenti* (29.5%) were the two dominant species for sandflies. A great diversity of arthropods vectors of pathogens of veterinary and medical interest was observed during this study. These will be the subject of molecular investigations of potential transmitted pathogens.

Keywords: vector-borne diseases, arthropod vectors, dog shelters, One Health, Morocco

ABS-508

Spatio-temporal distribution and the underlying molecular mechanisms of insecticide resistance in the malaria vector *Anopheles gambiae*

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The emergence and spread of insecticide resistance (IR) in African malaria vector population poses a major threat to the effectiveness of control programmes, particularly insecticide-based interventions. Decoding patterns of evolution of insecticide resistance to major classes of insecticides (pyrethroids, carbamates, organochlorines, and organophosphates) is imperative to improving control strategies and informing public health policy interventions. To demonstrate the evolution of phenotypic and genotypic IR, we abstracted data from published literature and the IR Mapper database. Exploratory data analysis was performed to determine resistance-association and track their space-time spread using known resistance markers. First, dimensionality reduction using Singular Value Decomposition (SVD) and k-means clustering were applied to rasterized geospatial environmental and mosquito covariates. Second, a multi-locus agent-based model (ABM) of vector genetics that accounts for allele frequencies and genotype-to-phenotype mapping was applied to investigate IR in space and its evolution in time. We characterized resistance association in genetic markers with the four major classes of insecticides. Additionally, the ABM highlighted the spatial distribution of two knockdown resistant (kdr) resistance mutations in the Voltage-gates sodium channel (Vgsc) gene (Vgsc-995S and Vgsc-995F) in space and time. Conclusions: Decoding the underlying mechanisms of insecticide resistance in malaria vector populations' enables optimization of vector control strategies. While this model provides insight into the potential dynamics of the evolution of IR, they also inform national malaria control policy.

Keywords: *Anopheles gambiae*, insecticide resistance, agent-based model, malaria.

ABS-531

A multi-disciplinary approach for building common understanding of genetic engineering: Lessons learned from Target Malaria activities in Burkina Faso

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Gene drive technology is considered a powerful tool to boost malaria elimination goal. However, it effectiveness does not guarantee its acceptance and adoption by end- users. Collaboration between scientists and end-users is essential to the success of the development and implementation processes as well as increasing ownership of the technology. This paper, presents the outcome of a productive

collaboration between scientists and local stakeholders in deepening understanding around gene drive research. The collaborative method consists of an interactive process involving individual and group meetings, focusing on a two-way dialogue. The strategy was developed through reflective encounters, within the research team itself, and between the research team and local community members. Interactions between the research team and community members were mediated by local theatre artists and actors. The main outcome of the productive collaboration between scientists and local stakeholders led to the co-construction of the meaning for key concepts relating to genetic engineering. This common understanding of the scientific concepts generated awareness of the research activities in the community, which in turn, raised questions and or suggestions as to the best way the research could be conducted. Community feedback impacted the research process in various area such as the development of the agreement model for the release of genetically modified mosquitoes. The experience of collaboration showed that local stakeholders actively engaging in discussions on genetic engineering, offered useful input to the team. Their contributions relate to non-gene drive technology, but the experience is likely applicable to gene drive projects as well, a technology based on similar concepts.

Keywords: gene drive technology, social science, stakeholder engagement, collaboration, Burkina Faso

ABS-542

Increasing Insecticide Resistance Among Malaria Vectors in Tanzania

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Insecticide resistance is a serious threat to the effectiveness of insecticide-based malaria vector control measures, such as LLINS and IRS. We describe trends and dynamics of insecticide resistance to *Anopheles gambiae* s.l. across Tanzania from 2004 to 2020. The WHO standard protocols were used to assess susceptibility of the wild female *An. gambiae s.l*. to insecticides. Mosquitoes were exposed to diagnostic concentrations of permethrin, deltamethrin, lambdacyhalothrin, bendiocarb, and pirimiphos-methyl. WHO test papers at 5× and 10× the diagnostic concentrations were used to assess the intensity of resistance to pyrethroids; synergist tests using Piperonyl Butoxide (PBO) were carried out in pyrethroids resistant sites. To estimate insecticide resistance trends from 2004 to 2020, percentage mortalities from each site and time point were aggregated and regression analysis of mortality versus the julian dates of bioassays was performed. Percentage of sites with pyrethroid resistance increased from 0% in 2004 to > 80% in the 2020, suggesting resistance has been spreading geographically. Results indicate a strong negative association ($p = 0.0001$) between pyrethroids susceptibility status and

survey year. The regression model shows that by 2020 >40% of *An. gambiae* mosquitoes survived exposure to pyrethroids at their respective diagnostic doses. A decreasing trend of *An. gambiae* susceptibility to bendiocarb was observed over time (p = 0.8413) and exhibited high level of susceptibility to p-methyl. *Anopheles gambiae*, Tanzania's major malaria vector, is now resistant to pyrethroids across the country with resistance increasing in prevalence and intensity and spreading geographically. This calls for new tool to sustain the gains obtained in malaria vector control. Strengthening insecticide resistance monitoring is important for its management through evidence generation for effective malaria vector control decision.

Keywords: Insecticide resistance, Malaria vectors, Resistance trends, Tanzania

ABS-544

Non-residential spaces around houses are important sources of *Ae. aegypti* mosquito vectors in western and coastal Kenya

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Aedes aegypti is an important vector of dengue, Zika and chikungunya and other arboviruses. Non-residential spaces close to human dwellings are rarely targeted during vector control activities due to the endophilic and anthropophilic behavior of this vector. The current study assessed the importance of non-residential spaces in production of *Aedes aegypti* in two cities in Kenya: Ukunda (coastal Kenya) and Kisumu (Western Kenya). The two study sites were divided into eight 200x200M zones. Mosquitos were collected in each of the zones using (BG) traps and Prokopack aspirators from Oct 2020 through Jan 2022. Trapping by BG traps was done once every two months in each of the 8 zones/study site. Prokopack was done monthly in each of the 8 zones/study site. Results: In total, 2,887 and 4,148 *Ae. aegypti* mosquitoes were collected by BG traps and Prokopack, respectively. BG traps collected significantly more *Ae. aegypti* mosquitoes in non-residential spaces compared to residential spaces. Prokopack collected significantly more mosquitoes in residential spaces compared to non-residential spaces. In residential spaces and for both traps, abundance of *Ae. aegypti* mosquitoes was positively associated with houses with higher number of rooms (>8) and negatively with houses with surrounding vegetation/bushes. Additionally, the number of *Ae. aegypti* mosquitoes trapped by Prokopack were negatively associated with having a cemented floor and absence of domestic animals. In BG traps, presence of vegetation was positively associated with abundance of *Ae. aegypti* non-residential spaces. Our results indicate the substantial contribution of non-residential spaces to *Ae. aegypti* mosquito abundance. Presence of vegetation and the type of non-residential space influences mosquito abundance. Non-residential spaces near human dwellings are important targets for vector suppression interventions.

Keywords: abundance, *Ae. aegypti*, residential spaces, non-residential spaces

ABS-553

Larvicidal efficacy of the combination of *Citrus aurantiifolia* (Rutaceae), *Lippia chevalieri (Verbenaceae) and Hyptis spicigera* (Lamiaceae) methanol extracts against *Anopheles gambiae* Giles (Diptera culicidae)

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The growing resistance of mosquito vectors towards synthetic insecticides constitutes a major challenge in the malaria control and synergistic action of two or more extracts may decrease the risk of insect resistance. For that, singly and binary combination of Citrus aurantiifolia peels, Lippia chevalieri leaves (Verbenaceae) and Hyptis spicigera leaves methanolic extracts were tested on *Anopheles gambiae* larvae in the laboratory. Extraction yields were 6.72, 4.62 and 6.92% for *C. aurantiifolia, L. chevalieri* and *H. Spicigera* respectively. Saponins, terpenoids, flavonoids, tannins and polyphenols were present in the extracts of the 3 plants except flavonoids in *H. spicigera* extract. The 3 plant extracts tested singly or in combination caused a significant concentration-dependent larvicidal activity ($P<0.001$) after 24 h post-exposure. C. *aurantifolia* peels was revealed as the most potent against the mosquito larvae (LC50 = 9.82 mg/mL), while the binary combination 50%Ca + 50%Lc induced a synergistic action against mosquito larvae. Thus, the combination 50%Ca + 50%Lc might be recommended as a natural bio-insecticide in mosquito control program to prevent malaria.

Keywords: Malaria*, Anopheles gambiae*, plant methanolic extracts, combination, larvicide

ABS-554

***Anopheles gambiae* complex in Ethiopia**

Graham B White (LSHTM)*

The original discovery of Anopheles amharicus near Jimma led me to survey the *Anopheles gambiae* complex across Ethiopia during 1972-74. Only two species were found: *An.arabiensis* widespread as the predominant malaria vector in most areas; zoophilic *An.amharicus* in highlands westwards from the Rift Valley (previously reported as species C or *An.quadriannulatus*). Seasonally they fluctuated together locally and sympatrically, with apparently synchronous biting cycles. Other members of the A*n.gambiae complex (viz: An.bwambae, An.coluzzii, An.gambiae s.s., An.melas, An.merus, An.quadriannulatus* s.s., etc.) were not detected in Ethiopia. This presentation reviews information on Ethiopian malaria vectors gathered since my observations on the *An.gambiae* complex 50 years ago.

Ethiopia, *Anopheles amharicus, Anopheles arabiensis, Anopheles gambiae*, malaria vectors

ABS-559

Ae. aegpyti spread in the United States and _An. stephensi_ - opportunities for bi-directional partnerships

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An. stephensi, a malaria vector native to south Asia and the Arabian peninsula, is increasingly being detected as an invasive species across Africa. This expansion is a cause for significant alarm, and indeed in some parts of Africa such as Djibouti, malaria incidences have increased dramatically since the detection of An. stephensi in the region with the vector being suspected as the major driver of this trend. In Africa, what makes the case of *An. stephensi* more urgent is the fact that malaria transmission is largely rural. However, *An. stephensi* has been shown to be capable of colonizing urban environments, breeding in artificial containers, and therefore, potentially expanding the malaria transmission foci to urbanised areas. On the opposite side of the world in the temperate climates of North America, *Aedes aegypti*, another vector with much similar ecology and behaviour like *An. stephensi*, is expanding its geographic foci northwards to colder regions thereby increasing the risk of arboviral epidemics in these areas. This northward expansion is primarily driven by the warming climate that is increasingly making it conducive for *Ae. aegypti* colonization. The growing range of these two invasive, urban vectors *An. stephensi* and *Ae. aegypti* on provides an interesting perspective for comparative case study of invasive urban vectors and their disease epidemiology. Given the similarity of contexts and the vector ecology and behaviour, there is an opportunity for national malaria control programs in Africa, and the mosquito abatement districts in the USA to cooperate in knowledge and experiences sharing in the containment and control of further invasion of these vectors in the respective regions. We will compare and contrast the dynamics of *An. stephensi /An. aegypti* invasions in both continents, ecology, behaviour, geography, and suggest bi-directional lessons on surveillance and control that can be shared between mosquito control agencies on both continents.

Keywords: LSM, Aegypti, collaboration, Stephensi

ABS-560

A comparative costing analysis for the replacement of DDT by 3rd Generation insecticides in South Africa

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Dichlorodiphenyltrichloroethane (DDT) is effective in suppressing vector populations and has led to countries from control to elimination of malaria. Resurgence of malaria in instances where countries attempted to discontinue the use of DDT without an alternative in place has been noted. South Africa is a member of the Stockholm Convention which noted despite the continued need for the use of DDT in malaria vector control, its use beyond 2030 will not be recommended for vector control. Furthermore, the increased pyrethroids resistance reported requires introduction of alternatives. The World Health Organisation has pre-approved 3rd generation insecticides(3GIRS) for countries to consider as alternatives to DDT such as, Actellic (AC), Sumisheild(SS) and Fludora Fusion (FF). The aim of this analysis therefore was to compare the cost effectiveness of replacing DDT in South Africa. A price differential costing was computed for DDT to compare with the alternative 3rd Generation Insecticides. Over the last three malaria seasons an average of 1.77 million structures were targeted. DDT sprayed structures accounted for 40%(715 000) at a cost of ZAR 28,3m. A change from DDT to 3GIRS insecticides will push the insecticide cost to ZAR 64,5m, an increase of 127% to implement IRS. This excludes the costs of shifting to different spray nozzles, other consumables, training costs and continued resistance monitoring. The substantial increase in costs to transition from DDT to 3GIRS in South Africa requires consideration as public health funding is a limited resource. Shifting from blanket spraying by refining sub-national tailoring of interventions through using data for prioritisation & targeting in IRS, will ensure cost effective IRS deployment. 3GIRS manufacturers need to apply competitive pricing bench marking against DDT and Pyrethroids to address costing and affordability. Consideration of deployment of other vector control measures to complement IRS is also recommended.

Keywords: IRS, 3rd Generation insecticides, DDT, Cost effectiveness, Malaria

ABS-581

Microbiota diversity *of Anopheles gambiae* and association with *Plasmodium falciparum* infection, the causative agent of malaria in Bankeng, a locality in southern Cameroon

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Malaria control requires the coordination of different strategies due to the lack of an effective vaccine and the emerging resistance of parasites to drugs and vectors to insecticides. Therefore, efficient, and environmentally safe alternative control strategies are still needed. In this study, we explored the composition of the microbiota of the *Anopheles gambiae* and its variability in the presence of natural Plasmodium infection, to determine their potential as a novel vector control-based approach to fight malaria. An entomological survey of

a collection of *An. gambiae* was conducted. After, DNA extraction from whole individual mosquitoes, we investigated the microbiota of mosquitoes naturally infected or not by P. falciparum using Illumina Miseq sequencing of the V3-V4 region of the 16S rRNA gene. Data analysis was performed using QIIME2 and R software programs. A total of 975 mosquitoes were collected and among them, 120 mosquitoes were selected randomly corresponding to 30 mosquitoes per infection status and season. Overall, 49 bacterial taxa with overall abundance equal to or greater than 0.1% were recovered in overall samples. There were significant differences in bacterial composition between both infections' status, with a separation observed between infected and uninfected mosquitoes (Beta diversity, Pseudo-F = 2.155; q-value = 0.016). In addition, three bacterial genera Corynebateriaceae, Hymenobacter and Pandorae were highlighted by (LEfSe) as more abundant in the uninfected mosquitoes, suggesting that some individuals of the microbiota could induce or restrict Plasmodium infection. This is the first report that showed the potential role of microbiota in natural populations of *Anopheles gambiae* in susceptibility to natural Plasmodium infection in Cameroon. Characterisation of some promising bacterial candidates for potential use in an innovative approach to controlling malaria should be further investigated.

Keywords: Microbiota diversity, *Anopheles gambiae*, *Plasmodium falciparum* infection, 16S rRNA gene amplicon sequencing

ABS-583

Assessment of Insecticide treated Bednet efficacy by Measuring Anti-gSG6-PI antibodies in Individuals with malaria infection in Bondo, Tanga

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Insecticide-treated bed nets (ITNs) are the cornerstone of malaria control in Tanzania. Antibodies against gambiae salivary gland protein 6 peptide 1 (gSG6-P1) measured at the individual-level may serve as a tool for evaluating effectiveness of ITNs, vector exposure and malaria transmission, but their relationship has not been fully evaluated. The objective of this study was to assess the effectiveness of ITNs by measuring antibodies against gSG6-P1. The study was conducted in Bondo, Tanga. Three surveys were conducted during rainy, dry and short rain seasons in 2021. Anti- gSG6-P1 antibodies were measures from blood samples using Elisa test. A total of 37. 8% (137), 24.9% (90) and 21.3% (77) individual were malaria positive during rainy, dry and short rain season respectively. Generally, there is significant difference in antibody response in three surveys (Kruskal Wallis test <0.0001). Results shows that no significant difference in anti- gSG6-P1 antibodies response among ITNs users and non-users who are malaria positive or negative in all surveys (Mann-Whitney U test, P>0.05). We advocate the continued use of anti- gSG6-P1 antibodies that can serve as a proxy measure for malaria transmission.

Keywords: Insecticide treated Bednet, Efficacy, Malaria

ABS-584

Trachoma control in East and West Africa: A 10-Year Bibliometric Analysis (2014-2023)

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Africa bears the highest burden (89%) of the global 1.9 million cases of active trachoma, therefore it is pertinent to investigate African researchers' involvement in interventional trachoma research. The aim of this bibliometric analysis was to identify trends in the publication of interventional studies (mainly randomized control trials) on trachoma in East and West Africa in the last 10 years. A systematic literature search was conducted for randomized control trials on trachoma published in the past 10 years (2014-2023). Keywords such as “trachoma RCT”, and “trachoma control interventions”, among others, were used to identify studies on Pubmed, Google Scholar, and Wiley Online conducted in east and west Africa. Variables such as study location, the number of citations, and availability of funding/funders were collated from the eligible studies and analyzed descriptively. A total of 20 eligible RCTs published between 2014 - 2023 were retrieved. They have a combined 304 citations with the most cited studies having 41 citations. Close to half of the RCTs (45%) were conducted in Ethiopia, 25% in Niger, 15% in Tanzania, and 5% in Mali. All of the studies were conducted in partnership with non-African institutions (majorly from the United States and the UK). Majority of the studies (80%) involved the mass distribution of antibiotics to participants and 10% were WASH interventions. Most of the studies were funded of which 68.75% were funded by The Bill and Melinda Gates foundation. African researchers need to build their capacity to conduct high-quality and innovative randomized control trials without foreign counterparts.

Keywords: Trachoma; RCTs; Africa

ABS-586

Malaria surveys in areas with High insecticide-treated bed nets Ownership in Handeni, Tanzania

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Several interventions have been made to eliminate Malaria in Tanzania including use of insecticide-treated bed nets and artemisinin combination therapy. Nevertheless, malaria is still high in some parts of the country. We assessed the burden of malaria in terms of prevalence as well explored about bed net ownership and utilization. Three cross sectional surveys were conducted in June-2021, September-2021 and January-2022. A total of 457 participants were recruited. The study included children aged between 2-10 years and

adolescents/adults aged 11-70 years. The study was conducted in Bondo site which comprises of Bondo, Kwadoya, Ngojoro and Kwamgwe villages in Handeni-Tanga Tanzania. A face-to-face interview were conducted. A pre-tested questionnaire was used to collect demographic information, bed net use, bed net ownership and factors for malaria exposure. The developed questionnaire was uploaded in the system and data was collected electronically using Open Data Kit (ODK) application (ODK collect version 1.30.1; link: https://odk-collect.en.uptodown.com/android). The blood sample from the finger-prick was used to test malaria parasites using malaria rapid diagnostic test. The prevalence of malaria was 32.8% (150), 21.7% (99), and 22.1% (101) in cross-sectional conducted in June, September and January respectively. Seventy percent (106), 66.7% (66) and 68.3% (69) who were malaria positive (by MRDT) used a Insecticide-treated bed nets in cross-sectional 1,2 and 3 respectively, $p<0.05$. This study highlight that Insecticide-treated bed nets usage were significantly associated with malaria positivity. In order to achieve malaria elimination, we advocate malaria campaigns targeting proper usage of Insecticide-treated bed nets.

Keywords: Malaria, Bednet, Ownership, Tanzania

ABS-591

Use of community dialogue in malaria social behaviour change intervention among women of mambai community unit, Vihiga county, Kenya

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Community dialogues bring together key members of a locality to discuss the issues that concern them and devise solutions to the problems raised. Mambai Community Unit (C.U) was experiencing high incidents of malaria especially to children under the age of five. The community employed the use of dialogue between April and September 2022 to get solution to their problems. The community dialogues brought together local authorities, religious leaders, head of health Facility, community health workers, women's groups, youth groups, and village members.The dialogues helped people understand the causes of their community's high incidence of malaria, such as improper use of LLINs, lack of prompt care-seeking, stagnant water, and bushes around the houses. Before the sessions begin, Community Health Volunteers (CHVs) mobilize the community by making public announcements about the upcoming sessions in churches, mosques, village meetings and women's groups. Follow ups were done to check on the outcome of the dialogues. By September, 13 community dialogue sessions were held, reaching out to a total of 2691 people and 1551 households. Women were 73%(n=1,979) and men 27%(n=712) . Follow ups visits showed reduction in misuse of LLINs from197 to 11 households who were found to be still using the net for fencing. Malaria cases reduced from 24% reported in quarter 2 of 2022 to 10% in quarter 3 after the intervention. Net use in households increased to 98%(n=1520) from 57%(n=884) after being demonstrated to on how to modify rectangular net to circular for ease of tying in the local houses. Community dialogues have proven to be an effective way to reach large numbers of community members.

The benefits of the sessions lie not only with the expansive reach of the dialogues, but also in their generation of referrals to health services and also a powerful tool in community social behavior change towards a health intervention.

Keywords: Dialogue, malaria, behaviuor, Change

ABS-616

Is the GSTE2 AS-PCR an effective screening tool for molecular markers of resistance in the African malaria vector mosquito *Anopheles funestus* s.s.?

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The predominance of metabolic resistance in Anopheles funestus and the detection of a single amino acid change in the GST epsilon 2 (GSTe2) gene conferring DDT/ pyrethroid resistance allows for longitudinal insecticide resistance screening of natural vector populations. Museum-stored *An. funestus s.s.* specimens collected from Nchelenge, Zambia, between 2012 and 2021 were screened for the presence of GSTe2 mutations by allele-specific PCR (AS-PCR). The GSTe2 AS-PCR protocol produced variable success when screening preserved *An. funestus s.s.* specimens for specific allele mutations. The high no-amplification rate in the AS-PCR and ambiguous results gained from DNA sequence analysis of the GSTe PCR product amplicons highlighted some challenges of using this protocol. The highest frequency of alleles detected were homozygous susceptible, and a low yet persistent frequency of heterozygous alleles were detected from every year screened, however, heterozygote allele mutations were often not confirmed by DNA sequence analysis. No homozygous resistant alleles were detected throughout the longitudinal sample set of vector populations from Nchelenge, Zambia, despite known phenotypic insecticide resistance within this population. The GSTe2 AS-PCR protocol, although used effectively in previous literature, showed low robustness when reproduced for this study using available commercial reagents. It is possible that using a more sensitive enzyme kit for the GSTe2 AS-PCR may increase sensitivity and improve reaction efficiency, thus providing a more robust amplification.

Keywords: Malaria mosquito, molecular markers, metabolic resistance, pyrethroid resistance, GSTe2, Zambia

ABS-617

Attribution of defaulted solid waste management system on persistence of mosquito vectors at rahaleo shehia in unguja-zanzibar

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Mosquito borne diseases are among the top listed causatives of morbidity and mortality in third world countries which are contributed in one way or the other by poor standard of environmental sanitation. The prevalence of Mosquito borne diseases and presence of Mosquito Vectors have been reported to persist in Zanzibar over the past few years. The impact of poor solid waste management system on persistence of mosquito vectors has never been systematically assessed in Zanzibar. A cross-sectional entomological survey was conducted in Rahaleo shehia within Urban District of Zanzibar. Twenty households, five waste collection points and five "final" disposal points were involved in the survey and selection of these representative areas was done using simple random sampling technique. Data were recorded in special designed forms and summarized in MS Excel. The study results were statistically analyzed using T-test program to compare data on Culicine and Anopheline species collected. A total of 600 containers were assessed of 56.2% found positive for immature mosquito stages. Numbers of positive containers around household were 93, waste collection points were 83 and final disposal points were 161. The total number of 1,023 of larvae and pupae were collected of which culicine were 95.5% and Anopheline 4.5%. Out of 977 Culicine collected 84.1% were Aedes spp and 15.9% were Culex spp. All Anopheline mosquitoes collected were *Anopheles gambiae s.s.* The findings indicate that solid waste management system in Zanzibar provides favorable conditions for mosquito's vectors hence posing a risk of disease transmission. Furthermore, results indicate that Malaria vectors have to some extent adapted behaviors for breeding in small water holding containers. Hence for attaining effective Mosquito vectors control improved collection and proper disposal of solid waste specifically small containers is of paramount importance.

Keywords: Mosquitoes vectors, Solid waste, sanitation, breeding sites

ABS- 621

Entomologic Risk Assessment of Yellow Fever Outbreak in Kenya 2022

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Yellow fever (YF) is a mosquito-borne infection of international public health. It is transmitted to humans through bite of infected Aedes mosquitoes. Assessment was carried out in Isiolo, Garissa, Meru and Wajir. The survey was to ascertain the presence of the Aedes mosquito, its abundance and determine the risk of exposure. Adult mosquitoes were collected through CO2-bated CDC light traps and BG-sentinels traps set during the day and night. Larvae and pupae were collected indoors and outdoors. Door-to-door survey was done to identify the breeding preference of the Aedes species. The data on larval survey were analyzed in R statistics using Chi-square and container index (CI), house index (HI), breteau index (BI), pupal index (PI) calculated as per the WHO procedure. 487 houses were surveyed with Wajir having the highest house positivity of 27% followed by Isiolo and Garissa having 12% and Meru with 4%. 2,013 containers were inspected and 69 (14.2%) had at least an Aedes larvae or pupae. Overall House Index, Container Index and Breteau Index were 11.3%, 3.4% and 14.2% respectively. Isiolo had the highest Container index (20.3), Breteau index (20.1) followed by Wajir (3.8), 2.5

and 1.7 for Garissa and Meru respectively. Of the 7,588 adult and 362 larval female mosquitoes collected, *Ae. furcifer* accounted for 60.2% followed by *Ae. aegypti* 6.6%, while *Ae. simponi* accounted for 0.8%., no adult mosquito was collected from Wajir. 245 were collected in ovicups and soil scrapings, while 117 were adult collection. Isiolo had 88(24%) *Ae. aegypti*, 218(60.2%) *Ae. furcifer*, 3(0.8%) *Ae. simpsoni*, 4(1.1%) *Ae. chausseri* while *Ae. aegypti* for Garissa and Meru was 48(13.3%) 1(0.3%) respectively. It was evident that *Ae. aegypti* is most abundant in the four counties assessed hence control measures should target breeding preference for the vector to minimize mosquitoes densities.

Keywords: Yellow fever,container index (CI), house index (HI), breteau index (BI), pupal index (PI), Kenya

ABS-642

Burden of mosquito borne diseases across rural versus urban areas in Cameroon between 2002 and 2021: prospective for community-oriented vector management approaches

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Over the past two decades, Cameroon recorded one of the highest rates of urban population growth in sub-Saharan Africa. However, it is not known how the subsequent urbanization affects mosquito populations and associated disease transmission in urban versus rural areas. We analyze data from studies conducted on mosquito-borne diseases in Cameroon between 2002 and 2021 with regards to urban areas versus rural areas. A total of 85 publications/reports were reviewed for entomological and epidemiological data. Findings revealed 10 mosquito-borne diseases across the country, mostly in the Northwest, North, Far North and East Regions. In urban areas, dengue

prevalence increased from 14.55% (95% confidence interval [CI] 5.2–23.9%) in 2002–2011 to 29.84% (95% CI 21–38.7%) in 2012–2021. In rural areas, Lymphatic filariasis and Rift valley fever, which were not present in 2002–2011, appeared in 2012–2021, with 0.4% (95% CI 0.0– 2.4%) and 10% (95% CI 0.6–19.4%) prevalence, respectively. Malaria prevalence remained the same in urban areas (67%; 95% CI 55.6–78.4%) between the two periods, while it significantly decreased in rural areas from 45.87% (95% CI 31.1–60.6%) in 2002–2011 to 39% (95% CI 23.7–54.3%) in the 2012–2021 period (*P = 0.04). Seventeen mosquito species were involved in diseases' transmission, of which 11 in malaria transmission, five in arboviruses transmission and one in the transmission of malaria and lymphatic filariasis. The current findings highlight the need for at least two patterns of integrated interventions against vector-borne diseases in Cameroon, e.g.: (1) malaria, lymphatic filariasis and Rift Valley fever intervention package in rural areas,(2) malaria, dengue and Zika viruses' intervention package in urban areas.

Keywords: Mosquitoes; arbovirus diseases; Plasmodium spp.; urban and rural areas; Cameroon.

ABS-656

Diversity of Arbovirus Vectors across different Land-use Habitats in The Gambia

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Understanding mosquito-borne arboviruses is critical due to their association with febrile illness, morbidity, and even mortality in multiple regions of the world. Clinical symptoms of arbovirus can be misdiagnosed as malaria, and non-malarial febrile cases do occur in The Gambia. Although research in neighboring Senegal shed has revealed arboviral activity and sylvatic virus cycles, The Gambia has a separate public health system, socio-economic-political setting, and unique riverine ecosystem. Practically nothing is known about the arboviruses that circulate in The Gambia, except for three instances: an outbreak of Yellow Fever over forty years ago, localized antibody evidence of Zika virus, and two one-off cases of Rift Valley fever. In addition, there is a paucity of data on local mosquito populations, other than the Anopheline vectors of malaria, and potential vectors of arboviruses. To enhance response to emerging public health threats in The Gambia, we sampled mosquitoes in coastal and eastern regions of the country between November 2021 to October 2022, assessing vector species communities in different landscapes (sylvatic, agricultural, urban) during both the dry and rainy seasons; mosquitoes are screened on cell culture to isolate evidence of arbovirus circulation and determination species/regional infection rates. 17,379 mosquitoes were captured, comprising 9 genera and 45 species. 73% of the mosquito species identified have been incriminated as vectors of arbovirus and/or other pathogens (Plasmodium, *W. bancrofti* etc). Arboviral status is being determined during 2023. When fever is not caused by

malaria, local epidemiology, including a baseline knowledge of what arboviruses and their vectors are circulating in a region, can guide medical decisions. Incrimination of mosquito species responsible for natural arbovirus transmission is pivotal to understanding pathogen dynamics and designing precise vector control strategies.

Keywords: The Gambia, Mosquito assemblage, Species diversity, Non-Anophelines, Arbovirus circulation, Land-use, One Health

ABS-658

Root-associated bacteria of the invasive plant *Parthenium hysterophorus* alters oviposition responses of gravid malaria mosquito

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Symbiotic bacteria in water habitat mediate selection of gravid female to suitable oviposition sites. They serve not only as food for developing larvae but also emit metabolites such as volatiles that influence the choice of egg laying. To date however, few data exist on the bacterial diversity associated with plant root exudates as well as their attractive potential to gravid mosquitoes. This work tested this hypothesis using the invasive plant Parthenium hysterophorus- malaria vector system. The plant is a preferred host attracted by the malaria vector *Anopheles gambiae* for sugars as a source of fuel for various metabolic functions. Bacterial species were isolated from root exudate water of *P. hysterophorus* by culturing on *Luria bertani (LB)* medium. Extracted DNA of pure isolates was amplified by PCR of a portion of the 16S rRNA gene. Amplicons were sequenced and queried against the GenBank to identify specific isolates. Dual choice oviposition bioassay was used to assess no. of eggs laid by gravid mosquitoes in individual bacteria isolates compared to crude bacteria-mixture and normal saline water (negative control). The headspace volatiles from individual isolates were analyzed by gas chromatography coupled to mass spectrometry (GC-MS). Culturing resulted in isolation of three bacterial isolates identified as Enterobacter sp., Enterobacter mori and Alcaligens aquatilis. Dual choice oviposition assays revealed the bacterial isolates to differentially affect egg-laying in *An. gambiae*. A total of 15 volatile organic compounds (VOCs) were identified from the headspace of individual isolates using GC-MS. The VOCs belong to different chemical classes namely benzenoids, pyrazines, aldehydes, terpenes, alcohols, alkanes and indoles. Findings from the study improve our knowledge of invasive plant-mosquito-microbe interaction, which is an overlooked aspect in the ecological dynamics of disease vectors.

Keywords: malaria vector, *Anopheles gambiae*, oviposition, mosquito, Parthenium hysteropho

ABS-677

Assessing the behavioural activity of Resistant Tiassale and Susceptible Kisumu *Anopheles gambiae* mosquitoes using the video cone test.

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The WHO cone bioassay measures the efficacy of insecticidal nets without considering the presence of a host, which makes the results less applicable to real-life situations. To ensure these nets work well, we need to understand how mosquitoes behave around them when a host is present. This study examines mosquito behaviour with a host using video capture techniques. 2-5 days old unfed female mosquitoes were used. Mosquitoes were starved of 10% sugar but were given water soaked in cotton until 4 hours before testing. 5 Mosquitoes were aspirated into cups and left to acclimatise to testing room conditions for an hour. Mosquitoes were gently introduced into a cone fixed on a board with the test net and a smartphone attached to it for both host present and no host tests. A three-minute video is recorded immediately after the introduction. Mosquito behavioural activity was analyzed using Boris and ViCTA video software. A total of 336 tests were conducted each with Kisumu and Tiassale colonies, 50% were provided with or without a human host. Total mosquito activity for Tiassale strain was significantly higher ($p<0.0001$) than observed for the Kisumu strain. The total mosquito activity for PN3.0-treated nets was significantly higher than observed for both PN2.0 and untreated nets. There was no significant difference between the total activity of mosquitoes in host-treated tests and no-host tests. When mosquito strain, host status and operator variables were held constant, the influence of both PN2.0 and PN3.0 compared to the untreated net was not statistically significant ($p>0.05$). The video analysis techniques aim to offer a more comprehensive assessment of ITN performance by incorporating behavioural aspects of mosquito interaction with the nets. The insights gained can inform the development of more effective strategies for mosquito-borne disease prevention and control.

Keywords: Vector control, LLIN, ITN, Insecticide Resistance

ABS-682

Biting behavior and status of *Onchocerca volvulus* transmission after 15 years of Ivermectin based preventive chemotherapy in Fontem (South West Region, Cameroon)

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Onchocerciasis affects some of the world's most marginalized people, perpetuating poverty and inequalities. Community-Directed Treatment with Ivermectin (CDTI) has taken place within the South West region of Cameroon forover15 years. Despite this, onchocerciasis is still prevalent due to existing and emerging contextual challenges. This study assessed the infectivity of *Simulium damnosum s.l.* around Begeh river at Fontem, South West Region of Cameroon. Human landing sampling method was used to collect adult female blackflies on human attractants from 7 a.m. to 6 p.m. for five consecutive days a month for one year period (July 2015-June 2016). Parity assessment was conducted to determine the age of fly populations. Parous flies were further dissected to detect the presence or absence of Onchocerca larvae. Biting rates and transmission potentials were calculated using standard methods. A total of 2,715 blackflies were collected during the study period and identified as forest species of *Simulium damnosum* sensu lato (*S. squamosum* group). The daily biting rate varied from 17 fly per man per day in November to 103 in July. The monthly biting rate was lowest in November (510 bites/man/month) but highest in July (3,193 bites/man/month). Nulliparous flies [1,549 (57.06 %)] were more abundant than parous flies [1,166 (42.94 %)]. The Onchocerca volvulus transmission was greater in October (118 infective larvae/man/month) compared to November which recorded zero infection. The annual transmission potential was 34 infective larvae/man/year. Onchocerciasis transmission is still ongoing in the study area despite more than 15 years of CDTI. In accordance with WHO recommendations, vector control should be used in combination with mass drug administration to accelerate transmission interruption of onchocerciasis.

Keywords: onchocerciasis, Ivermectin, blackfly, transmission indices, Fontem Cameroon

ABS-10

PfHRP2-PfHRP3 diversity among Kenyan isolates and comparative evaluation of microscopy and nested PCR methodologies

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Rapid diagnostic tests (RDT) are valuable tools that support prudent and timely use of antimalarial drugs, particularly if reliable microscopy is not available. However, the performance and reliability of these tests vary between and within geographical regions. The study evaluated the performance of routine malaria RDT in Kenyan febrile patients in Busia County, Kenya. A cross sectional study design was employed to recruit febrile patients attending health facilities between August and November 2016. A total of 192 febrile patients who were slide positive and negative were evaluated for their infection status by nested PCR and RDTs (PfHRP2/pLDH). In addition, *P. falciparum* diversity of the histidine-rich proteins 2 and 3, that influences the RDT test results were determined. All individuals were *P. falciparum* positive. Among the investigated 192 febrile patients, 76 (40%) were positive by microscopy, 101 (53%) by RDTs and 80 (42%) were PCR positive. The performance of the Care Start™ HRP2/pLDH (pf) RDTs was better than microscopy (Sensitivity 94%; Specificity 75%) and Nucleic acid testing (sensitivity 95%, specificity 77%) with high negative predictive values, indicating the suitability

of the RDT in routine practice. Specific pfhrp2/pfhrp3 deletions shown to associate with RDT false negativity was not observed. However, high genetic diversity among *pfhrp2* gene was observed. Eleven new *PfHRP2* and nine *PfHRP3* repeats were observed. False positivity by microscopy and under reporting of infections may thus be a barrier in malaria control and elimination programs. The HRP2/pLDH(Pf) based RDT yet demonstrate to be an effective tool for malaria surveillance program.

Keywords: Kenya; Malaria; Microscopy; *PfHRP2; PfHRP3*; RDTs

ABS- 11

Influence of house characteristics on mosquito distribution and malaria transmission in the city of Yaoundé, Cameroon

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Improving house structures is known to limit contact between humans and mosquitoes and reduce malaria transmission risk. In the present study, the influence of house characteristics on mosquito distribution and malaria transmission risk was assessed. The study was conducted from March 2017 to June 2018 in 32 districts of the city of Yaoundé. Mosquito collections were performed indoors in 10 to 15 houses per district using CDC light traps. A total of 467 houses were used. A questionnaire was used to collect information on the household. Mosquitoes collected were identified morphologically. Anophelines were tested by ELISA to detect infection by Plasmodium parasites. General model estimates were used to assess the influence of house characteristics on mosquito distribution. A total of 168,039 mosquitoes were collected; Culex spp emerged as the predominant species (96.48%), followed by *Anopheles s.l.* (2.49%). Out of the 1033 *An. gambiae s.l*. identified by PCR, 90.03% were *Anopheles coluzzii* and the remaining were *An. gambiae* (9.97%). The high number of people per household, the presence of screens on windows and the possession of LLINs were all associated with fewer mosquitoes collected indoors, whilst opened eaves, the high number of windows, the presence of holes in walls and living close to breeding sites were associated with high densities of mosquitoes indoor. Out of 3557 Anophelines tested using ELISA CSP, 80 were found infected by *Plasmodium falciparum* parasites. The proportion of mosquitoes infected did not vary significantly according to house characteristics due to low frequency of infected mosquitoes in the city. The study indicated that several house characteristics favoured mosquito presence in houses. Promoting frequent use of LLINs and house improvement measures, such as the use of screens on windows, closing eaves, and cleaning the nearby environment, should be integrated into strategies to improve malaria control in the city of Yaoundé.

Keywords: Malaria transmission, Houses characteristics, Culicines, Anophelines, *An. gambiae*, Yaoundé

ABS-15

Diagnostic performance of NxTek™ Eliminate Malaria Pf test for the detection of *Plasmodium falciparum* in schoolchildren with asymptomatic malaria

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One of the major roadblocks to the falciparum malaria elimination program is the presence of a large number of portions of the population are asymptomatic malaria infection. Targeting such reservoirs of infections is critical to enhancing elimination efforts. The NxTekTM Eliminate Malaria Pf is a highly sensitive rapid diagnostic test (hsRDT) for the detection of HRP-2. Knowledge gaps exist in Ethiopia on its the field performance in school children with asymptomatic malaria. To evaluate the diagnostic performance of hsRDT for the detection of P. falciparum in school children with asymptomatic infection in Jimma zone, in Ethiopia. A school-based cross-sectional study was conducted from September 2021- January 2022 in Gomma district of Jimma zone (low API) in 994 healthy schoolchildren (aged 6 to 15 years) using a multi-stage sampling technique. Finger blood samples were collected for microscopy, hsRDT, SD Bioline Malaria Ag Pf/P.v(cRDT) and qPCR. The hsRDT was compared to cRDT and microscopy. qPCR was used as a reference method. The average age of the children was 11.54 (±2.5 SD). The prevalence of *P. falciparum* was 1.51%, 2.2%. 2.2% and 4.52%, by microscopy, hsRDT, cRDT and qPCR, respectively. Asexual parasite density was ranges from 64 and 8080 parasites/µL. Using qPCR as a reference, the sensitivity of hsRDT was higher (48.89%) than that of microscopy (33.3%) and showed a showed 100% specificity and a positive predictive value (PPV). Microscopy showed similar specificity and PPV to hsRDT. Using microscopy as a reference, the diagnostic performances of hsRDT and cRDT were similar. The RDTs showed identical diagnostic performances. hsRDT has the same diagnostic performance as cRDT but improved diagnostic characteristics than microscopy for detection of *P. falciparum* in schoolchildren with asymptomatic malaria. It can be a useful tool for the national malaria elimination plan of Ethiopia.

Keywords: NxTekTM Eliminate Ag Pf, hsRDT, qPCR, asymptomatic *falciparum* malaria, school children, Ethiopia

ABS-18

Distribution and major ecological factors in the invasion of *aedes albopictus* along the rural-urban landscape gradient in Lambaréné, Gabon

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Tiger mosquitoes (aedes albopictus and aedes aegypti) are known for their potential as vectors of dengue and chikungunya viruses. However, entomological surveys are mostly carried out during epidemics. In Gabon where outbreaks of both viruses have occurred, there is no vector control programme related to these arboviruses. Therefore, our aim was to determine the main ecological factors associated with vector abundance in Lambaréné and its surrounding areas which are known to be endemic for dengue and chikungunya viruses. An entomological survey was conducted in Lambaréné and its surrounding rural areas. Mosquitoes were collected with aspirators around human dwellings. Ecological and environmental data were collected as well from each study areas. Morphological identification using the identification keys of Leopoldo were used to characterize the aedes species. Pools of female mosquitoes of both species were then extracted and amplified by RT-qPCR to check the presence of DENV and CHIKV viruses. *Aedes albopictus* was the most common vector collected making up to 97% (4236/4367) of the vectors collected in the entomological surveys followed by *Ae. aegypti* 3% (131/4367). There was no difference in the distribution of both vectors between urban (54%) and rural (46%) areas. In the urban area, Lambaréné zone 3 recorded significantly the highest number of mosquitoes collected compared to zone 1 and 2 with several neighbourhoods with over 201 mosquitoes collected per collection sites. For the rural area, the proportions of species were significantly higher along the south transect compared to north transect to lambarene. Vectors were also significantly very abundant in environments marked by monocultures of the plant species *Havea brasiliensis* and *Manihot esculenta* . Finally, no mosquito pools were positive for either dengue or chikungunya viruses.

Keywords: *Aedes albopictus*, *aedes aegypti*, dengue virus, chikungunya virus, *havea brasilensis*

ABS-27

Malaria framework and socioeconomic predictors among under-five children: study of three referral hospital in Kisumu East sub county Kisumu county, Kenya.

Silas O Awuor (Kisii university)*

African region accounts for 95% of all malaria cases and 96% of malaria deaths with under-five children accounting for 80% of all deaths in the region. This study was to assess the socioeconomic determinants of malaria prevalence and provide evidence on the socioeconomic

profile of malaria infection among under-five children in three referral hospital within Kisumu East sub county. The study used data from the 2021 to 2022 Demographic and Health Survey (DHS). The survey used a two-stage stratified-cluster sampling design based on the sampling frame of the population and housing census of countries included. Statistical analyses relied on Pearson's $\chi 2$, using the CHAID decision-tree algorithm and logistic regression implemented in R V.4.6. Of 3540 children considered, 24.2% (95% confidence interval CI 23.4–25.05%) had malaria infection. The prevalence of malaria infection seems to increase with age. This variable is statistically associated with the prevalence of malaria infection among under-five children, under-five child's age, maternal education, sex of household head, household wealth index, place of residence, and wards where mother–child pair lives. Children whose mothers have secondary education have about 56% lower risk (odds ratio=0.44; 95% CI 0.40–0.48) of malaria infection and 73% lower (odds ratio=0.37; 95% CI 0.32–0.43) among children living in the richest households, compared to children living in the poorest households. Findings of this study provide unique insights on how socioeconomic and demographic variables; especially maternal education level significantly predicts under-five malaria prevalence across the sub county. Therefore, ensuring that malaria interventions are underpinned by a multisector approach that comprehensively tackles the interplay of maternal education and other socioeconomic variables will be critical in attaining malaria prevention and control targets in Kisumu East sub county.

Keywords: Malaria, Children, Under-five, Determinants, Kisumu west

ABS-28

Sampling efficiency and screening of *Aedes albopictus* for yellow fever virus in Niger Delta region of Nigeria

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The vector potential of Aedes mosquitoes in the transmission of the albovirus responsible for the transmission of yellow fever around the world is well documented. Although, Nigeria is a high-risk country for yellow fever, there is paucity of information in the niger delta region on the distribution of aedes mosquito vectors and molecular screening for yellow fever virus. This study was carried out to breach the gap. The mosquitoes were sampled in four communities (Otolokpo, Ute-okpu, Umunede and Ute Alohen) in Ika North-east local government area of Delta state. The efficacy of various methods of sampling the mosquitoes (odour baited traps (bg sentinel), CDC light trap with attractant, CDC light traps without attractant and modified human landing catch (mhlc) were assessed for 12 weeks. Collected mosquitoes were transferred into a holding cages, killed by freezing at -4oC for 20 minutes. They were morphologically and molecularly confirmed as ae. albopictus. Seven hundred and twenty-five (725) mosquitoes were obtained from the various traps. They were then preserved in rnalater by pooling 10 mosquitoes per eppendorf tube. Mosquitoes were screened in national arbovirus and vector research centre institute, enugu nigeria using yellow fever primers and probes. Two samples (made up of 10 mosquitoes each) for every sample

location were analyzed. Mean abundance of the mosquitoes was highest in mhlc (42.9) compared to the mosquitoes sampled using other techniques and the difference was highly significant ($p < 0.0001$). The mean abundance of mosquitoes was lowest in cdc light traps without attractant (0.29). It was also observed that no yellow fever virus strain was detected in all the mosquitoes sampled at the four locations. This possibilities may be due to the mass vaccination exercise that was carried out in 2020 in the study area. Conclusively, adequate monitoring using the mhlc and continuous research are required to avoid resurgence of these virus in these locations

Keywords: *Aedes albopictus*, delta state, ika north east, molecular screening, sampling efficiency

ABS-29

Blackfly population dynamics over one year in the Eseka health district, Central Region, Cameroon: indication of a seasonal transmission

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The control of onchocerciasis or river blindness essentially relies on community-directed treatment with ivermectin (CDTI). It was demonstrated that CDTI can exhibit optimal effect if applied when blackfly population are the highest so as to highly impact the transmission of the parasite. To this end, entomological indicators were assessed throughout the year to identify the best period during which CDTI or other alternative/complementary control strategy can be optimally implemented. Monthly capture of blackflies was carried out over one year along the Kelle River. Flies were captured during three consecutive days per month using the human landing catching method, dissected under a stereomicroscope for parity, and parous females were checked for infection. Onchocerca volvulus L1 and L2 larval stages were searched in the abdomen/thorax of flies, and L3 larvae were searched in the heads. Entomological indicators (parity, monthly biting rate, infection rate, infectivity rate and annual transmission potential) were computed. 9,720 blackflies collected over one year, that is to say 3 days/month. Monthly biting rates varying between 20 b/p/m in August (Short dry season) and 9,870 b/p/m in April (short rainy season). Overall, 6,061 blackflies were dissected for parity, and 608(10.0%) were found parous. The infection rates were 0.23% (0-2) and infectivity rate were 0.06%(0-0.71), highest rates being observed during the short rainy season. The annual transmission potential was 17.7. This study revealed that the transmission of onchocerciasis is low in the Eseka health district, and the

dynamics of the transmission is surprisingly seasonal in this forested area where a perennial hydrographic network prevails. The implementation of CDTI or any other complementary strategy during the short rainy season when the densities of flies are the highest will guarantee higher impact of the intervention on the transmission of onchocerciasis.

Keywords: Blackfly, onchocerciasis, seasonal transmission, Eseka health district, Cameroon

ABS-37

Evaluation of residual bio-efficacy and fabric strength for the Olyset Plus compared to Interceptor G2 nets after 3 years of field use in Tanzania

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Long-lasting insecticidal nets (LLINs) provides physical protection through its fabrics that prevents human-vector contact and by its insecticide component that kills, or induce blood feeding inhibition (BFI) to vectors. Loss of this protection is attributable to washes and usage, and can put population at risk of malaria. To sustain gains in malaria control, nets that maintain high bio-efficacy and fabric strength for at least 3 years after distribution are required. Mortality in cone bioassays and tunnel tests against susceptible and resistant *An. gambiae* strains were assessed on single net randomly selected from the new unused Interceptor G2 (IG2), 20 times washed IG2, community used IG2, new unused Olyset Plus (OP), 20 times washed OP, community used OP from similar procurement. Similarly single net from the same net types were sampled for the fabric strength assessment in terms of bursting strength, tensile strength, mesh size and fabric weight. The community used nets are the ones retrieved by replacement from the project's previous distribution. In cone bioassay, mortality induced by OP nets decreased significantly with washes and community usage (50%, 46.3%) respectively against susceptible *Anopheles gambiae s.s* Kisumu strain, compared to IG2 (10%, 11.25%). However, results from tunnel test (against Kisumu strain and pyrethroid resistant *An. gambiae* Muleba-Kis), did not indicate significant difference between washed and community used IG2 and OP in terms of induced mortality and BFI. Conversely, bursting and tensile strength, mesh size and fabric weight of the IG2 were higher than that of the OP, with a decreasing trend from unwashed, laboratory washed to community usage. Significant difference in fabric

strength of two candidate nets overtime, should be an important consideration in choosing LLIN for malaria vector control programs even though there is insignificant difference in bio-efficacy.

Keyword: Long Lasting Insecticidal Nets, fabric strength, bio efficacy

ABS-39

Determination of a minimum effective dose of chlorfenapyr (Pyrolle) for *Anopheles gambiae* s.l. in a perspective of insecticide susceptibility monitoring in Senegal

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Malaria vectors have acquired widespread resistance to many insecticides currently used in public health, including synthetic pyrethroids. Therefore, there is an urgent need to search alternative insecticides such as chlorfenapyr or new formulations with different mode of action, to effectively control vectors resistant to the available insecticides. The overall objective of the study was to determine the minimal effective concentration of the chlorfenapyr. The study was carried out from september to december 2018 using wild populations of *An. gambiae s.l*. collected from five (5) different localities of Senegal. The minimal effective concentration of the chlorfenapyr was assessed using a decreasing battery of concentrations ((200, 100, 50, 25, 12.5) µg/ml) tested in the same experimental condition on wild *An. gambiae s.l.* populations. The test was carried out using unfed adult females aged of 3-5 days, reared from larvae sampled from several breeding found within and around each of the study localities. A minimum of 100 female specimens were exposed to impregnated CDC bottles as described by Brogdon & McAllister (1998). Sub-samples of dead and alive specimens from each test batch per localities were subsequently identified by PCR. The results revealed that the minimal effective lethal dose of chlorfenapyr on wild senegalese *Anopheles gambiae s.l*. populations was the concentration of 100 µg/ml. Subsequent molecular identification revealed the study population consisted of An. arabiensis , *An. gambiae* and *An. coluzzii* ,with the predominance of *An. arabiensis*. A total mortality was recorded for all the study populations exposed to the concentration of 100 µg/ml at the third days of the observation period. As a chemical family with a different mode of action compared to classical molecule used so far against anopheline vectors specie, the chlorfenapyr will complement the VC arsenal to better manage insecticide resistant populations.

Keywords: *An. gambiae s.l*., susceptibility, chlorfenapyr, Senegal.

ABS-42

Assessing the Tsetse Fly Microbiome Composition and the Potential Association of Some Bacteria Taxa with Trypanosome Establishment

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Tsetse flies are biological 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 additive tools to stop disease transmission. Some bacteria have been shown to be used as paratransgenic organisms capable of blocking trypanosome's development in flies. Understanding the role of tsetse microbiome in disease transmission could improve knowledge in initiatives to develop new vector control strategies. We aim to determine the microbiome composition of tsetse flies and their association with trypanosome establishment.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. 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% abundance. Globally, significant differences were observed in the microbiome diversity among tsetse species and between teneral and non-teneral flies and between flies displaying or not mature trypanosome infections. In addition, differential abundance testing showed several bacteria taxa associated with trypanosome maturation in tsetse flies. This study has shown some bacteria associated with trypanosome infection maturation in flies, which therefore need further studies to determine whether they could become targets for controlling tsetse competence.

Keywords: Tsetse flies; Trypanosomoses; Microbiome; Vector Control

ABS-43

Prevalence and Risk Factors of Urogenital schistosomiasis in Karonga District: An implication on MDA and knowledge of the disease Christopher S Nyondo (Mzuzu university)*

Urinary schistosomiasis is endemic in almost 76 countries grobally, Malawi inclusive. World health Organization recommends that young children in endemic areas be treated with prazquantel and therefore introduced Mass drug administration for school children and high risk communities of which Malawi government adopted and implemented in 2009. However, ever since MDA was introduced in Malawi, epidemiological data on schistosomiasis in several hotspot district has not been documented. This has implication in assessing the effectiveness of the intervention. This study Aimed at providing prevalence estimates for school going children in Karonga district. a

cross-sectional study was conducted in Kaporo, Karonga district from September to December 2022. Two primary schools were randomly sampled and 200 school children were targeted from which 179 (85.5%) were interviewed for demographics, Epidemiological and knowledge of the disease and then tested for urogenital schistosomiasis. Data was then analysed in SPSS for descriptive and inferential statistics using chi-square and Regression analysis. Overall, 79(44.1%) were found to be infected. Fishing and rice farming were found to be risk factors for the disease and majority of those who receive MDA in study year were infected. It was also found that involvement in MDA compaigns did not significantly associate with Level of knowledge on the disease. The study reveals that schistosomiasis is still prevalent in Karonga district. The findings support an urgent need to start an integrated, targeted and effective schistosomiasis control programme with mission to move towards the elimination phase. Besides periodic drug distribution, health education and community mobilization should also be stepped up.

Keywords: Urogenital schistosomiasis, MDA

ABS-46

Geospatial model of mosquito breeding habitats and physicochemical characteristics in Nigeria: Delta State as Case study

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Female mosquitoes are responsible for the serious disease burdens ravaging many regions of the world. Due to the limited information on geospatial model of mosquito breeding habitat and physicochemical characteristics (PCC) in Delta State, this study was designed. Six Local Government Area (LGAs) in Delta State, Nigeria was mapped out. Multiplex pen and GPS devices were used to determine PCC and geomap breeding habitats. Immature stages of mosquitoes were collected using 350 ml deep ladles and scooping spoons for density calculation. Breeding characteristics was recorded using WHO template. Four hundred and sixty-six (466) breeding sites were assessed between April, 2020 and July, 2022. Mosquito density was higher in Isoko North than in other LGAs. Geospatially, mosquito density was high in the western communities of all LGAs except in Ukwani and Aniocha South. pH was slightly acidic in all LGAs except in Isoko North. Water in Ukwani and Ika North were turbid (62 and 70%), puddles (37 and 40%) and had more of Anopheline mosquitoes whereas in other LGAs, water was clear, of diverse habitats and equally had more of Anopheline mosquitoes. Waters of breeding sites were majorly of rain sources, and when both Anopheline and *Culicine* larvae coexist, waters were clear and of man-made source. Water temperature (To), pH, total dissolve solids and conductivity were at optimum levels. To and pH were highest in breeding sites where Anopheline and Culicine coexisted. The differences between total dissolves solids, density of mosquitoes and electrical conductivity were significant ($p < 0.05$) whereas water temperature and hydrogen concentration were not significant in breeding sites ($p > 0.05$). The implication of this

result is that it can be adopted for vector control programs. Therefore, strengthened need is required for further studies on expanded focus and on manipulating these breeding site factors to minimize mosquito abundance.

Keywords: Breeding sites, GIS, Mosquitoes, Larval abundance, Physicochemical parameters

ABS-56

IgG antibody responses to *Anopheles gambiae* gSG6-P1 salivary peptide are induced in human populations exposed to secondary malaria vectors in forest areas in Cameroon

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Human IgG antibody response to *Anopheles gambiae* gSG6-P1 salivary peptide was reported to be a pertinent indicator for assessing human exposure to mosquito bites and evaluating the risk of malaria transmission. However, the applicability of this marker to measure malaria transmission risk where human populations are mostly bitten by secondary vectors in Africa has not yet been evaluated. Question: can anti-gSG6-P1 antibodies be induced in human population? Objective: Investigate whether anti-gSG6-P1 antibodies response could be induced in humans living in Nyabessang where *An. gambiae s.l* is not predominant. Blood samples were collected in October 2019 during malaria transmission picks from individuals living in Nyabessang, a malaria transmission hotspot located in the forest area of southern Cameroon region. Malaria diagnosis was performed by microscopy and species confirmed by PCR. The level of IgG Anti-gSG6-P1 response as a biomarker of human exposure to Anopheles bites was assessed by ELISA. Adult female mosquitoes were collected to assess Anopheles density and the related species. Out of the 1,442 Anopheles mosquitoes species collected, 849 (58.9%) were identified as *An. paludis*, 489 (33.91%) as *An. moucheti*, 28 (4.44%) as *An. nili*, 22 (2.08%) as *An. gambiae s.l* and 10 (0.69%) as *An. marshallii*. IgG antibody response to the gSG6-P1 peptide was detected in inhabitants of Nyabessang with high inter-individual heterogeneity. gSG6-P1 antibodies rate significantly correlated with malaria infection status. *Plasmodium falciparum*-infected individuals revealed high level of IgG response than uninfected individuals ($p = 0.0087$). Our findings reveal that IgG response to *An. gambiae* gSG6-P1 could be detected in humans exposed predominantly to *An. moucheti* and *An. paludis* bites. They further highlights the potential of anti-gSG6-P1 IgG antibody response as a potential marker to assess human exposure to any Anopheles species.

Keywords: IgG, gSG6-P1, *Anopheles*, Secondary vectors, Malaria, Equatorial forest

ABS-57

***Anopheles gambiae s.l.* populations biting and resting behaviors and they impact on the malaria epidemiological profile in the South of Senegal: Impact of exophagy/exophily on the malaria transmission**

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Malaria is a vector-borne disease caused by a protozoan of the genus Plasmodium transmitted by the infected bite of a female mosquito of the genus Anopheles. Residual malaria transmission is seen as the main challenge for malaria elimination in the South Senegal. Indeed, this region remains the area with the highest malaria incidences of the country likely due to its highest vector diversity with main vectors species being reported as mainly exophagic and exophilic without clear correlation to the observed disease burden. The objective of the study is to assess the potential impact of *Anopheles gambiae s.l*. biting and resting behaviors on the transmission pattern in South Senegal. The study was conducted from July 2020 to November 2021 in Djicomol and Cadjinolle in the district of Mlomp and in Wendaye in the commune of Diembering. Host-seeking and resting mosquito populations were respectively sampled indoors and outdoors by HLC, PSC and Prokopack aspirator. A total of 7162 *Anopheles gambiae s.l.* were collected over the study period, consisting of 3633 outdoors-HLC, 3106 indoors-HLC, 217 indoors-PSC and 206 outdoor-Prokopack caught specimens. An average biting rate of 20.06 bites per man-night was recorded. The physiological age of the females is on average 21.92%. The average resting indoors density was 1.55 females per room while the outdoors resting density was 0.69 females per resting shelter. *Anopheles gambiae s.s*. was the most predominant species of the complex in the study area during the study period. Surprisingly no infected female was found both among the whatever the biting place. The study showed that females of *Anopheles gambiae s.l*. have a relative tendency to be exophagic and rests both inside and outside of dwellings. However, the preliminary result failed to show the relation between these behaviors and the observed persistence of high malaria incidence in the study region.

Keywords: Biting and resting behaviors, *Anopheles gambiae s.l.*, exophagy, exophily, epidemiological, malaria, transmission, Senegal

ABS-78

Improvement of the malaria control in Cote d'ivoire: targeted strategy by identifying malaria risk hotspots to Bouna, 2021

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Wetlands and irrigated agricultural crops can create breeding sites for Anopheles mosquitoes, leading to heterogeneity in malaria transmission at the micro-geographical scale. This study aims to employ a multidisciplinary approach to identify hotspots of malaria

transmission in an agricultural context. Two cross-sectional surveys were conducted at the end of the dry season and the peak of the rainy season in rural and urban sites in Bouna, Northeastern Côte d'Ivoire. A total of 296 individuals from 148 agricultural households were randomly selected. During each visit, sociological, geographical, entomological, parasitological, and immunological data were collected. Vector density, malaria infection, and Anopheles exposure were then combined on thermal maps to identify malaria transmission hotspots.Results: Malaria vectors, including An. gambiae (96.38%), *An. funestus* (0.46%), and *An. nili* (0.22%), constituted the Anopheles fauna during the study. In rural areas, parasitic prevalence varied between the dry season (51.31%) and the rainy season (53.95%). In urban areas, parasitic prevalence was lower, with rates of (19.17%) and (18.49%) between the dry and rainy seasons, respectively. Geographical heterogeneity in malaria transmission was observed in both rural and urban areas. The presence of irrigated crops and wetlands increased the risk of malaria transmission. Households located within ≤400 meters of the lowlands were the most exposed to Anopheles bites in urban areas between the two seasons (p=0.0001). The presence of lowlands in urban areas and irrigated agricultural practices in rural areas sustain malaria transmission in agricultural households. The identification of micro-geographical areas, combining different epidemiological parameters on thermal maps, enabled the identification of malaria transmission hotspots and will contribute to the implementation of malaria control measures, such as seasonal chemoprophylaxis.

Keywords: targeted strategies; malaria control; hotspot; Bouna; Côte d'Ivoire

ABS-79

Contribution of *Anopheles gambiae* mosquitoes to malaria transmission during the dry season in Djoumouna and Ntoula villages, Republic of Congo

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Anopheles gambiae mosquitoes have been reported to play a major role in malaria transmission in Africa. So far, data on *Anopheles gambiae sensu lato* are poorly documented in rural areas. The present study assesses the implication of *Anopheles gambiae s.l*. in malaria transmission in two rural areas in Republic of Congo. Adult mosquitoes were collected using electric aspirator from June to September 2022 in Djoumouna and Ntoula villages and were identified morphologically. *An. gambiae* s.l. were further processed by PCR to discriminate members of this group. TaqMan analysis and Nested-PCR were performed to determine Plasmodium infection rate in *An.*

gambiae s.l. Entomological indexes including Aggressiveness rate, , Entomological inoculation rate, Density of resting Anopheles and Parity rate in *An. gambiae s.l*. and the diversity index were also determined.

A total of 176 mosquitoes were collected, the most common genus identified was Anopheles *An. gambiae s.l.* 85.8% (151) followed by Culex 13.6% (24) and Aedes 0.6% (1). Three Anopheles species were collected in both villages including *An. gambiae* 74.3% (107/144), *An. coluzzii* 22.9% (33/144) and *An. arabiensis* 2.8% (4/144) in mosquitoes samples subjected to PCR analysis. *Plasmodium* infection rate was 35.1% (53/151) using TaqMan assay, 82% (41/53) were confirmed by nested PCR, with 70.7% (29/41) and 29.3% (12:41) from Djoumouna and Ntoula respectively. Entomological inoculation rate was 14.6 p/h/n in the two villages. Three *Plasmodium* species were detected in *An. gambiae s.l, P. falciparum, P. malariae and P. ovale*. This study provides baseline information on the involvement of *An. gambiae* in malaria transmission in the rural areas during the dry season. All of identified Anopheles species were found to be infected with Plasmodium spp. at both rural areas confirming the implication of this malaria vector in malaria transmission in Republic of Congo.

Keywords: An. *gambiae s.l*, Plasmodium species, Malaria transmission, rural areas, Republic of Congo.

ABS-83

First detection of rifampin- and ofloxacin-resistant *Mycobacterium leprae* in chad (central africa).

Abakar Kirga Kabo (hgrn)*

Antimicrobial surveillance and identification of the genetic basis of antimicrobial resistance

provides important information to optimize patient care. The present study was an analytical crosssectional study aimed at determining the prevalence of rifampicin and ofloxacin resistance genes among *Mycobacterium leprae* strains in three health districts in Chad. The determination of the folP1, rpoB and gyrA resistance genes was carried out by PCR-RLEP and confirmed by sequencing from 80 biopsy samples taken from patients with multibacillary leprosy, including 12 relapsed patients and 68 new cases. In the whole cohort, 1/80 (1.2%) showed resistance to rifampicin and 1/80 (1.2%) to ofloxacin. No mutations were detected for dapsone. The presence of *M. leprae* mutation associated with rifampicin resistance was observed in a relapsed patient and the mutation associated with ofloxacin resistance was observed in a patient with multibacillary leprosy who had not been sensitized by ofloxacin but should have used other quinolones. Both mutant strains revealed the emergence of secondary resistance. This study, the first to highlight the emergence of resistance to rifampicin and ofloxacin in Chad. It raises the need to implement a robust surveillance system to detect resistance of *Mycobacterium leprae* in Chad and even in Central Africa.

Keywords: *Mycobacterium leprae*, resistance, Chad

ABS-84

Characterization of *Anopheles* species and larval habitats in Bobirwa district, Botswana: a malaria hotspot area in an elimination setting.

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Numerous *Anopheles* mosquito species are vectors of malaria with variance in vector capacity for the malaria parasite. However, there is limited entomological data in Bobirwa district. This study was formulated to characterize larval habitats, species abundance and distribution in Bobirwa district, in eastern Botswana. Anopheles larvae were sampled using the dipping technique between March and June in 2020 and 2021 from seven sampling sites. The larval habitats were characterized based on habitat type, permanence status, water turbidity, vegetation coverage and substrate type. All collected larvae were transported to a temporary insectary in Bobonong and reared to adult mosquitoes before carrying out morphological and molecular identification.Riverbed pools, leaking water pipes pools and a pond were identified as Anopheles breeding habitats, with riverbed pools as the main habitats. A total of 11,412 Anopheles mosquitoes emerged from the collected larvae in 2020 (n = 4,309) and 2021 (n = 7,103) from the 7 study sites. Morphological identity revealed presence of *Anopheles gambiae sensu lato (s.l.)*, *Anopheles funestus s.l., Neocellia Series* and *An. squamosus* group. Species specific PCR of a subset (n= 512) of *An. gambiae s.l*. from 2020 and 2021 revealed 99.8% dominance of *An. quadriannulatus* (n=511) and 0.2 % (n=1) *An. arabiensis* while *An. funestus s.l.* was not identified to species level. The diversity of the anopheline species and their high relative abundance possibly indicate a highly adaptable transmission system which may require additional vector control interventions. Characterization of the *Anopheles* breeding sites and proper implementation of larval source management strategies to reduce larval positivity would supplement the efforts of malaria elimination in Botswana. Further entomological research to characterize the biology and ecology of these species would be fundamental for effective control interventions.

Keywords: Malaria, *Anopheles* species, Larval habitats, Bobirwa district,

ABS-85

Constrasting association of Asaia spp. with pyrethroid resistance escalation in the malaria vectors *Anopheles funestus* and *Anopheles gambiae*

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Microbiome composition has been associated with insecticide resistance in malaria vectors. However, the contribution of major symbionts to the increasingly reported resistance escalation remains unclear. This study explores the possible association of a specific endosymbiont, Asaia spp., with elevated levels of pyrethroid resistance in *Anopheles funestus* and *Anopheles gambiae strains*. Genetic crosses were established between pyrethroid-resistant and susceptible mosquitoes in *An. funestus* (fumoz x fang) and *An. gambiae* (mangoum x kisumu). The F4 progeny of each strain was exposed to increasing concentrations of pyrethroids and genotyped for known insecticide resistance markers (CYP6P9a/b, 6.5 kb, L1014F, and N1575Y). *Asaia* spp. was then detected and quantified in the alive and dead samples in order to assess the association between the symbiont and the elevated level of pyrethroid resistance. A high level of pyrethroid resistance was observed in both species and genotyping of key resistance mutations revealed a strong association with the resistance phenotype. The prevalence of *Asaia* spp. in the fumoz x fang strain was associated with the resistance phenotype at a 5x dose of deltamethrin (OR = 25.7; p = 0.002). Mosquitoes with the resistant allele for the markers tested were significantly more infected with Asaia compared to those possessing the susceptible allele. Furthermore, the abundance correlated with the resistance phenotype at 1x concentration of deltamethrin (p= 0.02, mann-whitney test). However, for the mangoum x kisumu strain, findings rather revealed an association between the abundance of Asaia and the susceptible phenotype (p= 0.04, mann-whitney test), demonstrating a negative link between the symbiont and permethrin resistance. This bacteria should be further investigated to establish its interactions with other resistance mechanisms and cross-resistance with other insecticide classes.

Keywords: Malaria; *Anopheles gambiae*; *Anopheles funestus*; *Asaia* spp.; Resistance escalation; Cytochrome P450; Voltage-gated sodium chan

ABS-89

Community acceptance and longer residual effect and efficacy of a new IRS product VECTRON™ T500 (broflanilide) against pyrethroid-resistant *Anopheles gambiae s.l.* populations from rural Burkina Faso.

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Insecticide resistance spread in malaria vectors is a threat to vector control tools effectiveness. In searching the innovative compounds for insecticide resistance management, VECTRON™ T500 (broflanilide as a50% wettable powder), a newly developed Indoor Residual Spraying (IRS) product has been developed. The efficacy of VECTRON™ T500, a wettable powder formulation of broflanilide, was assessed for IRS against wild pyrethroid-resistant malaria vector in community (Phase Ⅲ) trial in rural areas, Burkina Faso. A two-arm non-inferiority cluster randomized controlled trial (Phase III) was undertaken in rice-growing in Burkina Faso. VECTRON™ T500 efficacy was tested alongside the reference IRS product, Actellic® 300 CS. Residual efficacy of both IRS products was monitored for 10 months post intervention on three types of walls. Indoor resting mosquitoes were also monthly collected to estimate mosquito mortality rate due to effects of applied insecticides per arm. A well-structured questionnaire was administered to explore acceptance, adverse effects and benefits of IRS.VECTRON™ T500 showed 100% mortality rates WHO bio-efficacy threshold on three types of walls either with susceptible or resistant *An. gambiae s.s*. over 10 months longer than reference product, Actellic® 300CS. Furthermore, VECTRON™ T500 induced 70–76% overall mortality whatever substrate-types while Actellic® 300CS induced 35-47% mortality but a statistically significant difference after 72-holding compared to unsprayed site (RR=0.51, IC95%= [0.31–0.6], P=0.0026. No adverse event was recorded in sprayed site by VECTRON™ T500. VECTRON™ T500 shows potential to provide substantial and prolonged control of malaria transmitted by pyrethroid-resistant mosquito vectors when applied for IRS. Due to the different mode of action of broflanilide, this product could be included in a rotation of IRS products for insecticide resistance management purposes.

Keywords: VECTRON™ T500, Actellic® 300CS, indoor residual spraying, efficacy, Anopheles gambiae sl, Burkina Faso

ABS-90

Biochemical mechanisms of *Aedes aegypti* resistance to insecticides in the communes of Pobè and Ifangni, Benin

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The *Aedes aegypti* mosquito is the main vector involved in the transmission of arboviroses, the most important of which are Dengue, Yellow Fever, Zika and Chikungunya. In the absence of a vaccine against most of these diseases, vector control using insecticides remains the panacea. The repeated use of these insecticides leads to the selection of resistant individuals. This makes the elimination of these diseases more complicated. It is therefore necessary to periodically review the resistance status of the incriminated vector. The present study was therefore initiated to assess the level of susceptibility of *Aedes aegypti* populations to the insecticides deltamethrin and bendiocarb, and to characterise the biochemical mechanisms of detoxification in the vector in the communes of Ifangni and Pobè in southern Benin. To achieve this, *Aedes* larvae were collected in the different localities. The susceptibility of 2- to 5-day-old *Aedes aegypti* females obtained from emerging larvae was tested to insecticides (deltamethrin and bendiocarb) and enzymatic resistance mechanisms (Glutathione-S-Transferase, esterase and oxidase) were characterized. The results showed a sensitivity of *Aedes aegypti* to bendiocarb. However, these *Aedes aegypti* populations developed a phenotypic resistance against Deltametrin. In addition, our results showed that the different *Aedes aegypti* populations have a significantly high enzymatic activity compared to the susceptible strain ($p<0.05$) in GST and MFO. In contrast, low esterase activity is observed in *Aedes aegypti* populations. This could make the control tools currently deployed in Benin less effective. These results encourage control programs to continue implementing updated resistance management mechanisms.

Keywords: *Aedes aegypti*, insecticide resistance, detoxification enzymes

ABS-94

Impact of using different types of mosquito traps to assess entomological efficacy of dual-active ingredient long-lasting insecticidal nets (LLINs) in Benin

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Selection of mosquito sampling traps is of crucial importance to evaluate impact of vector control tools on entomological outcomes. During a cluster randomised control trial evaluating the relative efficacy of two dual-active ingredient (a.i.) nets compared to pyrethroid only nets, we assessed performance of different mosquito trap types: Human Landing Catch (HLC), CDC light traps, and Pyrethrum Spray Catch (PSC). Anopheles mosquitoes were collected with the three trap types in 4 houses in each of the 60 trial clusters at baseline and every quarter for 24 months using PSC and HLC, while CDC light traps were performed during two quarters only. The density of *An. gambiae s.l* and its *P. falciparum* sporozoite infection were assessed. Mean density of vectors collected per trap per night was the highest with HLC (15.9), followed by CDC light trap (6.8), with the PSC (1.1) collecting 10 times less mosquitoes than HLC. All three trap types showed that the lowest mosquitoes density was collected in the Interceptor G2® dual a.i. arm compared to the other arms, although only HLC and PSC demonstrated strong evidence of this due to a greater number of collection rounds than CDC light traps. Furthermore, CDC light traps and PSC measured similar reductions in SR and EIR* (*CDC light trap only) as compared to HLC between study arms. The broadly similar results between trap types suggest that the more ethically acceptable, cheaper and logistically simpler methods such as CDC light traps could be prioritised for use in the present cluster randomized controlled trial for measuring efficacy of vector control tools.

Keywords: HLC, CDC light trap, PSC, Interceptor G2

ABS-97

Mosquito surveillance in maritime port of Cotonou, Benin: Monitoring of species diversity and assessment of mosquito susceptibility to insecticides

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Seaports are one of the most important gateways for coastal countries and deserve permanent surveillance of invasive species. The objective of this study was to monitor invasive alien mosquito species in the seaport of Cotonou. The study was conducted at the Port Autonome de Cotonou (PAC) from May to November 2022. Located in southern Benin, the PAC covers an area of 400,000 m2. Adult mosquitoes were captured using BG-Sentinel traps baited with a BG lure for 5 successive days each month at 11 selected sites. These mosquitoes are then identified morphologically using taxonomic keys. Larval collections of Aedes and Culex were made and reared until adult emergence. Four batches of approximately 25 unfed adult female mosquitoes, 2-5 days old, were exposed to four insecticides

(bendiocarb 0.1%, pirimiphos methyl 0.25%, permethrin 0.75%, and deltamethrin 0.05%) for 60 minutes using the WHO tube test protocol . Mosquito susceptibility was determined after 24 hours according to WHO criteria (WHO, 2006). 455 mosquitoes belonging to six species were captured: *Anopheles gambiae*, Anopheles pharoensis, *Culex quinquefasciatus*, *Mansonia africana*, *Mansonia uniformis* and *Aedes aegypti. Aedes aegypti and Culex quinquesfasciatus* were dominant.

A total of 294 female Culex mosquitoes and 399 female *Aedes* mosquitoes were exposed to bendiocarb, pirimiphos methyl, deltamethrin and permethrin. *Aedes* mosquitoes showed resistance to pyrethroids but were susceptible to bendiocarb and pirimiphos-methyl, whereas *Culex* mosquitoes were resistant to pyrethroids and bendiocarb but susceptible to pirimiphos-methyl. Our results show a low diversity of mosquito species, but they are all vectors of human diseases that can be effectively controlled by the molecule pirimiphos-methyl. Monitoring of mosquitoes at ports of entry is crucial to allow early detection of mosquito species that are potential vectors of pathogens.

Keywords: invasive, surveillance, *Aedes*, Resistant

ABS-98

Factors affecting the horizontal transmission of 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. A naturally occurring symbiotic microsporidian, Microsporidia MB, isolated from *Anopheles arabiensis* in regions of central and western Kenya was found to block Plasmodium transmission. The microbe is vertically transmitted from an infected mother to its offspring (at a 45%-100% rate) and horizontally transmitted through mating at a 59% rate from an infected male mosquito to an uninfected female and at a 33% rate from an infected female to an uninfected male. Our study investigated the effect of age on Microsporidia MB transmission and the effect of Microsporidia MB infection on the mating rate of the males. Different age groups of Microsporidia MB infected males were mated with age-matched virgin females. Mating success was determined by the presence of sperms in the females' spermathecae, and qPCR analysis was done to determine if Microsporidia MB transmission occurred. To compare the mating competitiveness, fluorescent dye (Rhodamine B dye) was used to differentiate between the Microsporidia MB infected and uninfected males. Virgin Microsporidia MB uninfected females were added and allowed to mate for 3 days, and the females' spermathecae were dissected. The number of females that had sperms and fluoresced and those that had sperms but didn't fluoresce were recorded and compared. The results show that Microsporidia MB transmission increases with age and preliminary results show that Microsporidia MB doesn't have any significant effect on the male mosquitoes' mating rate. These results

can be utilized to increase Microsporidia MB prevalence in *Anopheles* populations, aiding in the development of a Microsporidia MB dissemination strategy.

Keywords: Mcrosporidia MB, malaria blocking, Microsporidia MB transmission

ABS-100

Knowledge, practices and perceptions of women during a malaria larviciding randomized trial in the city of Yaounde, Cameroon

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Women are the key actors in the implementation of malaria vector control. To improve malaria vector control, a pilot larviciding trial was conducted to assess its impact on mosquito density and malaria transmission intensity in Yaounde. The present study investigated perceptions and practices of women on malaria control during the larviciding trial implemented in Yaounde. Quantitative and qualitative data were collected in non-intervention and intervention areas. Quantitative data were collected using a structured pre-tested questionnaire while qualitative data were obtained through interviews. A total of 26 in-depth interviews and eight focus group discussions with only women members were performed. A binary logistic regression model was used to assess the perception of the women on larviciding impact on some malaria or bed net use indicators. Women living in intervention areas were 2.64 times more likely to know the mode of malaria transmission (95% CI: 1.82–3.84; p<0.001) and 1.3 times more likely to know mosquito breeding habitats (95% CI: 1.06–1.56; p = 0.009) compared to those living in non-intervention areas. In intervention areas, women's opinions on larviciding were generally good i.e. most women reported having noticed a reduction in mosquito nuisance and malaria cases following larvicidingimplementation; whereas in non-intervention areas no report of reduction of mosquito nuisance was recorded. LLINs were regularly used by women and girls despite the implementation of larviciding treatments. There was high interest in the larviciding program and demand for continuation, even if this needs community involvement. The larviciding program in the city of Yaounde ´ did not negatively affect women's behaviour and practices concerning the use of treated nets. High interest of women in mosquito control methods and acceptance of larviciding programs, were noticed. This positive environment could favour the implementation of future antilarval control activities.

Keywords: Malaria, Vector control, women perception, practices, Larviciding, Behaviour change, LLIN, Yaoundé

ABS-102

Field Evaluation Of Carbondioxide And Light As Attractants In Mosquito Trap.

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Mosquito traps play a vital role in monitoring mosquito populations and mosquito-borne diseases. Through surveillance programs, mosquito trap efficacy has been used as justification for implementation and intervention of control measures. This study is aimed at testing the efficacy of light and carbon dioxide from yeast fermented sugar as attractants in mosquito trap.JAT-17 trap was used for the experiment, with four traps set close to each other in the environmental garden, the first one with light only, the second one with CO2 only and the third one with a combination of light and CO2, while the last one was left empty to serve as control for the experiment. The study revealed that combination of both light and the yeast fermented CO2 (synergistic effect) was found to be more efficient in trapping mosquitoes that the individual attractant having a percentage catch of 48.8%, followed by the light only having 29.5%, then the CO2 only with 17.8%, whereas the control had the least percentage catch of 3.9%. also the results shows that only two species were encountered during the experiment, which identified to be *Culex quinquifasciatus* and *Aedes aegypti* with 89.2% and 10.8% occurrence respectively. Therefore, based on the findings of this study, the combination of both light and CO2 will be more suitable for monitoring mosquito populations and mosquito-borne diseases and people are advised to take bath and switched off light before sleeping as odour and light are good attractants for mosquitoes.

Keywords: Light, Carbon dioxide, JAT-17 trap.

ABS-103

Characterization of *Anopheles gambiae's* phageome reveals an association between resistance to pirimiphos-methyl resistance and Petitvirales

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Efforts to control malaria vectors are undermined by the rise of insecticide resistance. Following the increasing evidence of the involvement of certain bacteria in the microbiota of mosquitoes in the degradation of insecticide molecules, we characterized the biodiversity of bacteriophage communities in wild-caught resistant mosquitoes. The CDC (Centre for Diseases Control) bottle assay was used to characterize the resistance profile of 4–5-day old adult mosquitoes to deltamethrin and pirimiphos-methyl. Using total RNA sequencing, we characterized the bacteriophage communities of natural populations of resistant *An. gambiae s.l*. collected in the larval state in Bassila and Djougou, which are sentinel sites of Benin's National Malaria Control Programme (NMCP). Forty (40) % of the mosquitoes from Djougou survived 5x the diagnostic dose of deltamethrin while none of those collected in Bassila survived the same dose. Fifty (50) % of the Bassila mosquitoes survived 1.5x the diagnostic dose of pirimiphos-methyl compared to 30% survival in the Djougou population. In total, eighty-three (83) bacteriophages grouped in 7 families and 2 orders (Caudovirales and Petitvirales) were identified in *An. gambiae* s.s. The diversity of bacteriophage communities between *An. gambiae s.s.* mosquitoes from Bassila and Djougou were significantly different (PERMANOVA; pseudo-F = 2.779; p< 0.05). Comparisons between mosquitoes that survived exposure and those that were not exposed to insecticide significantly associated the abundance of Petitvirales with resistance to pirimiphos-methyl in *An. gambiae* s.s. (EdgeR; p<0.05; FDR<0.05). Our findings show that the bacteriophage community of *An. gambiae s.s*. mosquitoes is dominated by Caudovirales and Petitvirales. Furthermore, they linked the abundance of Petitvirales in *An. gambiae* s.s. with resistance to pirimiphos-methyl and opens new possibilities for the design of alternative vector control tools.

Keywords: Insecticide resistance, *Anopheles gambiae*, phage, Petitvirales¸ pirimiphos-methyl.

ABS-108

Malaria Vectors and Insecticidal Resistance Status in Anambra State, Nigeria

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Malaria is a major public health problem in Nigeria. Insecticides play significant role in malaria control but the insecticides used for malaria vector control is threatened by emergence of insecticidal resistance. The study investigated the resistance status of major malaria vectors. Larval samples were collected from habitats using dipper method and reared to adult for susceptibility test. Target site resistance assay was carried out to determine knock down resistance. Data were analyzed using ANOVA and least significant difference (LSD) test. Fisher exact tests were also used for Mosquito mortality test. The result showed Anopheles gambiae as the predominant vector (54.2%), followed by *Anopheles coluzzii* (45.8%) . The percentage mortality of *Anopheles gambiae* s. l. after 24 hours was 100% in Malathion and Bendiocarb. The mortality rate in Permethrin ranged from 62%- 65% and that for Deltamethrin was 54%-63%. Awka South LGA recorded the highest knock down time (KDT) and the KDT50, KDT90, and KDT95 were 170 minutes, 396.5 minutes, and 501 minutes, respectively. The distribution of the frequency of resistant allele of the kdr gene F (L1014F) showed that the number of homozygous resistant genotype

(RR) in Awka North LGA for *An. gambiae* and *An. coluzzii* species was highest (31), followed by Awka South (20), and Njikoka (5) LGAs, respectively. The number of heterozygous resistant genotype (Rr) was highest in Awka South (7), followed by Awka North (2), and Njikoka (0). The highest number of susceptible homozygous genotype (rr) was observed in Njikoka LGA (2), Awka North (1) and Awka South (0). Homozygous resistant genotype (RR) was frequently observed in the study areas. The observed resistance threatens the use of pyrethroids for insecticidal control of malaria vectors.There is therefore an urgent need for implementation of insecticide resistance management strategies and expanded insecticide resistance monitoring in Anambra State to avert danger.

Keywords: Malaria, vectors, insecticide, resistance, status, Anambra State, Nigeria

ABS-111

Evolution of the Vgsc-1014, Ace1 and Gste2 Mutations and Their Potential Impact on the Use of insecticides in IRS for Controlling *Anopheles gambiae* s.l. the Major Malaria Mosquito in Senegal

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Widespread of insecticide resistance amongst the species of the *Anopheles gambiae* complex continues to threaten vector control in Senegal. In this study, we investigated the presence and evolution of the Vgsc-1014, Ace-1 and Gste2 resistance genes in natural populations of *Anopheles gambiae s.l*. in Senegal. Using historical samples collected from ten sentinel health districts, this study focused on three different years (2013, 2017, and 2018) marking the periods of shift between the main public health insecticides families

(pyrethroids, carbamates, organophosphates) used in IRS. Molecular species of *An. gambiae s.l*. and the resistance mutations at the Vgsc-1014, Ace-1 and Gste2 loci were characterised using real time PCR methods. The genetic diversity and the evolution of each gene were further analysed by sequencing. The results revealed the presence of four members of the *Anopheles* gambiae complex, with the predominance of An. arabiensis followed by An. gambiae s.s., An. coluzzii, and hybrids of *An. gambiae – An. coluzzii* . Both Vgsc-1014F and Vgsc-1014S mutations were found in all studied populations with a spatial variation of allele frequencies from 3% to 90%; and 7% to 41%, respectively. The Vgsc-1014 gene was found to be highly diversified with eight different haplotypes shared between Vgsc-1014F and Vgsc-1014S. The Ace-1 mutation was only detected in *An. gambiae* and *An. gambiae–coluzzii* hybrids at low frequencies varying between 0.006 and 0.02, while the Gste2 mutation was found in all the species with a frequency ranging between 0.02 and 0.25. The Ace-1 and Gste2 genes were highly diversified with twenty-two and thirty-one different haplotypes, respectively. These data are of the highest importance to support the NMCP for evidence-based vector control interventions selection and targeting.

Keywords: Insecticide resistance, *Anopheles gambiae* s.l., Vgsc-1014, Ace-1, Gste2, evolution, genetic diversity, haplotypes, Senegal

ABS-117

Using Serratia spp. bacteria to block *Plasmodium t*ransmission in malaria vector mosquitoes in Burkina Faso.

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The ever-increasing mosquito resistance to insecticides seriously limits our ability to fight malaria. The development of new strategies to control and eventually eliminate the disease is urgently needed. A promising strategy for malaria control is the use of symbiont bacteria to block parasite development within mosquitoes. This search aims to study the ability of bacteria Serratia spp. to inhibit the development of *Plasmodium*. The study was conducted of June to November 2021 at the IRSS and the Centre Muraz. Mosquitoes were collected in the localities of Soumousso and Vallee du Kou located in the west of Burkina Faso. Using molecular biology techniques, we characterized Serratia Spp. and to study their ability to block the development of Plasmodium falciparum, mosquitoes were co-infected with the Serratia bacteria and Plasmodium using microbiology, experimental infection and molecular biology techniques. From our findings the prevalence of Serratia spp. within mosquitoes was ~12.29% (56/456). *Serratia* showed a considerable lowering effect on the prevalence (control group =0.44±0.12 versus Serratia treated group =0.27±0.12) and intensity (control group =2.24±0.31 versus treated Serratia group =1±0,16) of oocysts in mosquitoes. Interestingly Serratia showed an important transmission reduction activity of 55.36% on wild

Plasmodium falciparum within mosquitoes. In addition, *Serratia* did not impact the survival rates of infected mosquitoes (10.40± 0.31) compared to the uninfected ones (9.64 ± 0.25). Our study has shown that Serratia spp. is a potential tool to block the transmission of malaria within mosquitoes. However, further studies under field conditions are required to draw more conclusions on the practical usefulness of this bacterium in the fight against malaria.

Keywords: Malaria, Burkina Faso, *Anopheles gambiae*, symbiont, bacteria, *Serratia* spp., *Plasmodium falciparum*

ABS- 334

Nationwide assessment of malaria vector susceptibility to chlorfenapyr, pyriproxyfen, and alpha-cypermethrin in preparation for widescale deployment of new generation nets (Interceptor® G2, PermaNet® Dual and Royal Guard® nets) in Benin

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Pyrethroid resistance is widespread in sub-Saharan Africa, and threatens the effectiveness of pyrethroid-treated mosquito nets. To manage this generalized resistance to pyrethroids, new-generation insecticide-treated nets (NG-ITNs) with new active ingredients (AIs) have been developed. This evaluation aims to assess malaria vector susceptibility to 3 AIs (chlorfenapyr, pyriproxyfen, and alpha-cypermethrin) before the widescale deployment of NG-ITNs nationwide. The study was conducted in all 34 health zones throughout Benin. In each health zone, a simple random sample of one commune was selected using the sample function in R. Larval collections, rearing to adults, and susceptibility testing was carried out in all communes between August and December 2022 on Anopheles gambiae s.l. Standard WHO tube test was Pused for alpha-cypermethrin, and WHO bottle bioassay was used from chlorfenapyr and pyriproxyfen. Mosquitoes were resistant to alpha-cypermethrin with mortality rates ranging from 1% to 69%. Mosquitoes exposed to 100 µg chlorfenapyr died after 24 hours except in 3 communes where mortality rates ranged from 80% and 97%; however, mortality did reach 100% after 48 hours. For pyriproxyfen, all mosquito populations exposed to 100 µg pyriproxyfen were infertile with no eggs reaching the Christopher stage V (the majority were blocked at stage III), whereas most eggs of the same mosquito population exposed to acetone (control) reached

the Christopher stages with fertility rates up to 68%. This evaluation provides key data on malaria vector susceptibility to the new AIs on NG-ITNs across Benin, suggesting that the deployment of NG-ITNs should be effective in controlling mosquitoes. Although chlorfenapyr was lethal and pyriproxyfen inhibited fertility, operational evaluations will help to better understand the relative efficacy of Interceptor® G2, PermaNet® Dual and Royal Guard® nets.

Keywords: Vector susceptibility, deployment, new generation nets

ABS 255

Building structures for *Anopheles stephensi* surveillance and control: Lessons Learnt from Kenya.

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In Kenya malaria is heterogeneous in its distribution with a prevalence of 6%. The mainstay malaria vector control interventions include; Insecticide-treated nets (ITNs), indoor residual spraying (IRS), and Larval source management (LSM). Currently, these malaria vector control interventions are facing a significant threat due to reports of the new invasive mosquito - Anopheles stephensi. An. stephensi has been expanding its geographic range over the last decade, with detections reported in Djibouti (2012), Ethiopia and Sudan (2016), Somalia (2019), and Nigeria (2020). Recently (December and February 2022), this species was reported in Kenya in Marsabit and Turkana counties which border Ethiopia and South Sudan respectively. Prior to its detection Kenya developed structures such as establishment the *An. stephensi* taskforce to guide the mobilization of partnerships, resources, and expertise to facilitate implementation of *An. stephensi* surveillance activities. The taskforce led development of guidelines that outline the surveillance activities for *An. stephensi* for timely detection, elimination from the invaded areas, and prevent invasion of new areas. This guided intensified vector surveillance whereby vector surveillance activities were harmonized to include *An. stephensi*. After its detection in December 2022, a policy brief was developed. The brief contained key recommendations for surveillance and control at national and community level. Currently, the country is training a critical mass of health workers who will be involved in surveillance and control activities, especially in dry ports, sea ports, major urban centers, and areas bordering countries where An. stephensi has been reported. The existing vector control strategies and novel ones are being explored further based on *An. stephensi* behavior. In conclusion, the establishment of structures for An. stephensi surveillance and control require strengthened collaboration through the coordination of the NMCPs.

Keywords: *Anopheles stephensi*

ABS-210

Treated eave screens in combination with screened doors and windows, are more effective than untreated eave screens in a similar combination in reducing indoor and outdoor Anopheles populations under semi-filed conditions in western Kenya

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Human dwellings remain the main point of human-mosquito interaction leading to malaria transmission despite sustained use of insecticide-based interventions indoors. Simple structural modifications have the potential to prevent mosquito entry into houses and reduce malaria transmission. The study utilized four huts, each constructed inside a semi-field structure for the experimental release of mosquitoes. Two huts had screened eaves, doors, and air cavities in place of windows while the other two were unscreened. In experiment 2, screened eaves were untreated with Actellic® insecticide while in Experiment 1, the eave screens were not. First filial (F1) generation of An. funestus from Siaya, F0 reared from An. arabiensis larvae from Ahero and An. arabiensis Dongola strain from the insectary were raised to adults and used in experiments. Two hundred, 3-day old adults of each species were released in each semi-field structure at dusk and recaptured the following morning. A single volunteer slept in each hut under an untreated bed net each night. Significantly fewer An. arabiensis from Ahero RR=0.10; (95%CI: 0.02-0.63), An. arabiensis Dongola strain RR=0.11; (95%CI: 0.06 – 0.19) and An. funestus from Siaya RR=0.10; (95%CI: 0.06-0.17) were observed inside modified huts compared to unmodified ones. Treating of eave screen material significantly reduced the numbers An. arabiensis from Ahero RR=0.05; (95%CI: 0.00-0.77) and An. arabiensis Dongola strain RR=0.34; (95%CI: 0.18-0.64) indoors of huts with treated eave screen compared to huts with untreated eave screens, while eliminating the An. funestus indoors. Modification of eaves, doors and windows are effective ways of reducing mosquito entry into houses. Treatment of eave screen material with an effective insecticide further reduced the Anopheles population in and around the screened huts under semi-field conditions and could greatly complement existing vector control efforts.

Keywords: house, screening, anopheles

ABS-149

Digitalizing school-based insecticide-treated net distribution as part of a contingency plan after the withdrawal of indoor residual spraying in Benin

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Continuous distribution of ITNs through schools has been recognized as a viable approach to maintaining net coverage and facilitating malaria control. In 2018, in Atlantic department, school-based distribution of ITNs and malaria prevention education was piloted in central Benin in 1st and 6th grade of which the approach was generally found to be feasible. In 2018, ITN distribution through primary schools was implemented as part of a contingency plan to mitigate malaria resurgence after IRS withdrawal. This school-based distribution used digitalization processes and tools to deploy the ITN. This abstract describes the implementation process and achievements of this activity. The distribution process was digitized with mobile phones installed with Open Data Kit (ODK) predesigned with data collection forms which were used to collect accurate data about the list of schools, the selected teachers for distribution, and the names of each student who received an ITN. An ArcGIS dashboard was set up to visualize data in real time. In 2022 a total of 707 elementary schools in Djougou-Ouaké-Copargo and Kandi-Gogounou-Ségbana Health Zones were enrolled, and 42,294 school children (22,254 boys and 20,040 girls) received an ITN. In addition, all school children were taught about malaria prevention before receiving nets. Moreover, anti-malaria clubs were set up in all beneficiary schools to conduct communication activities regarding malaria prevention. The digitalization of the distribution made the reporting process easy, accurate, and transparent. The ITN distribution through schools may play a key role in strengthening the ownership and use of ITNs; this may have strengthened protection against mosquito bites and minimized the risk of an upsurge of malaria transmission after IRS withdrawal.

Keywords: Digital, school distribution, contingency, IRS withdrawal

ABS-592

Determination of the residual efficacy of micro-encapsulated pirimiphos-methyl (Actellic® 300CS) Insecticide for indoor residual spraying in Ethiopia

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The rate of decay of the biological efficacy of insecticides used for indoor residual spraying (IRS) is an important factor when making decisions on insecticide use for national malaria control programs. Previous tests using bendiocarb and the organophosphate pirimiphos-methyl emulsifiable concentrate (EC) indicated a short residual activity and was strongly affected by both the wall surface and soil type.

Bendiocarb showed poor residual life on mud and dung walls, the most used in areas where IRS is conducted. A key concern of IRS program is insecticide resistance. Resistance is detected to most existing insecticides used for IRS (DDT, organophosphates and carbamates). However, micro-encapsulated pirimiphos-methyl (Actellic® 300CS) has had positive results in several trials, but little is known on its persistence in different settings in Ethiopia. Thus, the aim of this experiment was to confirm the persistence of Actellic® 300CS by spraying the insecticide formulation on different wall surfaces (mud, dung, paint cement and iron sheet) and determine its decay rates over time in Ethiopia. The results of this trial revealed that the residual efficacy of Actellic 300CS extends up to eight months in all treated wall surface types which is ideal to be considered as a potential candidate insecticide formulation in malaria endemic countries such as Ethiopia.

Keywords: Actellic® 300CS, IRS, Ethiopia

ABS-251

Effect of phytoplankton Scenedesmus quadricauda (Meyen, 1929) on larvae of Anopheles gambiae (Giles, 1902) in the presence of their reference food

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A preliminary study under laboratory conditions has shown that the phytoplankton species *Senedesmus quadricauda* has a deleterious effect on Anopheles gambiae larvae. The introduction of this phytoplankton species in the mosquito larvae breeding habitats requires a broad knowledge on mosquito's larvae behaviour in their habitat such as trophic preference. The present study was initiated to understand the effect of S. quadricauda phytoplankton on An. gambiae larvae in the presence of other food sources under laboratory. Anopheles gambiae larvae were exposed to S. quadricauda alone, the laboratory reference larval food (cat food) alone, and the mixture of the two foods. The gut contents of the larvae were observed microscopically immediately after feeding to determine the type of food ingested by the larvae. The feed digestibility was determined by observing the condition of the larval gut after dissection of the larvae every hour until 8 hours after exposure of the larvae to the feed. *Anopheles gambiae* larvae ingested both phytoplankton and cat food in

the presence of these two foods. When the larvae consumed the cat food, this food disappeared from the larvae's intestine 5 hours after exposure. In contrast, the larvae gut content changed very little when they consumed the phytoplankton S. quadricauda, which was observed in the larvae gut throughout the experiment. Under laboratory conditions, it appears that in the presence of S. quadricauda and reference mosquito larval food, *An. gambiae* larvae consumed *S. quadricauda* phytoplankton, are unable to digest it and die. Scenedesmus quadricauda seems a promising complementary tool for malaria vectors control and needs to be tested in natural conditions.

Keywords: *Anopheles gambiae*, Phytoplankton, *Scenedesmus quadricauda*, Digestibility, Vector control

ABS-69

Distribution and dynamics of An. arabiensis breeding sites in three health districts with high malaria incidence, Diourbel, Touba and Kaolack (Senegal)

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Urban malaria has become a challenge for most African countries due to high urbanization with increasing uncontrolled and overcrowded populations. The rapid extension of cities with inappropriate water drainage system, coupled with recurrent flooding represent a concern for water vector borne diseases including malaria. This situation could threaten the progress made so far toward the malaria elimination in several sub-Saharan country, including Senegal. In line with the national malaria control strategic plan for malaria elimination in Senegal, the NMCP consider urban malaria as a major threat for the Elimination goal, specifically in the three most populated cities after the capital city of Dakar. Indeed, the cities of Diourbel, Touba, and Kaolack. These three cities recording the highest malaria incidences in the Central Senegal. This 5-month study was carried out from August to December 2019 in the cities of Diourbel, Touba, and Kaolack to characterize malaria vectors larval habitats, their population dynamics over the seasons, and identify the main larval ecology factors contributing to observed urban malaria transmission context. The results showed that over the study period, a total of 145 anopheline larval habitats were found, mapped and monitored, including 32 in Diourbel, 83 in Touba and 30 in Kaolack. This study focusses on the distribution and characterization of the An. arabiensis larval habitat and their potential contribution to urban malaria epidemiology in the three most populous cities after Dakar with high malaria incidences. The data generated provides additional information on the vector larval ecology to better support the NMCP decision-making for tailored vector control in urban areas, using appropriate, cost-effective, and sustainable management of urban larval sources in Senegal.

Keywords: *An. arabiensis* breeding sites; Urban malaria; high malaria incidence

ABS-455

Aedes aegypti bionomics and spatiotemporal distribution of immature and adult stages in urban and peri-urban locations in Burkina Faso: consequences for control of dengue outbreaks

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Dengue and other Aedes-borne virus (ABV) infections are re-emerging in Sub-Saharan Africa. Various new integrated vector control strategies have the potential to improve sustainable prevention of ABVs, but all require better knowledge of local vector bionomics. We characterised immature stage habitats and productivity, and investigated adult host-seeking, resting and biting preferences in both urban and semi urban areas of Burkina Faso. We selected 40 households from urban and peri-urban areas of the cities of Ouagadougou and Banfora for monthly visit from July 2019 to December 2020 and all containers inspected for the presence of *Aedes* sp larvae and pupae. Resting adult *Aedes* mosquitoes were collected using Prokopack aspirators indoors and outdoors. Blood meal origin was assessed by PCR. Host-seeking behaviour was assessed using Human double bed nets trap for 24 hour periods during both daytime and night-time. A total of 801 water-holding containers were recorded of which 760 (94.9%) were outdoor and 41 indoor (5.1%). Aedes aegypti was found in diverse water holding containers with discarded tires, terracotta jars, tires and animal drinking pots being the most common and most productive containers. A total of 1011 Aedes females were collected (6.4 % of total mosquitoes) using the Prokopack aspirator. The abundance of Aedes females varied significantly between collection months ($p<0.0001$). Our data indicate that the local population of *Ae. aegypti* in Burkina Faso is predominantly anthropophagic (human blood meal>74%), outdoor resting/ exophilic (OR= 2.0). Host seeking behavior study suggested an exophagic behavior (OR=1.8) with a biting peak around 17:00 – 18:00. These results provide baseline data and essential information on ecology and behaviour of the primary arbovirus vector Aedes aegypti in Burkina Faso, enabling the informed selection of control methods most likely to achieve an impact.

Keywords: *Aedes aegypti*, larval ecology, biting and resting behaviour, dengue vector control, Burkina Faso

ABS-628

Using GPS-assisted mobile application and management system for control of Anopheles arabiensis and Integrating it Malaria Control Program in selected districts in Ethiopia

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Development of a fast-tracking digital information system that integrates the georeferenced information on parasite and vector populations, resistance profile, focal areas of high transmission, and clusters of infections saves unnecessary wastage of resources and time for mobilization. The objective of this study was to evaluate the efficacy of an AI-powered mobile application software to map vector populations, trace hot spot areas, and implement control interventions. A mobile application was used to map every vector breeding ground and the information gathered was stored in the central server. The software was used to capture data on satellite imagery to detect and map houses, climate information, Breeding habitat type, Size of habitat, Physical properties, and Stage of the instar. The house, climate, and probabilities maps were then used to identify areas suitable for intervention. A mobile app at grass root level was used to guide intervention implementation. During the first stage, field workers used the map-based Android mobile app to gather the required information and report their exact GPS location, and in the second phase, they used the app to introduce the intervention (larviciding) to the vector breeding habitat. Here we demonstrate that the newly developed software has helped in 90% detection of vector breeding habitats, a 70% reduction of malaria cases, and a 60% reduction in vector mosquito density in Ethiopia. We also report that the software has helped to instant prioritization of severely affected villages as it relays on AI information, unlike the conventional method that depends on a routine case reporting approach from each sentinel site. AI-powered apps can be crucial in ensuring malaria elimination.

Keywords: Zzapmalaria; malaria elimination, IRS, vector surveillance, AI-powered apps

ABS-414

Evidence from an observational trial of dual–active ingredient nets indicates a comparatively higher effect on resistant mosquito entomological indices in Nigeria

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Nigeria has a high burden of malaria in part due to insecticide resistance. The New Nets Project evaluated the impact of dual–active ingredient (AI) bed nets (ITNs) on pyrethroid resistant vector populations in Nigeria. This study was conducted in four local government areas (LGAs) with pyrethroid-resistant mosquitoes: Moro, Asa, Ejigbo, and Ife North where pyriproxyfen + alpha-cypermethrin, chlorfenapyr + alpha-cypermethrin, pyrethroid only, and piperonyl butoxide + alpha-cypermethrin ITNs were distributed, respectively, in 2020. Post ITN distribution, host seeking anopheline mosquitoes were collected indoors and outdoors monthly using human-baited CDC light traps. Additionally, indoor resting mosquitoes were collected monthly. Changes in total entomological indices were monitored for two years. Members of the An. gambiae s.l. constitute up to 98% of the total population of Anopheles spp. mosquitoes collected from each of the LGAs, with resistance profiles ranging from 11.8%–73.0% 24h mortality in WHO tube tests against alpha-cypermethrin. Very few An. arabiensis were identified (<3%). Post-distribution monitoring results show that mosquito density reduced by an average of 12% from the first to the second year across all sites. In Moro, Ejigbo, and Ife North, species composition did not change completely between the first and the second year but in Asa, An. coluzzii dominated vector population in the second year. Human biting rate was significantly reduced indoors (p=0.029) only in the mosquito populations in Asa where the chlorfenapyr + alpha-cypermethrin nets were distributed as compared with others (Moro, p=0.809; Ejigbo, p=0.730; and Ife North, p=0.808). Consequently, EIR was highest in Ejigbo which is where the pyrethroid-only net was distributed. This study provides evidence of improved village-scale efficacy of dual AI ITNs against pyrethroid resistant populations of Anopheles for programmatic consideration.

Keywords: entomology, insecticide-treated nets, malaria, Nigeria

ABS-195

Monography and biological control of A*edes albopictus* (Linnaeus, 1762) and *Aedes aegypti* (Skuse, 1894) in the forest area of southern Cameroon

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Aedes albopictus and *Aedes aegypti* are potential vectors of arboviruses in Cameroon. Knowing their bionomics and their insecticide resistance status is important to better plan control interventions. This study aims to determine the ecology of *Aedes aegypti* and *Aedes albopictus* in sub-urban and urban areas of Douala, Kribi and Ayos in order to propose an alternative method of vector control based on essential oils from Ageratum conyzoides and Chromolaena odorata. *Aedes* ecology was determined by characterizing different breeding sites with physico-chemical parameters. Larvae were collected with Dipping method and reared with Desfontaine method. Adult's mosquitoes were identified with appropriate keys. Essential oils from the fresh leaves of *Ageratum conyzoides* and *Chromolaena odorata* were extracted by steam distillation. The chemical composition was determined by GC-MS. Insecticide tests were carried out according to the WHO protocol on Ae. albopictus larvae. 533 breeding sites were identified, including 61.7% in urban areas. 98.3% were artificial and

mainly represented by used tires. In urban areas, Ae. albopictus and *Ae. aegypti* were mainly found in used tires. In sub-urban areas, *Ae. aegypti* was mainly found in the holes of concrete blocks. Brick molds (400.33±3.7 µs/cm) had the highest electrical conductivity. Essential oil main compounds were Precocene I (54.4%) for *A. conyzoides* and Geijerene (20.02%) for C. odorata. Essential oil from the fresh leaves of *A. conyzoides* was the most effective with 100% mortality of mature larvae obtained after 10 hours at 75ppm. *Ae. albopictus* and *Ae. aegypti* from study sites have exceptional ecological plasticity and aggressive behavior. The sensitivity of *Ae. albopictus* larvae to *A. conyzoides* essential oil suggests that the combination with existing vector control methods could significantly reduce *Ae. albopictus* density in an elimination context.

Key words: *Ae. albopictus*, *Ae. aegypti*, ecology, *A. conyzoïdes, C. odorata*, essential oil, Urban, Sub-urban.

Social Science Special Session: **Amplifying the impact of vector control interventions through social sciences**

Moderator: Ghislaine Ametchie; **Co-moderator:** Lea Pare Toe

For twenty years and beyond, great investments have been made to eliminate malaria globally. As we continue witnessing stalled progress and multiple recent outbreaks across Africa, it becomes urgent to diversify our toolbox of interventions and approaches. Social sciences offer the unmatched opportunity to engage communities in vector control, hence providing pathways to behavior change and greater community involvement in vector control. This panel discussion explores some of the gains made in Africa in this respect and unwraps the resistance towards using social sciences to amplify the impact of any vector control intervention.

ABS-131

Circumsporozoite positive Anopheles longipalpis C mosquito identified in Zimbabwe

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Surveillance of malaria vectors in Zimbabwe has historically focused on the two major vectors *An. gambiae s.l* and *An. funestus s.l*., both morphologically indistinguishable species groups that require molecular tools for species identification. During routine surveillance in Burma Valley, 174 samples that were identified morphologically as *An. funestus s.l*., but failed to amplify when processed using the standardized *An. funestus s.l*. PCR assay, were sequenced and 35 were identified as An. longipalpis C. The finding led Africa University laboratory to investigate the distribution and behavior of *An. longipalpis C* in Zimbabwe. Of 1841 *An. funestus* samples, 529 that had previously amplified the two band pattern matching *An. longipalpis C* in the *An. funestus* PCR assay were revisited and analyzed for distribution, biting behavior, and sporozoite detection. The findings indicate that *An. longipalpis C* was first collected in 2016 in Burma Valley and through 2022 in Beitbridge, Chakohwa, Burma Valley, Zindi, Acturus, Vumba, Mubairakuenda, Kawere, Makarara, Dendera, and Chiyadzwa. Of 180 blood fed samples, 74.4% were cattle-fed, 11.6% exhibited multiple host meals with a combination of human and animal blood, and 13.8% other animals blood. Circumsporozoite ELISA found one Makarara sample from 2021 to be positive for *Plasmodium falciparum* (0.5% infectivity). This study showed *An. longipalpis* C is widely distributed in Zimbabwe and supports that *An. longipalpis C* is still predominantly zoophagic, preferring cattle blood. However, the number of samples positive for combined animal and human blood and the single positive sample suggest *An. longipalpis C*, its distribution and behavior should be closely monitored. This study highlights the importance of investigating PCR species identification results that don't amplify, to characterize *Anopheles* species composition and detect previously unidentified Anopheles species and their potential contributions to the spread of malaria.

Keywords: Circumsporozoite positive, *Anopheles longipalpis* C mosquito, none amplifications

ABS-132

Strengthening the management surveillance of larval breeding sites potential vector of malaria "*Anopheles stephensi*"

Mohamed Mousse Ibrahim (Institut National santé Publique de Djibouti)*Since the discovery of *Anopheles stephensi* in Djibouti in 2012, the government has doubled efforts to fight malaria in the face of this threat and the invasion of the stephensi species. Start research to better understand and act better to face failure. The country has recorded an increase in malaria incidence of at least 60% between 2015

and 2020. Census and mapping of breeding sites (from 2013 to 2018). As part of the fight against malaria vectors, the destruction of mosquito larval habitats is an additional measure recommended by the WHO, in the country it is essential to stop this invasion. To do this, an inventory and mapping of mosquito breeding sites in the interior regions was carried out. The data show that Ali Sabieh and Dikhil are also border regions with Ethiopia where the numbers of positive roosts identified are greater. These are mostly wells and basins. Appropriate management of these breeding grounds or mosquito breeding habitats can aid in the control of malaria.

Keywords: *An.stephensi* , Djibouti, incidence , Mapping , census , management , malaria vectors ,

ABS-134

First detection and co-occurrence of mutiple kdr mutations in insecticide resistant *Aedes aegypti* from three agro-ecosystems in benin

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In Benin, the *Aedes aegypti* mosquito is the main vector of arboviral diseases such as dengue. As the treatment for this disease is limited, control of the vector with the use of pyrethroids insecticides is still essential. The emergence of insecticide resistance in vectors, especially against pyrethroids, is a serious threat to the insecticide-based vector control programme. No study has been carried out in Benin concerning the different mutations implicated in resistance. The aim of this study is therefore to explore the resistance status to pyrethroids (permethrin) and the underlying mechanisms of *Ae. Aegypti* population from Benin, West Africa. *Aedes* larvae were collected in three agroecosystems from April to October 2021 in three agroecosystems across Benin using oviposition cup traps once ovipositing female lay their eggs. After emergence, Adults (F0) were exposed to permethrin (0.75%) following WHO bioassay protocols. TaqMan RT-qPCR assays were used to detect kdr mutations and the expression profiles of eight detoxifying genes. Analysis was performed according to the Pfaffl method. A total of 1877 mosquitoes were collected comprising 1764 (93.97%) *Ae. Aegypti* and 113 (6.02%) *Ae. Albopictus*. All *Ae. aegypti* sampled were found to be resistant to Permethrin. Co-occurrence of kdr V1016G and F1534C mutations and the triple mutant combination S989P + V1016G + F1534C were detected in *Ae. aegypti*. P450s genes were also significantly overexpressed. This study reveals for the first time the Co-occurrence of kdr V1016G and F1534C mutations and triple mutant combination S989P + V1016G + F1534C in *Ae. aegypti* populations. The combination of the three kdr alleles confers high resistance to Permethrin. The role of other

insecticides needs to be established to provide relevant information which should be utilized in the implementation of arbovirus vector control and insecticide resistance management.

Keywords: Aedes species, insecticide resistance, vector control, Benin.

ABS-136

Do physico-chemical factors influence the occurrence of *Anopheles gambiae* larvae and its cohabiting fauna?

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At present, one of the key WHO-recommended outdoor strategies for malaria vector control is through larval source management (LSM). Understanding larval habitats is necessary for implementing effective LSM. Thus, good data on the larval ecology of *Anopheles gambiae*, the key transmitter of malaria is vital. The nature of mosquito larval habitats, including its co-habiting fauna and the factors that affect their prey-predator interactions in the water in which they breed is very critical for larval control programs. We sought to assess the correlation of the physico-chemical parameters of the aquatic habitat and the abundance of *Anopheles gambiae* larvae as well as their co-habiting fauna in the Volta region of Ghana. The study was conducted at Abutia Amegame (6° 26' 43.573''E 0° 19' 30.262'') and Mafi Agove (6° 12' 44.118''E 0°26'40.538'') communities in the volta region of Ghana. Monthly field data was collected from February 2021-January 2022 and temperature, pH, dissolved oxygen, conductivity were measured with a with a YSI Probe. Eight waterbodies from the two communities were sampled where we assessed the effects of water quality on the richness and relative abundance of mosquito larvae and their co-inhabitants. We used spearman rank correlation to study the relationship of the physicochemical parameters and the fauna. We identified 20 species belonging to 11 orders of aquatic fauna. Among the insect species found, Hemiptera were influenced by temperature, while Coleoptera, by temperature and pH. There was no significant influence of any measured parameters on the Diptera and Odonata insects, possibly due to predator-prey dynamics. In conclusion, the non–significant effect of the physico-chemical parameters on the Odonata and Diptera fauna could be due to prey-predator dynamics, which is currently being studied.
Keywords: *Anopheles gambiae*; larvae; physico-chemical parameters, ecology; aquatic habitat; fauna

ABS-137

Common predators and factors influencing their abundance in *Anopheles funestus* aquatic habitats in rural south-eastern Tanzania

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The role that larval predators play in regulating the population of malaria vectors remains relatively unknown. This study aimed to investigate the common predators that co-exist with anopheles funestus group larvae and evaluate factors that influence their abundance in the aquatic habitats. Mosquito larvae and predators were sampled concurrently using standard dipper (350 ml) or 10L bucket in *An. funestus* habitats in rural Tanzania. Predators and larvae were identified using standard identification keys. Habitats were characterized, geo-located and physicochemical parameters were measured. Generalised linear mixed effects models (GLMM) using template model builder (TMB) with zero-inflated negative binomial implemented under the glmmTMB package were used. Results were presented as risk ratio (RR) at 95% CI and statistical significance was considered when P<0.05. A total of 85 identified *An. funestus* habitats were sampled for larvae and predators. A total of 8,295 predators were sampled, with Coenagrionidae 57.7% (n=4785), Corixidae 12.8% (n=1,060), Notonectidae 9.9% (n=822), Aeshnidae 4.9% (n=405), Amphibian 4.5% (n=370), Dytiscidae 3.8% (n=313) being common. There were 5,260 mosquito larvae sampled, consisting of *An. funestus* group 60.3% (n= 3,170), Culex spp. 24.3% (n=1,279), *An. gambiae s.l.* 8.3% (n=438) and other anophelines 7.1% (n=373). Permanent and larger than 100 m square habitats were positively associated with *An. funestus* group and predator abundance (P<0.05). Only dissolved oxygen positively affected the abundance of *An. funestus* group (P<0.05).The study highlighted common predators and factor that influence their abundance in *An. funestus* habitats in rural Tanzania. Further studies should demonstrate predator's impact on larval and adult density, emergence rate and adult fitness traits. Interventions leveraging the interaction between mosquito and predators can be established to disrupt malaria transmission.

Keywords: Predators, *Anopheles funestus*, Malaria transmission

ABS-138

Susceptibility of *Anopheles gambiae sensu lato* to four classes of insecticides and the allelic frequencies of the genes kdr L1014F and ace 1 G119S in two villages in the circle of Kati in Mali

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The multiple resistance situation in *Anopheles gambiae sensu lato* found in Mali with the concomitant presence of the kdr L1014F and ace-1 G119S mutations constitutes a major threat to the success of current malaria control strategies (LLIN and IRS). While it is obvious that with the different uses of insecticides (controlled or not) it is difficult if not impossible to avoid the installation of resistance at any time,

it is crucial to accompany malaria vector control strategies with an efficient insecticide resistance monitoring system. The present study aims to evaluate the susceptibility of *Anopheles gambiae sensu lato* to the four classes of insecticides commonly used in public health for vector control and the allelic frequencies of the kdr L1014F and ace-1 G119S genes. The study took place from June to October 2021 in Ouassorola and Sogolombougou, two villages in the Kati circle. Bioassays were performed according to WHO standard procedures, identification of *Anopheles gambiae sensu lato* species and detection of kdr L1014F and ace-1 G119S mutations were done by PCR. The mortality rates were respectively in Ouassorola and Sogolombougou of : 100% and 91.25% for fenitrothion; 97.5% and 92.5% for bendiocarb; 67.5% and 50% for DDT; 8.75% and 0% for deltamethrin 3.75% and 0% for permethrin and 10% and 0% for lambda-cyalomethrin. The allelic frequencies of the kdr L1014F were 72.93% in Ouassorola and 79.67% in Sogolombougou and those of ace-1 G119S were 25% in Ouassorola and 46.15% in Sogolombougou. *Anopheles coluzzii* and *Anopheles gambiae* were the only members of *Anopheles gambiae sensu lato* identified in both study sites. This study showed strong resistance of *An. coluzzii* and *An. gambiae* to deltamethrin, lambda-cyhalothrin, permethrin, DDT and bendiocarb. *Anopheles gambiae sensu lato* was susceptible to fenitrothion in Ouassorola. A high frequency of genes kdr L1014F and ace-1 G119S was observed in both villages.

Keywords: Resistance, *Anopheles gambiae sensu lato*, kdr L1014F, ace1 G119S, Insecticides, Mali

ABS-142

Distribution and diversity of ticks collected from livestock in selected pastoral regions in Kenya

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Ticks have veterinary and public health importance as they transmit many pathogens. Identification of tick species, diversity and their geographic distribution is critical to understanding the epidemiology of tickborne diseases and developing targeted interventions. A total of 12996 ticks were collected from livestock in Isiolo, Baringo, Turkana and West Pokot counties, and identified to species using morphological identification keys and pooled (1774 pools). After identification, representative ticks of medical importance from each site were subjected to molecular identification. Briefly, DNA was extracted from thirty tick samples from each site and PCR was done using the mitochondrion cox1 gene. The PCR products were cleaned using Exo-sap, sequenced and sequences compared with those on GenBank by Blast analysis. Sequences with identities scores of 96-99% were used in phylogenetic analysis. Thirteen different tick species were identified across the four sites, with the highest diversity recorded in Isiolo (n=9) and Baringo (n=9) counties respectively. However, the highest number of ticks were collected from Turkana (45.4%), followed by Isiolo (23.1%), Baringo (22.7%), while West Pokot had the least collection (8.8%). Rh. appendiculatus was mainly collected in sheep in Turkana (n= 405), and H. marginatum from camels in Isiolo

(n=182). From the 120 tick DNA extracts, 73 PCR products were amplified by the mitochondrial cox1 gene and sequenced. The morphological and molecular identification for Amblyomma and Rhipicephalus tick species were comparable. However, incongruence was reported in the identification and classification of Hyalomma species. The two abundant tick species reported in this study are well known vectors of East Coast Fever and Crimean Congo Haemorrhagic fever virus. The data for morphological and molecular identification for Hyalomma species was not consistent and this may be due to genetic variation.

Keywords: Tick, Hyalomma, molecular diversity

ABS-143

First detection and isolation of sindbis virus (genotype i) from *Culex quinquefasciatus* mosquito collected from Burkina Faso

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Several mosquito-borne viruses (MBV) represent a major threat to human health worldwide. Beyond those well-known pathogens, a large diversity of arboviruses transmitted by mosquitoes remains largely unstudied despite an established potential for emergence in some cases. Beyond a high diversity, mosquito arboviruses have also shown an impressive capacity for spread into new regions. Thus, health services require updated characterisations of the arbovirus diversity in a given region to optimize diagnostics.Thus, diagnostics of potential arboviral infections is often limited to high-profile viruses, like dengue virus. This situation probably leads to a large fraction of undiagnosed cases due to arboviruses neglected or recently established in a region. ds: Here, we have characterized the diversity of MBV in two regions of Burkina Faso. To this end, we have screened a recent and large mosquito collection using untargeted metagenomics. The analysis focused on two mosquito species, *Aedes aegypti* and *Culex quinquefasciatus*, considered among the most important vectors of arboviruses worldwide. The screening detected Sindbis virus (SINV, Togaviridae) for the first time in Burkina Faso. This zoonotic arbovirus has spread into Europe from Africa and is the cause of disease outbreaks mainly in Europe. SINV was detected at low prevalence and only in *C. quinquefasciatus* from one of the regions and at a single year. A phylogenetic analysis placed the nearly-full SINV genome within the cluster of Central African sequences at the origin of the strains that have spread into Europe.Thus, this result extends the region as potential SINV source to Western Africa. Finally, a virus isolate was obtained for future experimental studies. Overall, our results

provide insights into the current arbovirus diversity in Burkina Faso and can help to improve diagnosis. Our approach could be applied to other regions to better characterization of the arbovirus

Keywords: Sindbis virus, Togaviridae, Arbovirus,Culex quinquefasciatus, Burkina Faso

ABS-144

Molecular surveillance and seasonal entomological indices in malaria transmission in Anambra state, Nigeria

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Longitudinal surveys of mosquito abundance and malaria infection status and pattern in a location is always beneficial for timely and correct application of vector control measures. Application of malaria vector control actions is mainly targeted at the indoor biting anophelines as this study sought to determine the specific species of the malaria vector biting indoors and the Plasmodium species predominant at varying seasons of the study. Longitudinal sampling of adult *Anopheles* species was done using CDC light traps indoor and outdoor and PSC in 44 houses selected from August 2019 to July 2020. Anopheles species collected were identified using morphological keys before sending out for molecular identification. ELISA was used to analyse the proportion with *P. falciparium* sporozoite. *An. gambiae s. l.* (91.9%) collected from the study site were more than 5 folds greater than *An. funestus* (1.2%), *An. hancocki* (3.5%), *An. moucheti* (2.1%) and *An. coustani* (1.3%). The indoor biting time across the study area peaked at 2 - 3am and 3 - 4am for the outdoor. Of the 550 *An. gambiae s.l.* that underwent species-specific molecular assay, An. gambiae was (12%), *An. arabiensis* (42%) and *An. coluzzii* (46%). The indoor biting rate (72.2 bites/person/night) across the site peaked in September, while outdoor biting rate (8.9 bites/person/night) was highest in month of July. Plasmodium falciparum sporozoite rates of the species collected indoors indicated that An. gambiae had the highest infection rate (7.3%) followed by *An. coluzzii* (1.4%) and An. arabiensis (0.7%). A strong correlation (r=0.8) exists between rainfall and the number of anophelines collected monthly. The high number of anophelines collected indoors with the different Anopheles species present, the seasonality and their transmission indices observed in the study avails the opportunity to develop a timely targeted control measure such as ITNs, IRS or larval source management.

ABS-146

Phenotypic resistance to pyrethroid associated to metabolic mechanism in Vgsc-L995F resistant-*Anopheles gambiae* malaria mosquitoes

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The indiscriminate use of insecticides in agriculture and public health lead to a selection of resistance mechanisms in malaria vectors compromising vector control tools and strategies. This study investigated the metabolic response in the Vgsc-L995F *Anopheles gambiae Tiassalé r*esistance strain after long-term exposure of larvae and adults to deltamethrin insecticide. We exposed, over 20 generations, Vgsc-L995F *An. gambiae Tiassalé* strain larvae to deltamethrin (LS) and adults to PermaNet 2.0 (AS) and combining exposure at larvae and adult stages (LAS) and compared to unexposed (NS) group. All four groups were subjected to the standard WHO susceptibility tube tests using deltamethrin (0.05%), bendiocarb (0.1%) and malathion (5%). Vgsc-L995F/S mutation frequency was screened using multiplex assays based on Taqman real-time polymerase chain reaction (PCR) method. Additionally, expression levels of height detoxification enzymes were measured. Our results indicated that deltamethrin resistance was a response to insecticide selection pressure in LS, AS and LAS groups, while susceptibility was observed in NS group. The vectors showed varied mortality rates with bendiocarb and full susceptibility to malathion throughout the selection with LS, AS and LAS groups. Vgsc-L995F mutation stayed at high allelic frequency level in all groups with a frequency between 87% and 100%. Among the overexpressed genes, CYP6P4 gene was the most overexpressed in LS, AS and LAS groups. Long-term exposure of larvae and adults of Vgsc-L995F resistant-*An. gambiae Tiassalé* strain to deltamethrin and PermaNet 2.0 net induced resistance to deltamethrin under a significant effect of cytochromes P450 detoxification enzymes. These outcomes highlight the necessity of investigating metabolic resistance mechanisms in the target population and not solely kdr resistance mechanisms prior the implementation of vector control strategies for a better impact.

Keywords: Resistance selection, *Anopheles gambiae*, Deltamethrin, PermaNet 2.0, Tiassalé strain, P450 genes, Vgsc-L995F, Côte d'Ivoire

ABS-148

Impact of interventions in the malaria elimination program, the Amhara Region Experience, Ethiopia

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Ethiopia has been launched the sub national malaria elimination in 239 districts of the country. Amhara Region is one of the region in Ethiopia and has to implement the strategy plan for elimination. The aim of this study reviewed the Amhara Regional Health Bureau malaria control program activities and assess the intervention impact. Descriptive retrospective study conducted in Amhara Region. From 2011 to 2022 the overall average regional weekly surveillance completeness increased from 27% to 98.5% and timeliness increased 17% to 98.5%. Enhanced surveillance system completeness; 60% of suspected fever cases tested by Microscope and 40% by Rapid Diagnostic test. Of the total malaria cases, 98% were parasitological confirmed. Of the confirmed cases, 63.1% were due to P. falciparum. Bed net distribution coverage raised from 54% in to 90% and IRS performance by unit structure coverage move up from 67% in to 98.5%. This contributed in number of malaria morbidity decreased by 48.8%. The selective control intervention activities (LLINs and IRS) have a major impact on malaria case decrement. Therefore, a continues involvement of all stakeholders shall be in place for further strengthening and eliminating malaria by this approach to district levels in the region.

Keywords: Malaria, Impact, Intervention, Amhara RHB, Ethiopia

ABS-152

Mapping of efficacy of combination pyrethroid (deltamethrin) + synergist (piperonyl butoxide) against pyrethroid resistant *Anopheles gambiae sl*: predictive effectiveness of PBO-ITNs in Burkina Faso

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Piperonyl butoxide (PBO), a synergist has been shown to improve the efficacy of insecticides by inhibiting the surexpression of mosquitoe enzymes activities. Th aim of this study was to assess the efficacy of synergist that could be improve mortality rates of pyrethroid resistant *An. gambiae sl* before the large deployment of PBO ITNs in Burkina in 2019. Larvae from the predominant vector, *Anopheles gambiae sensu lato (s.l.)* were collected in 2018 from 21 sites located throughout Burkina Faso and reared to adults for bioassays to assess insecticide resistance. WHO tube test were used to determine *An. gambiae* susceptibility to pyrethroid only and combination pyrethroid + PBO. Resistance intensity assays were conducted using CDC bottle technique to determine the level of resistance to pyrethroids commonly used on ITNs at 12.5µg, 25µg), 62.5µg or 125µg the diagnostic concentration. WHO tube tests revealed generalized resistance in *An. gambiae s.l.* to deltamethrin in Burkina Faso. One of sites showed a moderate resistance intensity could be compromise the efficacy of vector control

tool. However, PBO pre-exposure followed by deltamethrin restored full susceptibility (mortality rate>98%) in three sites (Gaoua, Boromo and Kaya). *An. gambiae s.l.* from 12 out of 21 sites showed a partial susceptibility restored (mortality rate: 90-97%). PBO + deltamethrin ITNs would likely provide greater control than pyrethroid nets in Burkina Faso. National Malaria Control Programme could be used PBO-ITNs during nationwide mass distribution planned in 2019 as vector control tool.

Keywords: *Anopheles gambiae s.l*; Resistance, Pyrethroid; PBO; Burkina Faso

ABS-153

Impact of livestock management on malaria transmission risks in rural Tanzania

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Livestock keeping is one of potential factors associated with malaria transmission. To date, the impact of livestock on malaria transmission is contradicting with some studies reporting a zooprophylaxis effect while others reporting zoopotentiation effect. This study aimed to assess the impact of livestock management on malaria transmission risks in rural south-eastern Tanzania. A longitudinal study was done in Minepa village from January to March 2023. Forty randomly selected houses were sampled, 20 had livestock and others without livestock. Mosquito collection was conducted daily in 8 houses to ensure each house was visited once per week. CDC-Light traps and prokopack aspirators were used for Indoor collections, while human-baited double net traps and resting buckets used for outdoor collections. Poisson GLMM was used to assess the influence of livestock on mosquito density. A total of 18,620 female *Anopheles* mosquitoes were collected. Out of these, 98% were *An. gambiae s.l*. while others were *An. funestus, An. pharoensis, An. coustani* and *An. squamosus.* The presence of at least one cow (RR=2.682, 95%CI:1.492-4.320, p=0.001), dog (RR=1.895, 95%CI:1.531-2.346, p<0.001) and chicken (RR=8.387, 95%CI:4.667-15.073, p<0.001) near houses was associated with increased catches of *An. gambiae* indoors. The Outdoor catches of *An. gambiae* were negatively associated to the presence of at least one sheep (RR=0.345, 95%CI:0.125-0.953, p=0.04). The outdoor catches, *An. gambiae* were associated with the presence of goat (RR=7.079, 95% CI:4.278-11.715, p<0.001). Indoor catches of *An. funestus* were higher in houses with chicken (RR=11.627, 95% CI:2.111-64.032, p=0.005) than those without chicken. This study shows that the association between livestock and malaria transmission is controversial. Thus, this study suggests that livestock-based malaria interventions should focus where cows, goats, chicken and dogs are kept. More studies should be done to verify study results elsewhere.

Keywords: Livestock management, Zooprophylaxis, Malaria transmission

ABS-154

Analysis of the genetic variation of the fruitless gene within the *Anopheles gambiae* (diptera: culicidae) complex populations in Africa

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One promising strategy for genetic control is to reduce the reproductive potential of disease vectors or pests by targeting genes involved in sexual determinism. However, targeting these genes requires a better understanding of their polymorphism in natural populations to ensure good stability and persistence of the transgene in nature. The genomic data of *Anopheles gambiae s.l.* used in our study were sequenced by the *Anophes gambiae* 1000 genomes (Ag1000g) project in which the institut de recherche en sciences de la santé is partner. We used jupyter notebooks to analyze the genetic variation and conservation score of the fruitless gene in 18 populations across africa. A total of 34339 snps were identified including 3.11% [1071 snps] of non-synonymous polymorphic sites. The overall nucleotide diversity of the gene was low (0.0036) and the Tajima neutrality test (-2.52) was negative indicating an excess of low frequency snps. Allelic frequencies of non-synonymous mutations were low except for snps at position x: 1309218 (c>g) and x: 1300290 (c>g) that were identified at high frequencies (0.8 - 1) in all populations. The conservation score was variable throughout the fruitless gene with maximum values in the exonic regions compared to the intronic regions. these results would be a good indicator for the spread and persistence of a transgene targeting the fruitless gene in wild populations of *An. gambiae s.l.*

Keywords: Fruitless, genomic, *An. gambiae s.l*, vector control, Africa

ABS-162

Species distribution, vector bahavour and susceptibility status of *An. gambiae s.s* to public health insecticides in Ndola district, Zambia.

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Malaria is one of the main causes of morbidity and mortality in Zambia contributing to 1.4% of the global burden. Vector control is the main malaria elimination strategy and its success hinges on a clear understanding of the bionomics and susceptibility status of the local vectors. Therefore, this study assessed the bionomics and susceptibility status of the local malaria vectors. This study was conducted in Ndola district. Mosquito collection was done in four sites using CDC – light traps, PSC, Aspiration and Larval Collection. Mosquitoes collected were morphologically identified and confirmation was done using PCR. Data analysis was done using Williams's mean, Kruskall Wallis H test and negative binomial. The susceptibility status of the local vectors was done using WHO tube and CDC bottle bioassay. Malaria vectors identified were *An. funestus s.s* and *An. gambiae s.s. Anopheles funestus* was the predominant malaria vector and exhibited a homogeneous distribution. *Anopheles gambiae* was found to be highly endophilic. The densities (Mw) of *An. funestus s.s* and *An. gambiae s.s* seeking a blood meal in the urban sites was higher than in rural sites. Indoor resting density of *An. funestus s.s* was higher in rural site whereas for *An. gambiae s.s* indoor resting density in urban sites was 262 times more than rural sites. Main breeding sites identified were irrigation trenches and garden ponds. Sprayed houses were significantly associated with reduced mosquito numbers. *An. gambiae s.s* was fully susceptible to organophosphates and neonicotinoids but highly resistant to pyrethroids, carbamates and organochlorines. Lastly, bionomics of local malaria vectors vary and vector control interventions implemented must be tailored to these findings. Susceptibility status of *An. gambiae s.s* was established but not for An. funestus due to the difficulty in finding *An. funestus s.s* larval habitats

Keywords: Vector bionomics, Insecticide resistance, Zambia

ABS-166

Using High Power Electric Fields to Repel Mosquitoes

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To control and prevent existing and (re) emerging mosquito-borne diseases, insecticides are often our only option. Insecticides reduce mosquito population sizes and/or prevent human-vector contact, but their excessive use raises concerns for our environment, our health,

and led to the rapid development and spread of insecticide resistance. As a result, the development of novel technologies for mosquito control is urgently needed. One of the new tools in development is the use of high power pulsed electrical fields (EFs) that create an invisible barrier and repel mosquitoes. I will provide an overview of the current knowledge of this first non-chemical insect repelling technology, and present novel data on how EFs generated with cheap over-the-counter insulated conductor wires prevent host-seeking Aedes aegypti mosquitoes from entering spaces, allowing us to protect typical mosquito entry points in houses (such as eaves, windows, and doors) as well as groups of people outdoors.

Keywords: Electric fields; electroreception; physical pest control; mosquito repellency; vector control

ABS-167

Surveillance of Aedes-borne arboviruses in selected sites in the savanna region of Ghana

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In October 2021, Ghana experienced a yellow fever outbreak in some areas in the savanna region (guinea savanna woodland vegetation) following previous studies in 2019 that predicted a risk of an arbovirus outbreak in these areas. Recent studies showed antibodies to dengue virus serotype-2 among febrile illness patients in some areas of the greater Accra region although the virus has not been detected in vectors. Therefore, this study assessed the prevalence of Aedes mosquitoes in Sawla, Larabanga, and Mole national park, as well as the arboviruses (yfv, denv, chikv, and zikv) they may be harboring, as a follow-up to the yellow fever outbreaks in these areas. A cross-sectional study was conducted in three study sites (Sawla, Larabanga, and Mole national park). Adult aedes mosquitoes were collected using the biogent sentinel traps and immature stages (eggs, larvae, and pupae) were sampled using ovitraps and dippers. The immature stages were raised to adults for identification using morphological keys/features and viral analyses using rt-pcr. Data analysis was performed using two-way ANOVA in Excel. A significantly higher number of eggs were collected in Sawla as compared to Larabanga and the mole national park. Estimated positive ovitrap index (poi) was high (>10) in all three sites; Sawla: poi = 50%; Larabanga: poi = 50%; mole national park: poi = 60%. All the Aedes mosquitoes identified from the three sites were *Ae. aegypti*, specifically of the subspecies *Ae.*

aegypti formosus. No arbovirus (yfv, denv, chikv, and zikv) was detected in this study. The study found that there is a high risk of Aedes-borne arboviruses in the study areas and regular surveillance is needed to prevent and contain outbreaks.

Keywords: Arbovirus, Aedes Mosquito, Surveillance

ABS-170

Characterization of a new laboratory colony of *Anopheles funestus* mosquitoes established in Ifakara, Tanzania

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Anopheles funestus carries most malaria in east and southern Africa. However, it has been challenging to study this species because it is difficult to colonize inside laboratories. Ifakara team was able to successfully colonize a strain of this species from Tanzania (FUTAZ) for >20 generations. This study compared the FUTAZ strain to two other strains of mosquitoes: a strain of *An. funestus* from Mozambique (FUMOZ) and a strain of *Anopheles arabiensis*. We examined the differences in fitness between these strains through measures like body size and mating success. This study also looked at the genetic makeup of the mosquitoes using PCR analysis of mitochondrial clades and restriction fragment length polymorphisms (RFLP) on the 28S ribosomal DNA. The mating success and body size of FUTAZ females declined significantly from filial generations F1 to F6 relative to the founder population (F0) but then increased from F7 onwards eventually matching FUMOZ by F9. Fecundity was similar across all colonies tested; wild *An. funestus* laid an average of 98 (95% CI: 91-106) eggs, while FUTAZ mosquitoes laid 74 (95% CI: 63 - 92) and FUMOZ females laid 80 (95% CI: 73 - 90) eggs per female. The number of eggs laid by *An. arabiensis* was 76 (95%CI: 63-92). However, it took significantly longer for 50% of the females in the FUTAZ and FUMOZ colonies (over 10 days) to mate compared to females in the *An. arabiensis* colony (approximately 5 days). Majority of mosquitoes in the

FUTAZ colony, as well as the wild-caught Tanzanian *An. funestus* belonged to Clade I (80.4-89.4%) and RFLP type "Y" (90.5-91.4%), while the FUMOZ colonies were mostly Clade II (65.5-88.5%) and RFLP type "MW" (90.5-91.5%). This study shows that it's important to have a large founder population when starting a new colony to ensure that the mosquitoes can adapt to laboratory conditions

Keywords: Mating, Colonization, FUTAZ, FUMOZ, Clade analysis and D3-RFLP

ABS-172

Investigation of a Microsporidia MB protective phenotype against entomopathogenic fungi in the malaria vector, *Anopheles arabiensis*

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Microsporidia MB is a maternally transmitted endosymbiont that has been reported to block the transmission of *Plasmodium falciparum* in *Anopheles arabiensis*. Entomopathogenic fungi play a vital role as biocontrol agents of mosquito vectors. The recent discovery of *Anopheles* symbiont, Microsporidia MB has provided new avenues for complementary tools to control malaria. However, the possibility of its protective phenotype interfering with pathogenic biological control agents is yet to be addressed. This study investigated the presence of symbiont-mediated protection phenotype when mosquitoes harbouring Microsporidia MB are exposed to a commonly used biopesticide for the management of ticks, which is also known to infect *An. arabiensis* mosquitoes. Mosquitoes with Microsporidia MB and uninfected controls were exposed to a standard dosage of spores of the entomopathogenic fungus, *Metarhizium anisopliae* (strain ICIPE 7). 1ML was pipetted from ICIPE 7 formulation and spread evenly on a printing paper using the K-bar hand-coater and allowed to dry. The dried spore-coated paper was then inserted in a PVC tube where it covered all the inner surfaces, and the rubber bands were used to fix mosquito netting at the open end. For the control experiment, an equal amount of Triton X-100 water was used. Mosquitoes with Microsporidia MB survived slightly longer than those without the symbiont, and the protection did not significantly vary with symbiont densities. We also observed that Metarhizium anisopliae ICIPE 7 marginally increased Microsporidia MB density. These findings underscore a potential link between Microsporidia MB and entomopathogenic fungi that could be relevant for Microsporidia MB-based control strategies.

Keywords: Microsporidia MB, Metarhizium anisopliae, Host fitness, *Anopheles arabiensis*

ABS-173

MB tissue localization and tropism is influenced by age and blood meal in somatic and reproductive tissues

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The *Anopheles* symbiont, Microsporidia MB, is maternally inherited and has a strong malaria transmission-interference phenotype in *Anopheles arabiensis*. Microsporidia MB is also vertically transmitted, sexually transmitted, and avirulent. These characteristics are expected to promote its spread through mosquito populations, enhancing the potential of Microsporidia MB as a candidate for the development of a symbiont-mediated malaria transmission-interference strategy. Using qPCR, PCR-HRM, and FISH imaging we set to determine the localisation and tissue tropism of Microsporidia MB from isofemale line F1 adults and larvae collected from Ahero, Kenya. Furthermore, we elucidated the effect of bloodmeal and age on the densities of the symbionts in guts and ovaries. We found that the patterns of Microsporidia MB localisation over the development of *An. arabiensis* indicate accumulation in tissues linked to its transmission, specifically the male and female gonadal tissues. Transovarial vertical transmission of Microsporidia MB occurs in the female *An. Arabiensis* ovary when Microsporidia MB becomes localised to the cytoplasm of the developing oocyte. In male An. arabiensis, Microsporidia MB is localised in the testis and vas deferens. Notably, a high intensity of Microsporidia MB can also be observed in the An. arabiensis adult but not larval gut. The levels of Microsporidia MB found in the female ovary are linked to the progression of oogenesis, increasing after blood feeding initiates the development of eggs. The levels of Microsporiodia MB in the male and female gonadal and gut tissue do not increase as mosquitoes age. Altogether, the high specificity of Microsporidia MB tissue localisation patterns and changes in infection prevalence and intensity suggest adaptation to maximise transmission and avirulence in Anopheles arabiensis

Keywords: Microsporidia MB, Malaria, Symbiosis, *Anopheles arabiensis.*

ABS-182

Involvement of metabolic enzymes in insecticide resistance of Aedes aegypti mosquitoes in vegetable-growing area, southern Côte d'Ivoire

Yapo Marie-Ange Edwige KADJO (Institut Pierre Richet)*

The intensive use of the insecticides in agriculture affects vector susceptibility to insecticides and represents a threat for vector control, including arboviruses. We assessed the insecticide susceptibility status of *Aedes (Ae) aegypti* and the role of detoxification enzymes involved in the insecticide resistance in a vegetable-growing area, Côte d'Ivoire. The use of insecticides and pesticides by farmers was investigated in the study area. *Aedes* eggs were sampled using the World Organization Health (WHO) ovitrap method carried out between March and August 2019 in a vegetable growing area at Songon-Agban. Adult 3–5-day-old females of *Ae. aegypti* reared from ovitrap eggs

were tested against deltamethrin (0.05%), lambda-cyhalothrin (0.05%), Dichloro-Diphényl-Trichlorohexane (DDT 4%) and chlorpyrifos-methyl (0.4%) using WHO susceptibility test kits. Synergist assays using piperonyl butoxide (PBO 4%) were conducted on pyrethroids and DDT resistant populations. Biochemical assays were performed to detect increased activity level in mixed-function oxidases, non-specific esterases and gluthation S-Tranférases. Pyrethroids and organophosphates-based products were the most used. *Ae. aegypti* was resistant to all insecticides tested with a mortality of 68% for deltamethrin, 57% for lambda-cyhalothrin, 41% for DDT, and 82% for chlorpyrifos-methyl. Partial restoration of the susceptibility to pyrethroids and DDT (all $p<0.05$) was associated with an overexpression of α-esterases activity (32.08 nanomol α-naphthol/min/mg protein) in *Ae. aegypti*. This study showed for the first time the involvement of metabolic enzymes (α-esterases) in insecticide resistance within Ae. aegypti populations in Côte d'Ivoire. It is therefore necessary to consider agricultural practices in the insecticide resistance management of arbovirus vectors.

Keywords: *Aedes aegypti*, Insecticide resistance, Metabolic mechanisms, Côte d'Ivoire

ABS-188

Effects of Microsporidia MB infection on female fecundity and host-selection behavior of *Anopheles arabiensis* mosquitoes.

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Malaria remains a significant threat to most of sub-Saharan Africa, with approximately 229 million cases reported annually. Despite remarkable efforts and strategies to control malaria in sub-Saharan Africa, particularly Kenya, the progress has stalled; hence, alternative methods are needed to reduce malaria incidence. The recent discovery of the Plasmodium transmission-blocking symbiont Microsporidia MB indicates that symbionts could play a role in the next generation of malaria control strategies. Currently, there is limited information about the symbiont's physiological and behavioral impacts on the vector. Here, we show the effect of Microsporidia MB on female fecundity and host-seeking behavior. Ovipositional behaviors of gravid Microsporidia MB-infected and non-infected Anopheles arabiensis mosquitoes were compared by counting the number of eggs from wild-caught females. The effect of Microsporidia MB on host choice was done by investigating the blood meal type found in wild-caught *An. arabiensis* mosquitoes. Microsporidia MB-infected females tended to lay fewer eggs as compared to non-infected females. On the effect on host choice, Microsporidia MB did not affect the blood meal type. These findings suggest the possibility that Microsporidia MB symbionts may confer a fitness cost that is manifested at oviposition, but that host choice behavior is not affected in female Anopheles arabiensis mosquitoes.

Keywords: Microsporidia MB, *Anopheles arabiensis*, mosquito, fecundity, host-seeking, oviposition, bloodmeal type

ABS-189

Knowledge, attitudes and practices on malaria of internally displaced women and girls living in the Biyem-Assi health district, Cameroon

Teh Monteh Caroline (University of Buea)*

Malaria is a major public health problem with approximately 40% of the world's population, mostly in the world's poorest countries, being exposed to the disease. The objective of this study was to assess the knowledge, attitudes and practices (KAP) on malaria of internally displaced women and girls living in the Biyem-Assi Health District, Cameroon. The cross-sectional, mixed-methods study was conducted from January to July 2022 among 549 internally displaced women and girls in the Biyem-Assi Health District, Central Region, Cameroon. Ethical clearance was obtained from the regional delegation of the Centre and research authorizations from the chief of service of the Biyem-Assi health district. The respondents associated malaria transmission with mosquito bites in 70% of cases. In case of a malaria attack, 40% of the respondents went to the hospital. The remaining population practiced either traditional medicine or self-medication, obtaining drugs from pharmacies or the street. For malaria treatment and prevention, each household complained about financial resources. The rate of use of insecticide-treated nets (ITNs) by respondents was 30%. However, other means of prevention were practiced: environmental sanitation, use of sprays and blankets/curtains. The study population has an acceptable level of knowledge of malaria, control practices and case management. However, the rate of LLMNs use remains below that recommended by the WHO. Awareness programs for the population should improve this situation.

Keywords: Knowledge, Attitude, Practice, Malaria, IDPs, Biyem-Assi

ABS-222

Malacological and parasitological descriptions of some aquatic ecosystems in the district of Ndikiniméki, Central Cameroon Region

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The low rate of quality water supply observed in most Cameroonian regions forces the population to use surface and ground water for their needs. These waters, subject to various sources of human pollution, particularly fecal, favor the dissemination and transmission of

infectious forms of parasites in humans. The purpose of this work was to determine the malacological and parasitological profiles of four watercourses in the locality of Ndikiniméki, Centre-Cameroon Region. This study was conducted in March 2021 in four aquatic environments of this locality. Malacological and parasitological analyses were carried out on mollusks and sludge respectively, followed by the quantification of parasites using the Kato-katz technique. In total, four species of molluscs were identified (Biomphalaria pfeifferi, Melanoides tuberculata, Mytilus sp., and Potadoma sp.) with a predominance of the species Mytilus sp. (40.99%). The analysis of the diversity and equitability indices of the mollusks showed that the Mandjon River was very diverse with a diversity index of 0.97 and that the species were equitably distributed (with an equitability index of 0.96). The parasitological study of the sludge revealed the presence of 7 species of intestinal parasites in the different collection sites with a total parasite density of 1752 individuals/g of sludge. Among the parasites found, protozoa were the most represented at 87.67% unlike helminths. The highest density of intestinal parasites (960 individuals/g of sludge) was observed in the Mandjon stream where the *E. histolytica* species presented 864 individuals/g of sludge. The cercarial emission tests were negative in the collected mollusks. These results could reflect the sanitary state of the populations constituting a risk of infestation of the latter by the identified parasites. In order to avoid these parasitosis, these waters must be treated before any use.

Keywords: Molluscs, Protozoa, Helminths*, E. histolytica*, Ndikiniméki, Central Cameroon.

ABS-228

Management of Invasive American weed *Parthenium hysterophorus* could prevent spread of mosquitoes borne diseases

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The spread of invasive plant species is currently a major problem in Kenya, where indigenous flora is replaced by dwellings. These species reduce agricultural yields, grazing areas, water availability, and contribute to the spread of vector-borne diseases. A neglected aspect of alien invasive plant species is their influence on mosquito vector ecology and arboviral, arthropod-borne viral transmission. Invasive plants that are highly attractive to Anopheles mosquitoes provide them with sugar that is critical to their survival Therefore, the structure of plant communities can influence the transmission dynamics of mosquito-borne diseases. A particular example is *Parthenium hysterophorus* (Asteraceae). The weed is able to spread aggressively outside its original geographical areas. In this study, we will investigate arboviral mosquito vectors, and their interactions with plants, and how these interactions affect virus evolution and transmissibility. The aim of the proposed research is to determine the abundance and diversity of vectors (mosquitoes) at sites with

different degrees of invasive plant infestations in the Baringo region of Kenya. A total of 50.000 mosquitoes were captured using a combination of different trapping techniques from six villages, three of them with Parthenium and three without Parthenium. Data was collected daily over a 30-day period. 48 mosquito species were identified. The survey was to assess mosquito abundance and diversity in selected areas, knowledge which could be helpful for targeted control. By the end of this project, we will expect to have an inventory of the mosquito population composition and richness of arboviruses. This study demonstrates how an invasive plant shrub promotes the arboviruses disease transmission capacity of African arboviruses vector mosquitoes. Proper management of invasive plants could potentially reduce mosquito populations and arboviral transmission.

Keywords: Agricultural intensification, arboviral disease vectors, invasive plants, land-use changes, mosquito ecology, Parthenium hyst

ABS-229

Mosquito species diversity and *Anopheles gambiae s.l*. insecticide resistance status in the region of Agneby-Tiassa, Southern Côte D'ivoire

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In Côte d'Ivoire, malaria remains the most important vector-borne disease and disease control is threatened by vector resistance to insecticides. This study aimed to participate in better vector control in rural areas by assessing mosquito diversity and *Anopheles gambiae s.l.* resistance to insecticides mostly used in the region of Agneby-Tiassa, southern Côte d'Ivoire. Studies were carried out in 30 rural villages for five weeks spaced by one week apart, from September to November 2018. In each village, four houses received a CDC light trap in a sleeping place and collections were made from one house to another per week, from 6 pm to 7 am. Mosquitoes collected were morphologically identified. The susceptibility of 3-5-day old *An. gambiae s.l.* to either deltamethrin or pirimiphos-methyl, two insecticides widely used in the region, was assessed using WHO tube bioassays. Classic PCR was performed to identify the species within the *An. gambiae s.l*. complex and the presence of mutation genes of insecticide resistance was investigated. A total of 8 694 mosquitoes belonging to four genera were identified. Anopheles was predominant (45.5%, n = 3 957), followed by Culex (29%), Mansonia (22.7%) and Aedes (2.8%). *An. gambiae s.l*. (98.3%, n = 3 889) was the most abundant Anopheles species. Samples shown resistance to both insecticides tested. In *An. gambiae s.s.,* the mutation in the Voltage Gated Sodium Channel (Vgsc) at the 995F locus was fixed, and the other target site

mutations were rare or absent. In *An. coluzzii*, various mutations (Vgsc-995F, Vgsc-402L, Ace1-280S) were detected. In southern Côte d'Ivoire, mosquito disease vectors are highly abundant and diversified in rural areas. The massive use of pyrethroid has led to the fixation of Vgsc-995F in *An. gambiae s.s.* These outcomes are important to inform disease vector control programmes of Côte d'Ivoire.

Keywords: Mosquitoes diversity, Anopheles, insecticide resistance, mutations, Côte d'Ivoire

ABS-230

Human and Environmental Reservoirs of Intestinal Parasites in the City of Yaoundé, Cameroon: An Update in the Context of COVID-19 Pandemic

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Intestinal parasitic infections are persistent in Africa, and we questioned here whether prevention measures imposed by the occurrence of the COVID-19 pandemic in 2020 could alleviate this threat in lowlands of the city of Yaoundé, Cameroon. We monitored the trend of intestinal parasites in human and environmental samples from the seven subdivisions of the city of Yaounde, before (November-December 2019) and during (July-August 2020, November-December 2020) the COVID-19 pandemic. Parasitological analysis were performed to check for the presence of helminths and protozoans in stools from inhabitants as well as in water, soil and fresh vegetables, using standard Kato Katz and Formol-Ether methods. The minimum effective sample size considered for the estimation of parasite richness, parasite infection and contamination indexes was 30 for human and 30 for environmental samples (i.e. soils, water and vegetables) per location. Of the 19 parasite species identified in human and the environments, twelve were helminths and seven protozoans. The overall parasite species richness reached 16 in 2019 (12 helminths and 4 protozoans) and 19 in 2020 (12 helminths and 7 protozoans), with about 62.5-68.4% of species shared by human and environments. The parasite frequencies in human (21.03%) and water/soils (32.3%) in 2019 did not differ statistically with those of 2020 (14.6-20.3% and 10.8-35.4%, respectively). The contamination rate of vegetables (i.e. carrots, lettuce, basil, celery, etc.) has increased from 2019 (6.1-9.1%) to 2020 (9.1-24.2%), and was frequently due to roundworms, hookworms, Entamoeba and Cryptosporidium cysts. The findings suggest persistent risk associated with intestinal parasite irrespective to measures imposed by COVID-19 in study locations. The current control approaches may therefore integrate ecological epidemiology of the intestinal parasite infections as complementary strategy in African cities.

Keywords: Intestinal parasites; human; soils; water; vegetables; COVID-19; Yaoundé.

ABS-233

Prevalence and Predictors of Asymptomatic Malaria in Boricha District, Sidama, Ethiopia: Implications for Elimination Strategies

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Malaria remains a major public health risk in Ethiopia despite the tremendous progress made toward the 2030 elimination targets. The silent transmission of asymptomatic infection is among the many barriers limiting the sustainability of the progress and challenging the elimination effort. Hence, the objective of this study was to investigate the prevalence and risk factors of asymptomatic malaria in the Boricha district, Sidama region, Ethiopia. A community-based cross-sectional study was conducted in eight selected kebeles in the district. Representative households were chosen using a multi-stage sampling process. A total of 573 participants were included in the study. The diagnosis was performed using RDT and light microscopy. A structured questionnaire was also used to gather socio-demographic information. Epi data 3.1 was used for data entry, and SPSS version 25 was used for analysis. Out of the 573 asymptomatic participants tested, 6.1% (95% Confidence Interval (CI: 4.3–8.4)) were found to be positive by RDT and 4.0% (95% Confidence Interval (CI: 2.6–6.0)) by microscopy. Participants aged under five years (AOR 1.57, 95 CI 0.46-5.39) and 5-14 years old (AOR=2.42, 95% CI 1.08-5.40), ITN utilization (AOR=8.41; 95% CI 1.09-65.08), travel history (AOR=6.85, CI 2.32-20.26) and living in the house with the window (AOR=2.11, 95% CI 1.02-4.36) were significantly associated with the asymptomatic malaria infection. The finding revealed that asymptomatic malaria was prevalent in the study area. Therefore, rigorous implementation of the existing interventions as well as the development of new ones that are tailored to the identified factors is strongly recommended to achieve the intended goal of elimination.

Keywords: Prevalence, Asymptomatic malaria, Boricha, Ethiopia

ABS-235

Anopheles gambiae s.l. knockdown resistant mutant alleles and susceptibility to insecticides in 3 sentinel sites of Zimbabwe.

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Indoor residual spraying and long-lasting insecticidal nets are the mainstay malaria prevention measures in Zimbabwe. Efficacy of the insecticides is affected by vector resistance mechanisms. Aim of this study is to assess the status of insecticide susceptibility to insecticides sprayed. 1929 mosquito larvae were collected in Mashonaland East province (Mudzi, Mutoko and Wedza district) from March 2020 to

August 2022. The larvae were reared under insectary conditions. WHO tube and bottle bioassays were conducted and mortality rate was assessed after 24 hours. *An. arabiensis* KGB strain was used as susceptible positive control. *An. gambiae s.l* specimens morphological identification and confirmatory PCR was determined by (Wilkins et al, 2006). Further analyse to detect kdr (Hyunh et al, 2007) and ACE1R (Weill et al, 2004) alleles were done. 5.6% were *An. arabiensis*, 0.73% *An. gambiae s.s*, 0.47 % *An. merus* and 93% *An. quadriannulatus* 100% mortality after 24 hrs exposure was recorded in Wedza. Kdr to clothianidin was recorded 75% in Mutoko and 86.6% mortality rate in Mudzi. PCR showed that 1.44% *An. quadriannulatus* was resistant to deltamethrin, DDT, pirimiphos-methyl and clothianidin in Mutoko and Mudzi. All *An. gambiae s.s* and *An. merus* were susceptible whereas 2.04% *An. arabiensis* species were resistant to deltamethrin in Mutoko. L1014S allele was found in Mudzi 0.01% and Mutoko 0.5%, whereas L1014F allele was 0.4% Mudzi and 0.7% Mutoko. ACE1 resistance was present in Mutoko 1.04% and 0.3% in Mudzi. Deltamethrin insecticide was associated with L1014S mutant allele (p=0.01). DDT and pirimiphos-methyl were associated with L1014F mutant allele (P=0.01). Using alpha-cypermethrin, chlorfenapyr and permethrin insecticides is recommended in study sites.Results have identified that new approaches for monitoring resistance are needed since larval collections can be dominated by non-vectors.

Keywords: Insecticides, Resistance, *An. gambiae*

ABS-237

Species composition, infection rate and detection of resistant alleles in *Anopheles funestus* (Diptera: Culicidae) from malaria hotspot areas of Ethiopia

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Anopheles funestus is a secondary malaria vector in Ethiopia & has morphologically indistinguishable species. Data on which sibling species is distributed in Ethiopia is limited. Accurate identification of sibling species is crucial to understand biology, behavior & vector competence. Molecular identification of *An. funestus* populations, detection of insecticide resistance mechanism markers and investigation of the infective stage of parasite adult female *An. funestus* of Ethiopia were conducted for better understanding of the vector bionomics. Adult female mosquitoes were collected from Lare, Gambella Region, Ethiopia between Nov.2017 to Jul.2020 using CDC traps & HLC. Samples of *An. funestus* were identified using species-specific PCR, insecticide resistant alleles was investigated using TaqManqPCR (N485I-Ace-1), PCR-Sanger sequencing (L1014F-kdr) & PCR-RFLP (CYP6P9a resistance allele). Following head/thorax dissection, the TaqManqPCR assay was used to investigate presence of the infective stage Plasmodium parasite species. A total of 1086 adult female *An. funestus* were collected during the study. All Samples (N=20) that were morphologically identified as *An. funestus s.l* were confirmed to be *An. funestus s.s* with species-specific PCR. Pyrethroid resistance (CYP6P9a) allele was not detected from 30 randomly selected *An. funestus s.l* specimens by the PCR-RFLP assay. The qPCR TaqMan resulted in no detection of N485I-Ace-1 and all samples (N=144) were characterized as wild type. The kdr L1014F and L1014S mutations in VGSC gene analysis with direct Sanger sequencing were also characterized as wild type. All samples (N=169) were negative for Plasmodium detection. Molecular identification of Ethiopian *An. funestus s.l* samples resulted in *An. funestus s.s*. No CYP6P9, N485I ace-1, kdr L1014F/S mutations & no Plasmodium were detected in the samples. This study provides a reference for future vector monitoring programs.

Keywords*: Anophelus funestus*, resistant allele, Genotyping, Secondary malaria vectors, Single nucleotide polymorphisms, Ethiopia

ABS-241

A human-centred design on human, mosquito behaviours and malaria risks in a highly endemic area of Malawi

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Malawi is among the top 15 countries with high malaria burden, with nearly 4 million people diagnosed yearly. Progress in malaria reduction has stalled, and residual transmission continues, despite improved availability and access to a mix of tools targeting the mosquito vector and disease parasite. Little is known about the interaction between the malaria reservoir (school-age children and adults) and the vector mosquito. We explored community members' experiences in identifying high-risk activities for malaria to empathize and stimulate local people's involvement in malaria control. Using an exploratory sequential mixed-methods approach, the study explored 1) sleeping patterns, 2) human behaviours, 3) outdoor activities and 4) preferences for vector control practices. The human-centred design (HCD) and thematic analysis guided and informed the community members' perceptions, needs, desires and experiences related to malaria risks, prevention and control. Comparative analysis linked human behavioural dynamics to mosquito surveillance data to identify high-risk activities to inform malaria control intervention strategies. Different population group activities, livelihoods, and contextual particularities influence malaria transmission, prevention and vector control behaviours. The risk of exposure to malaria is associated with places, events and relationships. Current obstacles to acceptability, feasibility and desirability in using new generation nets and other intervention options are discussed. The HCD approaches informed the empathy and flexibility of affected communities to respond to their malaria needs and lifestyles. Malaria is a complex disease influenced by human, mosquito, and parasite dynamics. Understanding the intertwining of human and malaria dynamics offers alternative possibilities and innovative ways for considering malaria control in endemic countries.

Keywords: Human-centred approach, Human-mosquito-behaviours, Malaria prevention and control, Malawi,Vector surveillance sentinel sites

ABS-250

Is Microsporidia MB environmentally transmissible? An investigation using oral feeding as an alternative horizontal transmission route and the viability of Microsporidia MB spores in the environment.

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Microsporidia MB is an obligate clade IV microsporidian symbiont identified in *An. arabiensis* and *An. funestus* mosquitoes that inhibit Plasmodium falciparum gametocytes and sporozoites development, making it a promising malaria control strategy. Despite Microsporidia MB having efficient vertical transmission (45-100%), it has a low prevalence in the wild at 0-20%. One possible dissemination strategy would be dispersing Microsporidia MB spores, mimicking other microsporidian species' transmission routes. This study investigated the potential success of alternative horizontal transmission routes for Microsporidia MB. Egg washes and egg homogenate from eggs laid by

Microsporidia MB-infected females were used to inoculate uninfected L1 mosquito larvae. The mosquito larvae were tested at the L4, pupae, and adult stages for Microsporidia MB infection. The viability of Microsporidia MB in the environment was tested by performing live/dead microscopy tests and determining the degradation of Microsporidia MB DNA over time. We detected Microsporidia MB in egg washes and homogenates, suggesting that Microsporidia MB spores could be found in or on the exterior of *An. arabiensis* eggs. Larvae fed with the egg homogenate and wash tested positive for a low-density Microsporidia MB infection at the larval stage, which was lost at the pupae and adult stages. Microsporidia MB also gradually degrades in the environment. The results suggest that spores cannot establish stable infections in non-infected larvae. These results confirm previous work, where Microsporidia MB transmission was not detected between infected and uninfected larvae sharing larval habitats, indicating specificity in Microsporidia MB transmission. Microsporidia MB also gradually degrades in the environment, as demonstrated by the viability work, which could confirm the specificity of Microsporidia MB transmission.

Keywords: Microsporidia MB, larvae, egg wash, egg homogenate, viability, spores

ABS-256

Impact of sugar diet on the sensitivity of insecticides-resistant mosquitoes

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The resistance of mosquitoes to insecticides is a rapidly growing problem. While resistance has a strong genetic basis, the environment also affects the extent of resistance. However, we know little of how, for example, the mosquitoes' diet affects their resistance. Our aim was to see how different types of sugar found in nectar influence the sensitivity of strongly insecticide-resistant mosquitoes. To do so field-collected larvae of the species *Anopheles gambiae s.l.* from Tiassalé were reared to adults. Then, their offspring (F1 generation) reared were used for the experiment. We provided adult female sugar meals consisting of sucrose, glucose, fructose or trehalose dissolved in distilled water at concentrations yielding 1.97 or 19.7 kcal/100ml. After five days we measured their knockdown rate and their mortality within 24 hours of exposure to 0.5% deltamethrin with WHO tube tests. We found that there was a positive correlation between the rate of knockdown and mortality for all sugar meals. Mosquitoes fed on the lower concentration were 1.4 to 2 times more likely to die than the better fed mosquitoes, but that the type of sugar had no effect on resistance. Results indicate that the amount of calories provided by sugar is a potential determinant of mosquito susceptibility to insecticides. Sugar meal containing fewer calories may provided less energy to

mosquitoes, making them less vigorous and more sensitive to insecticide. Further studies will consider other components of nectar in an attempt at using plants in an integrated approach to manage infection resistance of mosquitoes.

Keywords: Mosquito's sugar meals, Ecology, Susceptibility to insecticide,

ABS-267

Efficacy of Actellic 300 CS-based indoor residual spraying (IRS) on key entomological indicators of malaria transmission in Alibori and Donga, two regions of northern Benin

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The current study shows the results of three years of entomological monitoring of IRS in Alibori and Donga, northern Benin, in a context of resistance of malaria vectors to pyrethroids. After assessing the residual activity of Actellic 300 CS after each round of IRS, the main entomological indicators of malaria transmission in *Anopheles gambiae (s.l.)* were measured in both the IRS (Alibori/Donga) and control areas (Bembèrèkè and Bassila). The residual efficacy duration of Actellic 300 CS after the two IRS campaigns was 4–5 months. The parity rate and the sporozoite index (SI) of *An. gambiae (s.l.)* were 36.62% and 0.71%, respectively, after the first spray round in treated areas compared to 57.24% and 3.7%, respectively, in the control areas ($P < 0.0001$). After the first spray round, each person received 1.6 infective bites/month (ib/m) in the treated areas against 12.11 ib/m in the control areas, resulting in a reduction rate of 86.78%. Similarly, the EIR was 1.5 ib/m after the second spray round in the treated areas vs 9.75 ib/m in the control areas, corresponding to a reduction of 84.61%. A decrease in the parity rate (46.26%), SI (85.75%) and EIR (87.27%) was observed after the first round of IRS compared to the pre-intervention period. Vector density and blood feeding rate ranged from 0.38-0.48/room and 62.5-63.37%, respectively, in the treated areas compared to 1.53-1.76/room and 80.74-96.20% in the control areas. This study showed the positive impact of IRS in reducing key entomological parameters of malaria transmission in Alibori and Donga. However, the considerable blood-feeding rate of *An. gambiae s.l.* in spray areas, stress the need for the population to sleep under long-lasting insecticidal nets (LLINs) in addition, to prevent from mosquito bites which did not succeed in resting on sprayed walls.

Keywords: IRS, Efficacy, Actellic 300CS, Malaria transmission, Benin

ABS-268

Genetic polymorphism of cytochrome cyp6p4 associated with a pyrethroid resistance in the major malaria vectors *Anopheles coluzzii* and *Anopheles gambiae* from yaoundé, cameroon

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The spread of insecticide resistance in malaria vector populations is reducing the effectiveness of control tools. As playing a major role, metabolic resistance needs more attention. Thus, assessing the genetic diversity of resistance genes, such as P450s, helps to understand the dynamics and evolution of resistance in the field. Here, we analysed the polymorphisms of CYP6P4 in 2 malaria vector to detect potential resistance markers. In this study, larval collection was carried out in Yaoundé and bioassays were performed to determine adults' resistance profile. Permethrin survivors were crossed with a susceptible lab-strain and the F4 progeny was exposed to permethrin for 15min and 90min to discriminate respectively highly susceptible (HS) and highly resistant (HR) mosquitos. On these, CYP6P4 gene and upstream region were both sequenced for polymorphism analysis. Significant permethrin mortality reduction was observed after pre-exposure to PBO (5.37-fold increase compared to mortalities with permethrin alone, $\chi 2=27.38$, $P< 0.0001$), suggesting the involvement of P450s genes. This correlates with the qPCR result which revealed significant overexpression of CYP6P4 (6.73±1.15 *An. coluzzii*; 23.62±5.72 An. gambiae). The analysis of 870-bp of the upstream region of CYP6P4 revealed low polymorphism in HR (Hd=0.48) defining 2 haplotypes, compared to HS (7 haplotypes) with Hd = 0.85, suggesting a possible ongoing directional selection in HR. In parallel, for the full-gene, the HR sequences of *An. gambiae* exhibited 11 polymorphic sites, the HS sequences showed 13 polymorphic sites. A candidate synonymous substitution in codon 168 (TGC->AGC) was found with a frequency of 70% in the HR, 28% in HS. These results highlighted that CYP6P4-associated resistance is potentially driven by mutation in the upstream region. However further work is needed to determine the causative variants to design simple assay to track this resistance.

Cytochome P450, CYP6P4, Polymorphism, Pyrethroid resistance, Malaria vectors, *An. coluzzii*, *An. gambiae*, Cameroon

ABS-273

Assessing Asymptomatic Malaria Carriage of *Plasmodium falciparum* and Non-falciparum Species in Children Resident in Nkolbisson, Yaoundé, Cameroon

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Malaria is still a threat to public health as it remains the first endemic disease in the world. It is a pervasive parasitic disease in tropical and subtropical regions where asymptomatic malaria infection among humans serves as a significant reservoir for transmission. A rapid and correct diagnosis is considered to be an important strategy in the control of the disease especially in children, who are the most vulnerable group. This study assessed the prevalence of asymptomatic malaria in children at the Nkolbisson health area in Yaoundé, Cameroon. A cross-sectional study design and a convenience sampling plan were used. A total of 127 participants were recruited after informed and signed consent from parents and/or guardians. Blood samples were collected by finger-pricking and venipuncture from children aged 6 months to 10 years and then screened for asymptomatic parasitemia by a rapid diagnostic test (RDT), light microscopy (LM) staining with Giemsa and 18S rRNA polymerase chain reaction (PCR) for speciation. The data were analyzed using SPSS version 20 software. The study identified 85 children who were positive from the PCR, 95 positive from the RDT and 71 from the LM, revealing a malaria prevalence of 66.9%, 74.8% and 55.9%, respectively. The prevalence was not observed to be dependent on the sex and age group of the participants. *Plasmodium falciparum* was the predominant species followed by *Plasmodium malariae* and then *Plasmodium ovale*. The RDT and LM had the same sensitivity (90.6%) with a slight difference in their specificity (RDT: 57.1%; LM: 54.8%). The RDT also demonstrated higher positive and negative predictive values compared with those of the LM.

Keywords: Asymptomatic malaria; children prevalence; Plasmodium species; Yaoundé; Cameroon

ABS-278

Does Plasmodium develop faster in mosquitoes with higher ageing rate?

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According to life history theory, parasites that can adjust their investment into growth or transmission stages in response to environmental conditions should have greater fitness all else being equal. Temperature affects both mosquito lifespan and Plasmodium's

extrinsic incubation period (EIP). Understanding how the effect of temperature on the ageing rate of mosquitoes impacts the EIP of Plasmodium is crucial to produce good estimates of malaria risk, particularly in the context of climate change. Our experiments involve rearing mosquitoes in environmental chambers with fluctuating temperatures that mimic real-world conditions. Using generalised linear models, we describe the impact of temperature on 1) mosquito ageing rate and 2) the time to salivary gland invasion by sporozoites. We also monitor sporozoite expectoration during sugar feeding to explore its potential as a non-destructive EIP analysis method. Our experimental pipeline also includes using mid-infrared spectroscopy (MIRS) to analyse mosquitoes. MIRS spectra are influenced by the chemical composition of the samples, and spectroscopic methods have been used in the past to distinguish mosquitoes of different species or age groups. These methods require no refrigeration chain, reagents, or sample preparation, and offer much higher throughput than molecular methods. We have found an association between the temperature regime under which mosquitoes are reared and their lifespan, which in turn affects their EIP. We will also discuss the potential of mosquito saliva analysis as a tool for vector surveillance, and show how we trained machine learning algorithms to predict the species, age, and infection status of mosquitoes based on their MIRS spectra. We will apply concepts from life history theory to refine models of malaria dynamics, as well as present our advances towards developing a vector surveillance strategy that requires minimal resources.

Keywords: EIP, temperature, ageing rate, machine learning, MIRS, mosquito saliva

ABS-280

Is Anopheles gambiae an effective plant pollinator?

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Target malaria is developing genetically modified mosquitoes with the aim of suppressing *Anopheles gambiae* population. However, the species is part of three ecological niches: larval niche (aquatic, and forms part of the aquatic food chain), adult niche (may be fed on by birds, dragonflies etc.) and pollinator niche (both male and female visit plants for sugar and may pollinate). Hence, before suppressing the species' population, it is important to understand its role in each of these niches. This study focuses on establishing the effectiveness or otherwise of An. gambiae as a pollinator. Sixty plants, each of Helianthus annus (sunflower), strawberry (Fragaria ananassa) and Melanthera scandens were raised in greenhouse in University of Ghana. Selected plants have open flowers and also allows for nocturnal pollination. Prior to flowering, the plants were subjected to three treatments: 20 individuals outside (all pollinators could visit), 20 in a

greenhouse (no biotic organism can visit) and 20 in another greenhouse compartment (only un-fed day-old *An. gambiae* were introduce). Yield (weight per seed and number of seeds) were analyzed using GLMM and compared. For strawberry, shape and weight of fruits were also considered. For Sunflower and Melanthera scandens, there were no statistically significant difference between number of seeds in all treatments. However, the weight per seed were significantly higher ($p<0.05$) in treatment 1 than in treatment 2 and 3. This is an indication that seed weight in both plants are likely enhanced by efficient pollination. The results from strawberry are expected to be ready in July 2023. Seed weight of sunflower and Melanthera scandens are likely enhanced by efficient biotic pollination. *An. gambiae* could not act as efficiently pollinators of the two plants. Hence, suppressing the population of An. gambiae is not expected to impact negatively on reproductive success of plants.

Keywords: *Anopheles gambiae*, pollination, genetically modified mosquitoes, population suppression, malaria, ecological niche

ABS-283

Exploring community acceptability of two biorational approaches for cattle centred One Health interventions to control infectious diseases in coastal and western Kenya

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Participatory exploration of disease challenges posed by arthropods in the target communities, highlighted the need for integrated management of human and cattle disease vectors. A possible novel intervention is the application of entomopathogenic fungal spored directly on cattle or on fabric located around cattle enclosures to reduce the survival of mosquitoes, biting flies and ticks. Focus group discussions (FGDs) assessed community perceptions on vector borne diseases and cattle keeping practices and explored the acceptability of a biorational, cattle-targeted intervention. Tsetse, ticks and mosquitoes were perceived as common livestock pests by participants across the two study sites. Current methods to control pests, especially ticks, were reported to be ineffective. Participants felt they had limited information on vector-borne diseases affecting livestock which does not enable them respond appropriately. The veterinary extension services were perceived barriers for accessing efficient approaches to improve cattle health. An integrated approach idea for controlling human and cattle disease vectors was well received, since presence of malaria vectors was attributed to cattle ownership. Farmers had no reservation using fungal spores to spray cattle or other surfaces around cattle if there is evidence of safety. Uptake of the product would be likely if it is highly efficient to control ticks, and the costs would not be higher than those in the market. Spraying directly

on cattle was preferred as the target communities do not keep their cattle indoors. The participants suggested that treated fabric might be used around houses instead. Clear gender roles were identified in animal husbandry. Whilst acceptable in principle, the proposed interventions require gender-specific engagement, high efficiency, and low cost of the product for sustainability, and a process of building trust into multi-sectoral collaborations.

Keywords: One Health, Participatory, entomopathogenic, fungal spores, Gender , Veterinary extension services

ABS-287

Automation of malaria vectors data abstraction from published literature.

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Malaria is a deadly disease that continues to have a significant impact in Africa, with children under five being particularly vulnerable. Efforts to control and eradicate the disease require accurate and up-to-date information on malaria vectors, including their occurrence, bionomics, and insecticide resistance. The Vector Atlas Project aims to build a common database for malaria vector data to facilitate malaria control and elimination efforts. To date, the project has manually extracted data from published literature, producing highly reliable outputs used by several organizations. However, the manual data abstraction process is time-consuming and labour-intensive, hindering progress toward the project's objective of a one-stop-shop platform for malaria vectors worldwide. To address this challenge, we propose a novel web-based data-abstraction pipeline, which exploits semantic web technologies and powerful language models

(Bidirectional Encoder Representation from Transformers (BERT)) to accurately extract relevant information from the pdf format of journal publications and format them to a more usable form (a knowledge base). The obtained knowledge base is then queried to extract specific information to fit the final database. Our approach significantly reduces the time required for data abstraction and increases the accuracy compared to the manual process. We demonstrate the effectiveness of our approach by evaluating the performance of our pipeline on a subset of the Vector Atlas Project dataset. We obtain encouraging results in terms of accuracy and time. The proposed methodology is highly adaptable to other domains, thanks to its use of common ontologies as a foundation. It offers a promising result for accelerating progress toward malaria vector data abstraction, which will support efforts to control and eradicate malaria in sub-Saharan Africa and other regions affected by the disease.

Keywords: Information extraction, language model, Bidirectional Encoder Representation from Transformers, knowledge base

ABS-288

Geographic modeling of weighted regression of self-reported malaria cases associated with environmental risk factors in Benin during the rainy season

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Geographically Weighted Regression (GWR) is a technique applied to capture variation by calibrating a multiple regression model, which allows different relationships to exist at different points in space. With malaria elimination at the top of the health agenda, integrated action on all elements of the malaria system that contributes to improved knowledge and local capacity building for positive effects on the health of the local population is needed. Several variables were collected for 192 sampling points in 12 communes in Benin, one per department. A questionnaire was sent to the head of the household to analyze the impact of environmental factors on reported malaria cases. Numerous GIS classification software for spatial analysis, remote sensing, data analysis/modeling and GPS management, R and MGWR software were used for geographic modeling. An abundance of malaria cases reported in crop areas than in non-crop areas and in rural areas than in urban areas. The Hot Spot Analysis shows the localities of South Benin and Malanville as priority issue areas with a remarkable increase in crop diversity favorable to malaria vector proliferation. The spatial autocorrelation z-score of 4.83653470763 shows that there is less than a 1% probability that this clustered pattern is the result of chance. The observed non-stationarity means that the relationship between the variables studied varies from location to location depending on the physical factors of the environment

that are spatially autocorrelated. Environmental factors therefore influence the intensity of transmission, seasonality, and geographic distribution of malaria. With minimal funding, we plan to correlate these data with parasitological and entomological data

Keywords: GWR, malaria, communes, Bénin, impact of environmental factors, GIS, GPS, rural areas, urban areas, hot spot analysis.

ABS-290

A second blood meal increases Plasmodium falciparum sporozoite infection in Anopheles mosquitoes but not parasite genetic diversity

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Nutrients from blood meals ingested by malaria mosquito vectors accelerate the development of monoclonal laboratory strains of Plasmodium falciparum. The impact of blood meals on the development of distinct P. falciparum genotypes from polyclonal natural human malaria infections (field-isolates) remains unexplored. Here, we experimentally infected Anopheles gambiae mosquitoes with field isolates of *P. falciparum* and measured the impact of a second blood meal on parasite development and assessed the diversity of individual parasite genotypes from the human blood to the mosquito salivary glands. We found that a second blood meal increases prevalence and intensity of sporozoite infection but does not affect the genetic diversity of *P. falciparum* in the mosquito vector. The most abundant parasite genotypes present in the human blood were transmitted to mosquitoes, suggesting an impact of genotype density. Our data underlines the importance of multiple mosquito blood meals for parasite development even with low density wild infections.

Malaria, *Plasmodium falciparum*, *Anopheles gambiae*, Parasite development, Sporozoites, Nutritional stress, Genetic diversity

ABS-291

Assessment of dengue and chikungunya infections among febrile patients visiting four healthcare centres in both urban (Yaoundé) and rural (Dizangue) settings from Cameroon

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Dengue and chikungunya are now widely distributed in Cameroon but information on their prevalence in different epidemiological settings are still lacking. This study was undertaken to assess dengue and chikungunya prevalence in both urban and rural settings in Cameroon using 3 diagnostic tools. From December 2019 to September 2021, willing outpatients with an axillary temperature ≥38°C visiting 4 hospitals of Yaoundé and Dizangue were screened for malaria, dengue and chikungunya. Patients' clinical symptoms were recorded and their blood samples analysed using rtRT-PCR, RDTs and ELISA. Odds ratios were used to determine the level of association between socio-demographic factors, clinical features and the infection status. RDTs performances were assessed by calculating sensitivity, specificity and Kappa coefficient. Overall, 301 patients were recruited: 198 in Yaoundé and 103 in Dizangue. The prevalence varied according diagnostic tool. For dengue, 110 patients were positive to rtRT-PCR: 90 (45.45%) in Yaoundé and 20 (19.42%) in Dizangue. Abdominal and retro-orbital pains were significantly associated to acute dengue infection. All the four dengue serotypes were recorded with a predominance of DENV-3 (35.45%) and DENV-4 (25.45%). The prevalence of dengue IgM with ELISA was 22.3% in Dizangue and 30.8% in Yaoundé. Dengue IgM prevalence with RDTs was 7.6% in Yaoundé and 3.9% in Dizangue. For chikungunya, one (0.5 %) patient in Yaoundé was positive to rtRT-PCR. The prevalence of chikungunya IgM with ELISA was 18.4% in Dizangue and 21.7% in Yaoundé, while with RDTs, it was 4.5% in Yaoundé and 12.6% in Dizangue. RDTs for either chikungunya or dengue displayed very poor sensitivity when ELISA was used as gold standard. This study highlights contrasting prevalence patterns of both dengue and chikungunya in Yaoundé and Dizangué. Such data stress the need for active surveillance of cases to prevent outbreaks across the country.

Keywords: Acute and recent infections, dengue; chikungunya; Dizangue; Yaoundé; Cameroon

ABS-298

Therapeutic efficacy and safety of artemether-lumefantrine plus single dose primaquine in the treatment of uncomplicated *P. falciparum* malaria at Maksegnit health center, north western Ethiopia

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As per WHO recommendation, continuous monitoring of antimalarial drug therapeutic efficacy is crucial in Ethiopia. This study aimed to assess the therapeutic efficacy of AL plus SLD-PQ in the treatment of uncomplicated *P. falciparum infection*. This study aimed to assess the therapeutic efficacy and safety of AL plus SLD-PQ for the treatment of uncomplicated *P. falciparum malaria*. An in vivo prospective single-arm study was conducted at Maksegnit Health Center from February to May 2022. A 42-day, one-arm prospective evaluation of the clinical and parasitological response to AL plus SLD-PQ was conducted at Maksegnit Health Centre, North West Ethiopia. Patients were treated with a six-dose regimen of AL over three days and 0.25 mg/kg primaquine and monitored for 42 days with clinical and laboratory assessments. Participant recruitment and outcome classification were done following the 2009 WHO methods for surveillance of anti-malarial drug efficacy guidelines. Among the 88 enrolled patients, 85 patients completed a 42-day follow-up. The per-protocol PCR uncorrected and corrected cure rates were 94.1% (95% CI: 86.8–98.1%) and 96.4% (95% CI: 89.8–99.2%), respectively. Artemether lumefantrine plus a single low dose of primaquine cleared parasites and fevers quickly, with only one participant having parasitemia on day 3 and no febrile cases on day 2. On day three, gametocytes were completely cleared. The mean hemoglobin on days 0, 14, 28, and 42 was 14.2±2.07 g/dl, 13.96±1.47 g/dl, 14.4±1.32 g/dl, and 14.65±1.35 g/dl, respectively. Generally, adverse events were mild to moderate, but no severe adverse events were recorded. Therefore, Artemether lumefantrine plus single-dose primaquine should continue as a first-line drug to treat uncomplicated *P. falciparum* malaria in the study area. Artemether-lumefantrine plus single-low-dose primaquine was efficacious and safe in the study area for the treatment of uncomplicated *P. falciparum* malaria.

Keywords: Efficacy, Safety, Artemether-lumefantrine, Primaquine, *Plasmodium falciparum*

ABS-299

Characterization of malaria transmission and susceptibility profile of *An. gambiae s.l* to insecticides in two localities in the east region of cameroon (bélabo and ouami).

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Malaria remains a major public health problem in Cameroon. For several years, the Eastern Region of Cameroon remains one of the most affected areas. However, few studies have assessed the factors influencing malaria transmission in the region. This study aims to assess the factors that maintain high malaria transmission in this region. The study was done in Bélabo and Ouami. Adult mosquitoes were collected using HLC and CDC light traps. After morphological identification, heads and thorax of the Anopheles mosquitoes were used to determine infectivity by ELISA. Species of the *Anopheles gambiae* complex were identified by PCR. *Anopheles gambiae s.l* Adults coming from larva collected were tested to insecticide to determine their susceptibility using WHO tubes bioassays. Out of the 3107 mosquitoes of the Anopheles genus collected (1406 in Bélabo and 1701 in Ouami) *An. gambiae s.l* (86.93%) was the most abundant followed by An. ziemmani in both localities. *An. gambiae* (60%), *An. coluzzii* and *An. arabiensis* were identified after PCR. The biting rate was 18.44 b/m/n in Bélabo and 22.63 b/m/n in Ouami. The sporozoite index was 1.35 (42/1406) and 0.42 (13/1701) in Bélabo and Ouami respectively. A total of 1875 adult Anopheles from larval collections were tested to insecticide. Resistance of *An. gambiae s.l* to deltamethrin 0.05 (29% in Ouami to 62% in Bélabo) and permethrin 0.75 (0% in Bélabo to 28% in Ouami) was noted. The PBO synergiste increased the sensitivity of *An. gambiae s.l* to permethrin 0.75 in both localities (0% to 38% in Bélabo and 27% to 52% in Ouami) . Resistance to malathion and bendiocarb was also observed in Ouami (95% and 76% respectively). Probable resistance of *An. gambiae s.l* to malathion was noted at Bélabo. This study reveals a high bite rate of Anopheles in both localities and resistance of An. gambiae s.l to insecticides.

Keywords: Malaria, Anopheles, Resistance, Bélabo, Ouami.

ABS-302

Stochastic Delay Model of Anopheles Mosquitoes Population with Microsporidia MB

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Malaria continues to be a deadly disease in the world despite intervention strategies and control measures. Africa remains the most affected by malaria because most of its environment is conducive to the spread of this vector-borne disease. In order to achieve possible eradication of malaria, it is essential to combine new control strategies with the existing ones due to Anopheles mosquitoes' resistance to indoor residual spray (IRS), and insecticide-treated nets (ITNs). One of the promising malaria vector control methods is the use of symbionts, such as Microsporidia MB. The aforementioned has a potential malaria-blocking ability. It can be passed from adult mosquito to adult mosquito during mating and from infected adult female to offspring. This article suggests using mathematical modeling to investigate how the symbiont, Microsporidia MB spreads among Anopheles populations. Stochastic differential equations with delay are used to describe the population dynamics of the adult and aquatic stages as well as the symbiont transmission parameters. Stochastic perturbations are integrated to the mortality rates of both the immature and mature stages. Positive global solutions are identified using the Ito formula and Lyapunov functions. The conditions for the extinction and persistence of the Anopheles symbiont within mosquito populations are also provided. Numerical simulations are carried out using the Euler-Maruyama discretization. The results show that temperature and rainfall affect symbiont-infected Anopheles mosquitoes and that they can live in the wild with merely slight environmental changes.

Keywords: Stochastic, Lyapunov, Anopheles, Microsporidia MB, Malaria

ABS-306

series spatial characterization of malaria larval sites commonness and divergence.

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Efforts to control, manage and eliminate malaria, a serious vector-borne disease, have been witnessed globally. The most successful strategies employed have been the use of treated bed nets and indoor insecticide spraying that target adult malaria vectors. Larval site control measures have also been practiced as a supplementary approach to controlling malaria, by targeting the aquatic stages of the malaria vectors. However, the gains obtained so far are threatened by poor surveillance of these malaria larval sites among other challenges. Therefore, this study aims at unveiling patterns of changes in malaria larval sites over time and space, to improve malaria larval sites surveillance in Kenya, Cameroon and Tanzania. This study utilizes geospatial and remote sensing techniques in the acquisition, pre-processing and processing of time-series satellite imagery from 1986-2023. Land use and land cover classification (LULC) of the time-series satellite imagery from 1986-2023 with 5 years interval is then carried out to analyse LULC change detection. Multi-criteria decision analysis is also conducted to delineate larval site areas from the LULC and existing larval sites data are used as validation. Thereafter, rule-based methods i.e., fuzzy logic classification methods, are applied upon incorporating the delineated larval sites, other LULC classes, climatic, topographical, and edaphic variables among other environmental variables, to predict shifts in the commonness and divergence of the malaria larval sites.

Conclusions: The results obtained are useful in providing timely tools for improved surveillance of malaria larval sites, towards the achievement of sustainable development goal number three, which focuses on ensuring healthy lives and promoting well-being for everyone, through efforts such as ending the malaria epidemic by 2030.

Keywords: *Anopheles gambiae*, larval sites, land use and land cover, fuzzy logic, malaria.

ABS-312

Malaria Vector Phenology: Application at Landscape

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The infection dynamics of Malaria are highly influenced by changes in the abundance and seasonality of its vector, the mosquito, which is subject to changes in climatic conditions, most especially temperature. To ease the magnitude of the malaria burden, malaria control through vector control is largely practiced. In Africa, this vector is the Anopheles mosquito. Data collection efforts have so far been used to identify presence or absence of the primary vector species but this is largely limited to site accessibility and previous citing of the vectors. In addition, countless experiments have been undertaken to understand their phenology, however, these experimental data are not always readily available and where accessible may require lengthy protocols to acquire. Here, we synthesize life table data of these species from published data sources. We then use these synthetic data to generate temperature dependent phenology models and create a suitability index to model and map the distribution of the primary vector species across the African landscape. This is validated using known species occurrence. While this study overcomes the biases associated with presence/absence only data it further expounds on possibly overlooked occurrence through its basis being the vector species' phenology. This will greatly inform decision making on better and effective vector control strategies.

Keywords: *Anopheles gambiae*, phenology modeling, malaria

ABS-313

Semi-field evaluation of indoor residual spray bio-efficacy and residual activity of two different pyrethroid formulations against susceptible *An. arabiensis* species in Sudan.

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Indoor residual spraying (IRS) is a crucial insecticide-based vector control tool for controlling and eliminating malaria in a variety of malaria epidemiological settings. The malaria control program in Sudan relies mainly on applying the (IRS) along with the distribution of Long-lasting insecticidal nets (LLINs). In Sudan, the application of IRS using deltamethrin has become the most common practice, with permethrin used for ultralow volume (ULV) and thermal-fog space spraying to control *An. arabiensis* species. The IRS was conducted for two different pyrethroids formulations; Etofenprox (Pheto 20% Wettable powder) and Lambda-cyhalothrin (IPhoen 10% Capsule suspension) in Khartoum State, Sudan. We assessed the Pheto 20% WP duration and IPhoen 10% CS residual efficacy against susceptible laboratory-reared *An. arabiensis*, using standard World Health Organization cone bioassay test on painted cement walls, in selected households in the field. Cone Bioassays Test of Pheto 20% WP, showed close 100% mortality 24h after exposure up to 16 weeks. With an overall average of 30 mins knockdown averages 95.28% and 24h mortality averages 98.97%. Similarly, bioassays test for IPhoen 10% CS, showed nearly 100% mortality 24h after exposure up to 16 weeks, with an overall average of 30 mins knockdown averages; 93.96% and 24h mortality averages; 98.47%. WHO cone bioassay tests concluded that both pyrethroid formations (Lambda-cyhalothrin & Etofenprox) show higher residual efficacy up to four months.

Keywords: Vector control, WHO cone bioassay test, IRS, pyrethroids, Lambda-cyhalothrin, Etofenprox, *Anopheles arabiensis*.

ABS-316

Characterisation of the parameters involved in the *Anopheles coluzzii* swarms formation in Vallée du kou, Burkina Faso

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The mating behavior of *Anopheles gambiae* complex is an important aspect of its reproduction biology. Success of mosquito release programs based on SIT, genetic control of malaria crucially depends on competitive mating between both laboratory-reared and wild

individuals. It is known that both intrinsic and extrinsic factors can influence mating success. We therefore characterised the parameters involved in the formation of *An. coluzzii* swarms in the Kou Valley from June to October 2021. The swarm survey was carried out on 40 compounds. Identified swarms were geolocated and swarming times were reported. The height and distance between swarms were then measured. Finally, the number of mosquitoes in each swarm was determined using cameras and the ImageJ software, the number of pairs counted and the wing length of the mosquitoes was measured. ArcGIS, Image J and R software were used for analysis and spatial representation of the data. A total of 169 swarms were identified. Number of swarms per concession varied between 3 and 10. It was positioned an average 2.87 meter (1 min, 3.2 max). The appearance time varied between 18:05 and 18:45 mn. The height of the swarms varied between 1 and 3.2 meters. We did not find a standard distance at which the swarms formed. Pairing was higher in larger swarms. The smallest swarm had 83 mosquitoes and the largest 3000. Mosquito size did not influence swarm formation but there was a positive correlation between size and swarm formation ($p < 0.001$). The results of our study provide fundamental information for the development of control strategies targeting swarms and also for the success of the release of sterile males. We then started video-tracking the mosquitoes in swarms to better understand the internal dynamics of swarms in order to develop tools to target them.

Keywords: Swarm, *Anopheles coluzzii*, mating, vallée du kou, Burkina Faso

ABS-319

The role of car tyres on the ecology and fitness of aedes mosquitoes in Ghana

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The aedes mosquito is an important vector of arboviral diseases including dengue and yellow fever. despite the wide distribution of the aedes mosquito, there is limited data on the ecology of aedes mosquitoes in ghana. In this study, we report on the oviposition preference and the larval life table of aedes mosquitoes in accra, Ghana. The oviposition preference of aedes mosquitoes to three habitat types (tyres, drums and bowls) was measured by setting up ovitraps. Ovitraps were checked for the presence of aedes larvae every 3 days and the number of larvae was recorded. Two-hour-old aedes larvae were introduced into and raised in these three habitat types for the larval life tables. The number of surviving larvae at each developmental stage was recorded daily until they emerge as adults. Other larval life table parameters were measured. Tyres showed a high abundance of aedes larvae; 52.3% than bowls (15.2%) and drums (32.5%). The mean development time of aedes larvae was significantly lower in tyres (7.0 days) compared to that of bowls (9.0 days) and drums (12.6 days)

(p = 0.024). The differences in pupation and emergence rates were not significant across the habitat types. However, the highest pupation rate was observed in bowls (0.92) and the emergence rate was highest in tyres (0.84). The proportion of first-instar larvae that survived to adults was significantly higher in tyres with a shorter survival time (0.84; 9 days) (p= 0.009) compared to that of bowls (0.72;10 days) and drums (0.62 ± 0.2; 13 days) (p= 0.02). Our results confirm that discarded car tyres were the preferred habitat for the oviposition of gravid female aedes mosquitoes and provide the best habitat conditions for larval development and survival. These findings will contribute to the evidence for the development of vector control strategies for aedes mosquitoes in Ghana.

Keywords: Aedes, larval ecology, larval life tables, ovitraps

ABS-321

Comparative study of variation of genes associated with antimalarial drug resistance between human blood and mosquito in malaria endemic settings of Burkina Faso

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The spread and emergence of antimalarial drug resistance are obstacles to the elimination of malaria. Despite the important role of mosquitoes in the Plasmodium life cycle, only human-based molecular surveillance of antimalarial drug resistance has received much attention. The aim of this study was to compare the molecular polymorphisms associated with antimalarial drug resistance in both humans and vectors. Mosquitoes were collected using CDC light traps from 355 randomly selected houses in two distinct areas of the Health and Demographic Surveillance System of the Nouna Health Research Centre. Simultaneously, blood from the inhabitants of these houses was collected on filter paper. DNA extracted from human blood and head-thorax of mosquitoes by Qiagen was used for the identification of Plasmodium species by nested PCR and the characterization of markers associated with antimalarial resistance by restriction fragment length polymorphism (RFLP) assay. A comparison of mutant gene prevalence was performed using chi-square analysis. The prevalence of mutants pfcrt76T did not differ significantly between parasites in humans and mosquitoes (p=0,551). However, the prevalence of mutants pfmdr86 was more prevalent in mosquitoes than in human samples (p=0.038). The prevalence of the

mono mutation in dhfr51 (p=0,410), dhfr59(p=0,940), dhfr108(p=0,262), and dhps437 (p=0,796) genes were not statistically different in humans and mosquitoes. Only the double mutation dhfr51/dhps437 was more prevalent in mosquitoes than in human blood samples (p<0,001). Our study indicated the differences in the prevalence of resistance genes in humans and mosquitoes. Therefore, we suggest that mosquitoes should be considered in resistance assessment and monitoring.

Keywords: Antimalarial, drug resistance, human, Mosquitoes, Burkina Faso

ABS-322

Reduced performance of bednets against pyrethroid-resistant *Anopheles funestus* and *Anopheles gambiae*, major malaria vectors in Cameroon

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Long-lasting insecticidal nets (LLINs) are a vital tool in the fight against malaria vectors. However, their efficacy in the field can be impacted by several factors. We have investigated the effectiveness of the various brands of LLINs available in markets and households in Cameroon on pyrethroid resistant mosquitoes and assessed their post-exposure effect. Methods: We evaluated the immediate and delayed mortality effects of exposure to LLINs both bough LLINs and used ones collected from households in Elende village, Cameroon using standard WHO cone tests on Anopheles gambiae and *Anopheles funestus* populations. Alive female mosquitoes were genotyped at different time points post-exposure to evaluate the impact of insecticide resistance on the efficacy of bednets. The laboratory-susceptible strain experienced high mortality rates when exposed to all pyrethroid-only brands of purchased nets (68.66±8.35% to 93.33±2.90%). However, low mortality was observed among wild *An. funestus* mosquitoes exposed to the bednets (0±0 to 28±6.7%), indicating a reduced performance of these nets against field mosquitoes. Bednets collected from households also showed reduced efficacy on the laboratory strain (19–66%), as well as displaying a significant loss of efficacy against the local wild strains (0±0% to 4±2.6% for An. gambiae and 0±0% to 8±3.2% for *An. funestus*). Mosquitoes with the CYP6P9a-RR and L119F-GSTe2 mutations conferring pyrethroid resistance on bednet efficacy and delayed mortality. These findings show that although standard bednets drastically lose their efficacy against pyrethroid resistant field mosquitoes, they still are able to induce delayed mortality in exposed populations. Also, this study provides evidence of the actual impact of resistance on the quality and efficacy of LLINs, with mosquitoes carrying the CYP6P9a-RR and L119F-GSTe2 mutations conferring pyrethroid resistance living longer than their susceptible counterparts.

Keywords: Malaria, LLINs, Insecticide resistance, *Anopheles funestus*, *Anopheles gambiae*, Post-exposure, Longevity, CYP6P9a, G

ABS-324

Biodiversity of natural bacterial microbiota in the primary malaria vector *Anopheles gambiae.*

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Insecticide resistance in malaria vectors remain a significant public health concern, threatening malaria control efforts. Several mechanisms, including microbiota-mediated modulation of insecticide toxicity, underlie this phenomenon. However, little is known about the relationship between microbiota biodiversity and target-site resistance mechanism. This study aimed to investigate the biodiversity and to identify resistance-associated bacteria colonising laboratory *An. gambiae*. Three laboratory strains, Kisumu (susceptible), Kiskdr (pyrethroid resistant) and Acerkis (organophosphate and carbamate resistant) were used. Thirty specimens of each development stage (L4 larvae, pupae and adult females) were collected from each mosquito strain. After surface sterilization, each sample was broached on sterile PBS and the mixed solution was plated onto Luria-Bertani. The number and the biodiversity based on Gram strain were calculated by mosquito strain and development stage. PCR targeting the 16S-23S rRNA region and biochemical tests were performed for some putative insecticide degrading bacteria identification. We found 345 bacterial strains, of which 48.41% were Gram negative bacilli, 28.41% were Gram positive bacilli and 23.18% were Gram positive cocci. A significant difference (p=0.016) in biodiversity was found according to the developmental stage. Putative insecticide-degrading bacteria Staphylococcus aureus was identified in the microbiota of all three strains at all developmental stages, while Streptococcus and Micrococcus were identified in mosquito-carrying target-site resistance alleles. The present study showed that mosquitos' microbiota varies according to the developmental stage. The positive bacilli relative abundance was high in larvae and pupae while negative bacilli abundance was found in female adults. Overall, putative insecticide-degrading bacteria were present in malaria vector *An. gambiae* microbiota.

Keywords: Microbiota, Staphylococcus, *Anopheles gambiae*, Resistance allele, Malaria

ABS-326

Baseline susceptibility of *Anopheles gambiae* to clothianidin in Northern Ghana

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Clothianidin, an insecticide with a novel mode of action, has been deployed in the annual indoor residual spraying (IRS) programme in northern Ghana since March 2021. A key roadblock to successful IRS programmes is insecticide resistance. To inform pragmatic management strategies and guide future studies, baseline data on local *Anopheles gambiae s.l* susceptibility to the clothianidin insecticide were collected in Kpasolgu, a village in the Northern region, Ghana. Insecticide resistance bioassays were undertaking with *Anopheles gambiae s.l* using 2% SumiShieldTM 50WG. The WHO cone bioassay was conducted on mud and cement walls sprayed with SumiShieldTM 50WG. Mortality rates were observed up to 168 hours. Species of the An. gambiae complex present in the area and the detection of insecticide target-site mutations (kdr and Ace-1) were determined by PCR. The WHO susceptibility bioassay revealed a delayed killing effect of clothianidin. Mosquitoes exposed to the cone bioassays for five minutes died 120 hours after exposure. Slightly higher mortalities were observed in mosquitoes exposed to clothianidin-treated cement wall surfaces than mosquitoes exposed to mud wall surfaces. The kdr target-site mutation L1014F occurred at very high frequencies (0.89-0.94) across all vector species identified whereas the Ace-1 mutation occurred at moderate levels (0.32-0.44). *An. gambiae s.s* was the most abundant species observed at 63% whereas *An. arabiensis* was the least observed at 9%. *An. gambiae s.l* mosquitoes in northern Ghana are susceptible to clothianidin. They do harbor kdr mutations at high frequencies. It is therefore critical to closely monitor the susceptibility of local Anopheles populations to the clothianidin insecticide.

Keywords: *Anopheles gambiae s.l*, Insecticide Resistance, Target-Site Mutation, Clothianidin, Indoor Residual Spraying, Ghana

ABS-328

Evidence of chloroquine-susceptible *Plasmodium falciparum* malaria in an urban, medium transmission zone in Zambia.

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Anti-malarial drug resistance continues to be a challenge in malaria control and elimination in Zambia. This led to the discontinued use of chloroquine. However, some neighboring countries observed decreased prevalence of chloroquine-resistance after years of discontinued use. Due to current limited treatment alternatives and threats of emergence of resistance to available anti-malarial drugs, reintroducing chloroquine could be a viable option. This study aimed at determining the prevalence of chloroquine resistance-associated Pfcrt-76T and Pfmdr-86Y mutations in samples collected from patients in Ndola, Zambia. A cross sectional study was conducted at Chipulukusu clinic in Ndola district between January and May, 2020. Samples were collected from all consenting malaria positive individuals attending the clinic. Rapid Diagnostic Tests were used to screen for malaria among patients referred to the laboratory. Parasite DNA was extracted from Dried Blood Spots (DBS) using the chelex method. Using appropriate primers and enzymes and 3d7 and DD2 controls, samples were run for PCR and RFLP, to detect *P. falciparum* chloroquine resistance transporter, Pfcrt K76T and the P. falciparum multi-drug resistance Pfmdr1 N86Y Single Nucleotide polymorphisms associated with Chloroquine resistance. A total of 1327 patients were screened from which 412 were found positive on RDT. DBS samples collected and DNA extracted. Only 398 specimens had sufficient DNA and were successfully analysed. No chloroquine-resistant genotypes were detected for both Pfcrt K76T and Pfmdr1 N86Y genes. The study revealed the return of chloroquine-sensitive malaria in Ndola District following the cessation of Chloroquine use in treatment of uncomplicated malaria. There is need for a surveillance system in the country for monitoring of drug resistance markers for possible reintroduction of cheaper drugs in combination with another anti-malarial drug.

Keywords: Chloroquine resistance, *Plasmodium falciparum*

ABS-329

Assessing the potential of Microsporidia MB as a bio-based agent for malaria control using mathematical modelling.

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The use of Microsporidia MB (a plasmodium-blocking symbiont), as a bio-based agent for the mosquito population replacement, is a promising strategy for malaria control. Therefore, lab experiments are ongoing to understand the spread mechanism of MB. Concurrently, this study uses mathematical modelling to understand and mimic the mechanisms underpinning the low prevalence of MB-infected mosquitoes reported from field experiments, to identify areas in Kenya where Microsporidia-MB is more likely to persist and to predict the effects of the presence of MB-infected mosquitoes on malaria incidence. We used a compartmental model and the mathematical analysis consists of determining the reproduction numbers and studying the stability of the equilibria. The comparison in the susceptibility of areas to the spread of Microsporidia MB is obtained through the introduction of the mosquito temperature-dependent

traits and mapping of corresponding target reproduction numbers. By extending the model and including the human part, we relate the prevalence of MB-infected mosquitoes and the reduction of malaria incidence. Overall, the level of malaria transmission reduction with a given prevalence of MB-infected mosquitoes depends on the initial level of malaria in the given area. We use data from field experiments to define assumptions and create interesting scenarios concerning the spread of MB-infected mosquitoes. This study is relevant in designing new strategies for malaria control.

Keywords: Microsporidia MB, Plasmodium transmission-blocking, Vertical-Horizontal transmission, Modelling, Seasonality

ABS-331

Insecticides Susceptibility and Knock Down Resistance (kdr) of Anopheles mosquitoes in parts of Benue State, North Central Nigeria.

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Vector control remains the method of choice for effective malaria control. The achievements in malaria control are however threatened by emerging resistance to available insecticides by Anopheles mosquito vectors. This study aimed at determining the pattern of Knock down resistance kdr in Anopheles mosquito vectors in two Local Government Areas of Benue State, Nigeria. Larvae and pupae of Anopheles mosquitoes were collected in villages of Buruku and Katsina Ala LGAs of Benue State from April- May, 2019 and reared to adult. Emerged 2-3 day old non-blood fed adult mosquitoes were tested for resistance using WHO and CDC bottle bio assay.Both resistance and susceptible mosquitoes were identified morphologically and a subsection of the samples were characterised into sibling species using PCR and further screened for L1014F mutation using PCR protocol. A total of 145 mosquitoes all belonging to *An gambiae* complex subjected to PCR showed the presence of three (3) subspecies of *An. gambiae*; *An colluzi*(51%), An. gambiae s.s (39.3%), and An arabiensis (6.9%) with *An colluzi* been the predominant species. 2.1% of the species were hybrid (M and S forms) and 0.7% of the samples were unamplified.Out of the 145 mosquitoes tested and were analysed for kdr gene mutation, over 70% had homozygous (RR) resistance gene, less than 10% heterozygous (Rr) resistance gene while less than 5% had none. Both homozygous (RR) and heterozygous (Rr) resistance gene in both LGAs were not statistically significant (P=0.333). This data confirmed the presence of 1014F allele in the LGAs. This study provides baseline and useful information on the susceptibility status and knock down resistance of Anopheles mosquito populations to four classes of insecticides approved for public health use. Proper regulation should therefore be put in place on the procurement and use of this insecticide.

Keywords: Susceptibility, knock down resistance, Anopheles, Benue state

ABS-336

Potential use of aminoglycoside and fluoroquinolone antibiotics for malaria vector control

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Insect microbiota has been shown to be involved in their development. It was reported that bacteria of the genus Staphylococcus increase fecundity in mosquitoes. In the malaria vectors *An. gambiae* and *An. coluzzii,* Staphylococcus bacteria have been identified as symbionts of male and female reproductive organs. Consequently, the loss of Staphylococcus community members in malaria-transmitting mosquitoes could lead to the development of innovative vector control strategies. The present study aimed to determine the resistance profile of Staphylococci obtained from the laboratory strains of *Anopheles gambiae s.s.* Three laboratory *Anopheles gambiae s.s*. strains, Kisumu (susceptible), Kiskdr (pyrethroid resistant), and Acerkis (organophosphate and carbamate resistant) were used. Thirty (30) specimens of L4 larvae, pupae and adult females were collected from each mosquito strain. The crushed material from each sample (L4 larvae, pupae and adults) was plated onto Luria-Bertani after surface sterilization with sterile distilled water and ethanol for microbes growing. PCR targeting the 16S-23S intergenic region specific to Staphylococci was performed to identify bacteria of the genus Staphylococcus. Antibiotic-resistance profile of these bacteria (belonging to the genus Staphylococcus) was assessed according to classical Kirby-Bauer diffusion method. Out of the 270 An. gambiae samples analysed, 78 colonies of Staphylococci (32.05% in Kisumu, 29.49% in Acerkis and 38.46% in Kiskdr) were isolated and identified. Isolated Staphylococci from Kisumu and Kiskdr were more sensitive (96% and 96.67%, respectively) to aminoglycoside antibiotics (netilmicin) and those isolated from Acerkis were more sensitive (95.65%) to fluoroquinolone antibiotics (ofloxacin). Our results strongly encourage further investigations on the potential use of antibiotics targeting Staphylococci in malaria vectors towards developing complementary vector control strategies.

Keywords: Microbiota, Staphylococcus, Antibiotics, *Anopheles gambiae*, Malaria

ABS-338

Efficacy of Pyriproxyfen in Control of off-host stages of Tunga penetrans

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Tunga penetrans is the cause of a severely neglected parasitic skin disease (tungiasis) in the tropics. Regardless of treatment, re-infection occurs almost immediately due to the environmental off-host stages hence the need to identify targets for parasite control for disease prevention. Insect growth regulators have the ability to mimic a natural hormone in insects and disrupt their growth. Pyriproxyfen (an insect growth regulator) is used widely in high income countries for parasite control in pets and livestock and is available in low-income countries for plant pest control. This study assessed the efficacy of pyriproxyfen against Tunga off-host stages in the laboratory and its impact on disease outcome in a randomised field trial. Dose-response tests with four concentrations of pyriproxyfen were implemented for their impact on development and adult emergence. The recommended concentration of pyriproxyfen was tested in a randomised control trial of 34 tungiasis infested households in each arm 1)PPF, 2)Water and 3)Untreated controls. Applications were done weekly for 4 weeks and the disease outcomes assessed. Unexposed controls in laboratory bioassays resulted in 100% of all larvae successfully developing into adults. Pyriproxyfen prevented 100% pupation in as low concentrations as 0.0075 parts per million active ingredients. During the field trial, prevalence of infection with live fleas among the household members reduced by 68% in the PPF arm (OR 0.32, 95% CI 0.24-0.42; <0.001) and by 38% for water arm (OR 0.62, 95% CI 0.52-0.74; <0.001) in comparison to the baseline and untreated control. Similarly, the intensity of infection reduced by 80% in the PPF arm and by 40% in the water arm.Conclusions:Weekly spraying of a very low-dose pyriproxyfen solution results in a relatively fast clearance of disease. The water impact was surprising but is likely associated with unfavourable larvae development conditions after repeated application.

Keywords: *Tunga penetrans*, larvae, off-host-stages, control, ppf, insect growth regulator.

ABS-341

The effect of Asaia spp. on the fitness of *Anopheles coluzzii*

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Recent reports reveal the presence of natural Asaia in Anopheles mosquitoes in Cameroon. This endosymbiont has emerged as a promising candidate for paratransgenic control of malaria. However, its effect on the fitness of the vector into which they have been introduced has

never been evaluated. Thus, the aim of this study was to investigate the effect of Asaia on the fitness of *Anopheles coluzzii*. Laboratory adults An. coluzzii were used to investigate the impact of Asaia on life traits of this vector. The mosquitoes were divided in 3 groups: antibiotic treated (axenic mosquitoes), non-antibiotic treated (no ATB) and non-antibiotic treated supplemented with an asaia culture (no ATB +Asaia) through sugar meal. The mosquitoes were then monitored on longevity/survival, fecundity and larval development. Axenic mosquitoes had reduced life span with median survival of 15 days while the (no ATB) and (no ATB +Asaia) groups survived to day 23 and 25 respectively ($p < 0.0001$). Also, treatment with antibiotic has negatively affected the average egg deposition ($p < 0.0001$). Assessment of the odds ratio (OR) showed that the ability of axenic mosquitoes to lay eggs was lower compared to no ATB (OR= 0.299; confidence interval (CI) 95%: 0.192–0.458; $p < 0.0001$) and no ATB +Asaia (or = 0.65; CI 95%: 0.43–0.982; $p = 0.052$) mosquitoes suggesting an association between the antibiotic treatment and reduced fecundity and thus, a positive effect of Asaia on fecundity. However, there was no evidence suggesting that Asaia could have an effect on larval development ($p>0.05$). This study was able to demonstrate that increase of abundance of this bacteria in the midgut of Anopheles mosquitoes does not confer a fitness disadvantage. Thus, the impact of this bacteria symbiont on plasmodium development should be investigated.

Keywords: Asaia, fitness,*An. coluzzii*, longevity, fecundity, larval development

ABS-346

Evolution of insecticide resistance of *An. gambiae s.l.* in western kenya from the years 2019-2022

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Insecticide resistance is a major threat to malaria vector control efforts. Understanding insecticide resistance is crucial for developing effective resistance management strategies and informing the selection of vector control interventions. This study evaluated the evolution

of resistance and mechanisms underlying resistance to pyrethroids, organophosphates and neonicotinoids in malaria mosquitoes in western kenya. Larvae were collected from Busia, Siaya, and Homa bay counties in 2019, 2020 and 2022. Susceptibility tests, synergist PBO and intensity bioassays were performed on adult *An. gambiae s.l*. Five insecticides (deltamethrin, permethrin, alpha-cypermethrin, pirimiphos-methyl, clothianidin) were evaluated. The presence of knockdown resistance was investigated using taqman assay. The level of resistance was shown to increase over time for deltamethrin across all sites, with average change in mortality at 46%, 56% and 58% in Busia, Homabay and Siaya, respectively. Similar trends were also recorded for permethrin across the sites. Pre-exposure to PBO for *An. gambiae s.l* prior to exposure to pyrethroids significantly increased mortalities but did not fully restore susceptibility. Resistance intensity was low in Homa bay (>98% mortality at 5x), moderate in Siaya (>98% mortality at 10×) and high in Busia (<98% mortality at 10×). Low to moderate allelic frequencies were detected ranging from 2% to as high as 74% across the sites with 1014s having the highest frequencies of 74% and 61% for An. gambiae s.s. and 8% and 50 % for An. arabiensis in 2021 and 2022 respectively for Busia. Susceptibility to pirimiphos-methyl and clothianidin was recorded across all sites. The findings revealed increasing resistance to pyrethroids, highlighting the need for alternative strategies such as dual-active insecticide -treated bed nets. Pirimiphos-methyl and clothianidin can be used for IRS in western Kenya.

Kewords: Evolution, insectiside Resistance, *An. gambiae,* Western Kenya, Malaria

ABS-348

Bionomics and sibling species composition of *Aedes simpsoni* complex: Implications For Arbovirus transmission risk In East Africa.

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Aedes simpsoni complex has a wide distribution in Africa and comprises at least three described sub-species including the yellow fever virus (YFV) vector *Ae. bromeliae*. To date, the distribution and relative contributions of the sub-species and/or subpopulations including bionomic characteristics in relation to YF transmission dynamics remain poorly studied. In this study conducted in two areas with divergent ecosystems: peri-urban (coastal Rabai) and rural (Rift Valley Kerio Valley) in Kenya, survival rate was estimated by parity in *Ae. simpsoni s.l*. mosquitoes sampled using CO2-baited BG Sentinel traps. We then applied PCR targeting the nuclear internal transcribed spacer 2 (ITS2), region followed by sequencing and phylogenetic analytics to identify the sibling species in the Ae. simpsoni complex among parous and blood fed cohorts. Our results show that Ae. bromeliae was the most dominant sub-species in both areas, exhibiting high survival rates, human blood-feeding,and potentially, high vectorial capacity for pathogen transmission. We document for the first

time the presence of *Ae. lilii* in Kenya and potentially yet-to-be described species in the complex displaying human feeding tendencies. We also infer a wide host feeding range on rodents, reptile, and domestic livestock besides humans especially for *Ae. bromeliae*. This feeding trend could likely expose humans to various zoonotic pathogens. Taken together, we highlight the utility of genotype-based analyses to generate precision surveillance data of vector populations for enhanced disease risk prediction and to guide cost-effective interventions (e.g. YF vaccinations).

Keywords: *Aedes bromelie*, arbovirus surveillance, yellow fever, East Africa

ABS-349

Transmission of The Malaria Plamodim vivax by *Anopheles gambiae* in Kedougou, Senegal

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Malaria is responsible for approximately 500 million cases and half a million deaths worldwide, 90% of which occur in Africa hence a major public health problem. The majority of malaria cases are due to P. falciparum, but severe cases and deaths regularly reported in recent years are due to *Plasmodium vivax.* This study determines the importance of *Plasmodium vivax* transmission among the Anopheles populations in Kédougou, Senegal. Human-Landing collections were carried in 11 villages of Kédougou in Senegal interior and exterior of two houses from August to November 2015. After morphological identification of the species, ovary dissections were performed to determine the parity rate. The infectivity was checked by PCR and ELISA CSP for the determination of the sporozoite index. All data will be analyzed by R software and the comparisons by chi 2 tests. About 3443 mosquitoes belonging to 13 species were collected with a predominance of An. gambiae (93.41%), then *An. funestus* (1.66%) and An. nili (0.58 %). *An. gambiae* has shown an exophagic tendency. The parity rate was relatively high in all villages and ranged from 72.73% in the Kédougou site to 89.52% in Taifa. These rates were significant (chi2=15.74, ddl =9, p=0.07). An. gambiae, biting rates varied between 2.68 bites/human/night (bhn) Tenkoto to 23.19 bhn in Bandafassi. They varied according to the sites and months of collection. Of the 3293 Anopheles tested, *P. falciparum* infection was detected in 22 mosquitoes at a plasmodial infection rate of 0.68% and 13 mosquitoes were found to be infected with *P. vivax.* This study shows for the first time Plasmodium vivax infections in Anopheles in West Africa. the exophagic tendencies of *An. gambiae* should be monitored on a regular basis as they could jeopardize the use of control strategies.

Keywords: Transmission, Malaria, *Plasmodim vivax*, Senegal

ABS-350

Control of medically and veterinary important vectors with a Metarhizium anisopliae-based formulation for cattle treatment

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Mosquitoes, tsetse and ticks are of public health importance in Sub-Saharan Africa. Chemical-based vector control agents and approaches are loosing effectiveness, leading to rising cases of malaria and several Neglected tropical diseases (NTDs). This study aimed at testing a biorational agent for human and livestock disease vector control: Metarhizium anisopliae formulated and sprayed on cattle, in a One Health approach. Survival bioassays and standardized field trials were conducted to determine the efficacy of Metarhizium anisopliae isolates ICIPE 7, and ICIPE 30 at a range of dilutions (106, 108, 109, and 1010 conidia/ml), against insectary Anopheles arabiensis, wild Glossina fuscipes, and wild Rhipicephalus spp. In subsequent field trials, experimental ICIPE 7 was compared to its commercial formulation, TICKOFF®, on their impact on survival of wild mosquitoes and ticks. This was investigated on cadaver mycosis, conidia attachment to vectors, conidia retention on cattle fur, and conidia viability. The ICIPE 7 isolate, known for efficacy against ticks, also killed mosquitoes (LT50- 7 days), though slightly slower than ICIPE 30 isolate (LT50- 6 days). Mortality was dose-dependent, but not affected by exposure duration. ICIPE 7 also killed tsetse (LT50- 16 days) and ticks (LT50- 27 days). In the field, both ICIPE 7 and TICKOFF® killed wild Anophelines (LT50- 15 and 16 days), Culicines (LT50- 18 and 20 days), and, ticks (LT50- 25 and 31 days), respectively. Conidia were confirmed to attach to vectors on contacting the treated cattle. Cadaver mycosis, conidia numbers on cattle fur, and conidia viability decreased with increasing days post-treatment. The findings show the potential of ICIPE 7 formulations in control of malaria and several NTDs. As a result, TICKOFF® is being tested in the field through a community-based engagement, with involvement of health and agricultural stakeholders, for integrated disease management.

Keywords: Neglected tropical diseases, One Health, Control, Malaria, Mosquito, Tsetse, Ticks, Metarhizium anisopliae, ICIPE 7, Cattle

ABS-352

Bioassays for the evaluation of the attractiveness of attractive targeted sugar bait (ATSB) against Anopheles mosquitoes in controlled semi-field systems in Tanzania.

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Sugar-feeding is an essential aspect of mosquito life history that may be exploited for mosquito control by adding insecticides to sugar attractants in attractive sugar baits (ASB). This study aimed at developing a bioassay to evaluate the olfactory and gustatory attraction of ASBs against *Anopheles gambiae* and *Anopheles funestus* in a controlled environment. A standard comparator was developed that contained 20% sucrose. Mosquitoes were exposed to attractive sugar bait (ASB) stations in choice or no-choice experiments. In non-choice experiments, each ASB station was placed into each cage, while in choice experiments, two ASB stations with different attractant blends were placed in the same cage. Cages were 2mx5mx2m cage to test short-range responses or 2mx40mx1.6m to test long-range responses. Mosquitoes were exposed overnight and assessed for olfactory attraction using a fluorescent powder marker placed on the ASB. Both male and female mosquitoes responded to the ASB, with no difference between sex (Odds ratio (OR)= 0.93, (95% Confidence Interval (95% CI): 0.80-1.08), p=0.34). Older mosquitoes (3-5 days old) were 6 times more responsive to ASB (OR=6.28, (95%CI: 5.34-7.37), p<0.001) than younger mosquitoes (0-1 day old) (OR=1). No difference was observed in the responsiveness between *An. gambiae* and *An. funestus* (OR=1.00, (95%CI:0.87-1.15), p=0.99). ASB v1.2.1 showed higher intrinsic attraction than ASB v1.1.1 at short range (OR=2.1, (95%CI: 1.79-2.49), p<0.001) and greater relative attraction compared to ASB station v1.1 at long-range (OR=1.29, (95%CI: 1.21-1.38), p<0.001). *An. gambiae* and *An. funestus* prefer to feed on ASB station v1.2.1 (OR=1.71, (95%CI: 1.33-2.18), p<0.001) compared to ASB station v1.1.1 (OR=1). Bioassays for ASB should be performed in choice and no-choice experiments on older mosquitoes, both sexes, and over long and short ranges.

Keywords: Attractive sugar bait, *Anopheles gambiae*, *Anopheles funestus*, Olfactory attraction.

ABS-354

The MTego Trap: A Potential Tool for Monitoring and Control of Malaria and Arbovirus Vectors

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Odour-baited traps are useful for vector surveillance and control. However, most existing traps have shown inconsistent recapture rates across different mosquito species, necessitating the need for more effective and efficient traps. The MTego trap with integrated thermal

stimuli has been developed as an alternative. Therefore, this study was undertaken to determine the efficacy of the MTego trap relative to the Modular Biogents Pro (BGP) trap for sampling different mosquito species in a semi-field system. Fully balanced Latin square design experiments (No-choice and dual-choice) were conducted in the semi-field chambers using laboratory-reared species of female Anopheles gambiae sensu stricto, *An. funestus*, *An. arabiensis, Culex quinquefasciatus* and *Aedes aegypti*. Sixteen replicates and 50 mosquitoes of each species were released in each chamber per replicate. Traps evaluated were MTego trap baited with PM6 (MT-PM6), MTego baited with BG-lure (MT-BGL) and BGP baited with BG-lure (BGP-BGL). In the no-choice test, the MT-BGL and BGP-BGL traps captured a similar proportion of *An. gambiae* (31% versus 29%, P-value = 0.519) and *An. funestus* (32% vs 33%, P = 0.520). The MT-PM6 and BGP-BGL traps also showed no significant difference in capturing Ae. aegypti (33% vs 31%, P = 0.324). However, the BGP-BGL caught more *An. arabiensis* and *Cx. quinquefasciatus* mosquitoes than the other traps. In the dual-choice test of MT-PM6 vs BGP-BGL a similar proportion of *An. funestus* (25% vs 27%, P = 0.473) and *Aedes aegypti* (29% vs 25%, P = 0.264) were captured in either trap, while the BGP-BGL captured more *An. gambiae, An. arabiensis* and *Cx. quinquefasciatus* mosquitoes than MT-PM6. The study demonstrated that the MTego trap is a potential tool that can be used interchangeably with the BGP trap for sampling anthropophilic mosquitoes including African malaria vectors *An. gambiae* and *An. funestus* and the principal arbovirus vector *Ae. aegypti*.

Keywords: MTego, BGP, Human landing catch, Trap, Odour-baited trap, Mosquito, Anopheles, Culex, Aedes

ABS-357

Housing improvement reduces exposure to the bites of malaria vectors in forested area of Cameroon

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Scaling-up of malaria control interventions such as increased coverage of insecticide-treated nets led to significant reduction of malaria morbidity and mortality in sub-Saharan Africa. However, the emergence and rapid spread of insecticide in mosquito vectors seriously impede malaria control efforts. 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 are dire needed. This study aimed to investigate whether housing improvement could contribute reducing exposure to mosquito bites in forested area of Cameroon where malaria transmission is intensive and supported simultaneously by several Anopheles vectors species. Ten households were chosen at random and on the five one, openings

on the doors and windows, the eaves and the holes in the walls were closed and the other five household was use as control. Mosquitoes were collected inside and outside the ten houses by the human volunteer collection method before and after home improvement. These mosquitoes were morphologically identified and the presence of Plasmodium falciparum infection was then verified by the ELISA csp technique. A total of 2390 Anopheles were collected including 5 (0.21%) A. coustani, 82 (3.43%) *A. gambiae*, 237 (9.82%) *A. marshallii*, 599 (25.06%) *A. moucheti*, 76 (3.18%) *A. nili*, 1003 (41.97%) *A. paludis* (0.5%) and 388 (16.23%) *A. ziemannii.* Of these 2390 Anopheles, 952 were collected indoors and 1438 outdoors. After improvement, mosquitoes were more abundant inside unimproved households than in improved one ($\chi 2 = 43.729$; $P < 0.0001$). 16 mosquitoes collected were infected, giving an overall circumsporozoite protein rate of 0.67%. Houses improvement reduced indoor density of Anopheles and consequently the rate of mosquito bites. It was cheap and can easily incorporated into malaria vector strategies by local and national communities.

Keywords: Houses improvement, indoor Anopheles, malaria prevalence, South Cameroun

ABS-361

Risk of arboviral transmission in yellow fever outbreak and non-outbreak areas in Ghana

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In late 2021, Ghana was hit by a Yellow Fever outbreak that started in two districts in the Savannah region and spread to several other Districts in 3 regions (Oti, Bono, and Upper West). In previous years, there have been reported outbreaks of yellow fever in the country. Despite the frequent outbreaks, there is currently no structured vector control program for yellow fever. Moreover, there have been reported cases of Dengue and exposure to Chikungunya. This suggests the public health importance of Aedes mosquitoes in Ghana and the need to effectively control them. This study sought to determine the risk of arboviral transmission in yellow fever outbreak areas and non-outbreak areas in Ghana. Aedes larvae were collected from water-holding containers in and around human habitations in the study sites. Stegomyia indices were calculated to ascertain the risk of disease transmission in the study areas. Adult Aedes mosquitoes were collected using Biogents Sentinel (BG) traps, Human Landing Catch (HLC), and Prokopack (PPK) aspirators and identified using morphological keys. A total of 2,664 immature Aedes were sampled, with > 60% found in car tires. Aedes immatures were more abundant

during the rainy season (n = 1,342/2,664, 50.4%). Larabanga (outbreak area) (BI:84%), and (CI:26.4%) was classified as a high-risk zone for Yellow Fever outbreak using the WHO criteria for Stegomyia indices. A total of 1,507 adult Aedes mosquitoes were collected over the entire sampling period. *Aedes aegypti* (92%, n = 1,386/1,507) was determined as the predominant vector species. A significantly high abundance of Aedes mosquitoes were collected during the dry season (n = 922, 61.2%) (X2 = 75.361, df = 1, P < 0.001), outdoors (n = 914, 60.6%) (X2 = 68.375, df = 1, P < 0.001). This study indicates that Aedes mosquitoes in Ghana pose a significant risk to public health, and there is a need for continuous surveillance to inform effective vector control strategies.

Keywords: *Aedes aegypti*, yellow fever, Stegomyia indices, Ghana

ABS-362

Maintenance of ISO/IEC 17025:2017 laboratory accreditation for identification of Anopheles malaria vector species.

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The accurate identification of Anopheles vector species is essential for malaria vector control programs as it enables the assignment of key surveillance indicators (insecticide resistance, biting, breeding, feeding and resting behaviours)to malaria vector populations. This information is used for fine-scale tailoring of vector control interventions. Quality Assurance for Anopheles species identification is key for producing accurate results. The Vector Control Reference Laboratory (VCRL) of the National Institute for Communicable Diseases is an ISO/IEC17025:2017 accredited laboratory, with accreditation for performing the following tests: *Anopheles gambiae* complex and *An. funestus* group species identification and the presence of *Plasmodium falciparum* within those species. Quality Management systems (QMS) on accredited tests require the periodic assessment of personnel's competencies, calibration and maintenance of laboratory equipment, proficiency testing programmes, verification and reviewing of results. These quality assurance systems improve the quality of results and turn-around time for all accredited tests, with reports subsequently generated and submitted to the relevant stakeholders. The VCRL's accreditation systems are assessed by annual internal audits as well as external audits performed by the South African National Accreditation System (SANAS).Ongoing accreditation assessments by SANAS confirmed that VCRL is ISO/IEC17025:2017 compliant. This ensures that the VCRL provides quality service to its stakeholders. By employing the abovementioned methods, the VCRL has maintained its ISO/IEC17025:2017 accreditation status for the past two years with the laboratory deemed complaint during the same period. Through this system, the VCRL provides a quality assured identification of Anopheles vector species of the sub-Saharan African region, an essential service to South Africa's malaria control programs and other stakeholders

Keywords: maintenance ISO/IEC 17025:2017 laboratory accreditation quality assurance

ABS-366

Bionomics of arboviruses vectors in three eco-epidemiological settings of cameroon and their susceptibilities profiles to insecticides

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Arboviruses represent a serious concern in tropical/subtropical countries. In Cameroon, port cities and cities surrounded by forests constitute the main hot-spot of dengue and yellow fever. To date, little is known about bionomics of their main vectors *Aedes aegypti* and *Aedes albopictus* in such environments. This study aim to assess the bioecology, distribution and susceptibility profiles to insecticides of these vectors in three cities of Cameroon. Entomological surveys were undertaken from September 2021 to October 2022 in Bertoua (savanna area), Kribi (city port) and Sangmelima (forested area). Immature stages of Aedes spp. were collected by deeping and Stegomyia indexes were estimated. After emergence and morphological identification, the F1 progeny of Ae. aegypti and Ae. albopictus were tested using WHO bioassays and mortality rates were assessed according to the different insecticides tested. A total 475 breeding sites in Sangmelima (41.47%), Kribi (33.47%) and Bertoua (25.05%) were identified. Tires and plastic containers were most abundant. A total of 2364 mosquitoes belonging to 4 genera and 9 species were collected. Aedes species recorded (1864) included *Ae. albopictus* (72%), *Ae. aegypti* (25.91%), and Aedes spp. (2.09%). These main vectors were present in all the study sites. Ae. albopictus was predominant in Sangmelima and Kribi while *Ae. aegypti* was mostly found in Bertoua. According to house indexes, transmission risk of dengue and yellow fever are high in Kribi and Bertoua. *Ae. aegypti* across study sites were found to be resistant to permethrin, deltamethrin and DDT, while *Ae. albopictus* was resistant to bendiocarb in Kribi and Bertoua. However, all these species were susceptible to malathion. Measures against vectors of arboviruses seem to enhance their proliferation and insecticide resistance. These data highlights the need for alternative strategies in vector control interventions in Cameroon.

ABS-368

Impact of various temperature regimes for larval growth on Microsporidia MB-positive Anopheles arabiensis

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Anopheles arabiensis harbors an avirulent entomopathogenic fungus, Microsporidia MB, that interferes with Plasmodium development in mosquitoes, thus its potential usage for malaria control. However, for its successful utilization, there is a need for improved and maintained infection in the insect population. Environmental parameters such as temperature affecting malaria vectors may also have direct/indirect effects on the host endosymbionts. Therefore, understanding how these factors affect Microsporidia MB would be necessary to identify areas that could maintain high levels of Microsporidia MB infection for Malaria control. This would also assist us in establishing the best temperature for rearing Microsporidia MB infected. Objectives: Our study aimed at determining the effect of different constant larval growth temperature regimes on the development time, Microsporidia MB prevalence, Microsporidia MB density, and survival in Anopheles arabiensis. Methods: F1 larvae from Microsporidia MB positive iso-female lines were split into four groups and reared in incubators at constant temperatures of 220C, 270C, 320C, and 370C until the pupation stage. Results: Microsporidia MB-infected larvae survived best at lower temperatures with a longer development time than their Microsporidia MB-negative counterparts. Microsporidia MB density was highest at temperature 370C; however, there was no significant difference in densities at lower and higher temperatures. Microsporidia MB density was determined through the qPCR analysis 18s MB in reference to the s7 host-keeping gene. Conclusion: The high prevalence of Microsporidia MB infection at 270C makes the tropical areas suitable for this endosymbiont field trials and growth of the infected colony in the insectary.

Gaps: Further studies should investigate how these specific larval growth temperatures affect reproduction and the adult mosquito population.

Keywords: Microsporidia MB

ABS-370

Novel malaria vectors in dryland ecosystem of Kenya

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Outdoor transmission is a recognized impediment in achieving effective malaria control towards elimination. This phenomenon could involve diverse vectors in different eco-epidemiologic settings. However, the profile of vectors that drive this phenomenon is not well understood. This study focused on dry land ecologies of Kenya, prone to malaria epidemics, yet with limited data on the driving vectors. Cross-sectional surveys of adult female mosquito vectors were conducted outdoors around randomly selected homesteads using CO2-baited CDC light traps in three select sites: Kerio Valley, Nguruman and Rabai, between August 2019 and May 2020. Mosquitoes in the *An. funestus* group and *An. gambiae s.l.* were analyzed by PCR to determine sibling species composition and Plasmodium infection rates, followed by Sanger sequencing and phylogenetic analysis. Anopheline mosquitoes from the Funestus group were further screened for mutations in glutathione S-transferase epsilon 2 (GSTe2) gene which has been implicated in the metabolic resistance to pyrethroid and DDT. Abundance of *Anopheles funestus* group was significantly higher than that of *An. gambiae s.l*. The findings revealed *An. longipalpis C*, as the most abundant outdoor vector species with high *P. falciparum* sporozoite rates. Additionally, six cryptic species were uncovered associated with *An. funestus* group and found to harbor *Plasmodium falciparum* sporozoites. Also evident, was the first detection of mutations in the GSTe2 gene in *An. longipalpis C* besides *An. funestus s.s* in the Funestus group. Emergence of novel vectors and detection of mutations that confer metabolic resistance to pyrethroid and DDT could contribute to residual malaria transmission, which is a threat to effective malaria control.

Keywords: Residual malaria transmission; cryptic vectors; *Anopheles funestus* group; *An. longipalpis C*; dryland ecosystems

ABS-372

Investigating the genetic diversity of *Anopheles coluzzii* in Western Burkina Faso reveals low genetic differentiation

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Knowledge of the genetic diversity of species is necessary to better develop management programmes for living organisms. With this in mind, we undertook to study the genetic structure of the populations of *Anopheles coluzzii*, one of the main malaria vectors in Burkina Faso. Populations of *Anopheles gambiae s.l.* from four localities in Burkina Faso were tested phenotypically for insecticide susceptibility and molecularly for species identification and detection of the kdr-w mutation. Further molecular tests targeting exclusively *Anopheles coluzzii* were conducted to assess the polymorphism of three microsatellite markers. The results show that all four populations of *An.*

gambiae s.l. were highly resistant to deltamethrin with mortality rates ranging from 2.02 to 17.24%; and overall more susceptible to pirimiphos-methyl and bendiocarb with rates of 100 % and 69.57 to 96.38 % respectively. Molecular identification revealed a strong predominance of *Anopheles coluzzii* in Bama and Founzan, which represented 92.93% and 58.33% of the species respectively, while in Santidougou and Douna *Anopheles arabiensis* dominated with proportions of 73.74 % and 56.84 % respectively. The frequencies of the L1014F allele of the kdr gene varied between 0.30 and 0.51. Concerning the microsatellites, the three markers, AGXH24, AG2H187 and AG3H811 recorded one, three and five alleles respectively, whose frequencies did not vary overall between the three populations. These markers also revealed weak inter-population differentiations with Fst varying between 0.008 and 0.028, genetic distance between 0.011 and 0.039 and finally 98 % of molecular variance coming from differences between individuals from the same population versus only 2 % from differences between populations. These results show that the genetic structure of *Anopheles coluzzii*, although evolving, remains homogeneous in western Burkina Faso.

Keywords: Microsatellite, kdr, genetic diversity, *Anopheles coluzzii*, malaria

ABS-373

Knowledge and Adherence to the National Malaria Treatment Guidelines for Malaria Diagnosis in Pregnancy among Health-Care Workers in Southwestern Nigeria, A Cross-Sectional study.

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Malaria in pregnancy remains a significant contributor to maternal morbidity and mortality in malaria-endemic countries. Malaria case management is a critical strategy for malaria elimination. This entails early diagnosis and prompt treatment with effective antimalarial medicines recommended for use in the country. Our goal is to identify the knowledge and adherence to national guidelines on malaria treatment in pregnant women by public health workers in Level II government facilities regarding uncomplicated malaria treatment. In Lagos, a Southwestern state of Nigeria, from November 2021 to March 2022, a multi-center descriptive, cross-sectional survey was carried out. In 10 general hospitals and 20 Comprehensive healthcare centers among 255 public health workers selected by multistage sampling, a questionnaire was administered via phone. Provider knowledge of national diagnostic guidelines for uncomplicated malaria in pregnant women was assessed using standardized questionnaires. Overall, we had 100% responses from 255 public health workers. 97.5% of respondents accurately described clinical malaria signs and symptoms. In 82%, malaria was parasitologically confirmed before treatment. 90.1% knew the drug of choice for malaria prophylactic in pregnancy. 80% accurately administer prophylactic antimalaria. 62.1% were

aware that microscopy was the gold standard for malaria treatment. 20% still use chloroquine to treat malaria during pregnancy. Availability of antimalarial medicines was the main factor influencing treatment prescriptions. The study highlights crucial gaps among public health providers in diagnostic knowledge and adherence to the National guideline in malaria treatment. Interventions to improve health workers' capacity to diagnose treat malaria and implementation of the National guidelines should be prioritized.

Keywords: Malaria, Prophylaxis, Pregnancy

ABS-381

Molecular detection and genetic diversity of microsporidia MB in field-caught anopheles mosquitoes from Cameroon

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Malaria control relies mainly on insecticide-based tools. unfortunately, the effectiveness of these tools is threatened by the widespread insecticide resistance in malaria vectors highlighting the need for alternative control approaches. Recently, the discovery of microsporidia MB in Anopheles mosquitoes and the subsequent demonstration that it blocks malaria transmission, suggests that it is a promising candidate for developing a symbiont-based malaria transmission-blocking strategy. However, studies exploring the diversity of microsporidia MB, particularly in major malaria vectors, have never been investigated in Cameroon. Thus, the aim of study was to investigate the presence and phylogenetic relationship of microsporidia MB in the natural population of *Anopheles gambiae s.l* in Cameroon. Adults in door resting mosquitoes belonging to 3 species (*An. coluzzii, An. arabiensis* and *An. gambiae s.s*) were collected from 3 different eco-geographical localities in Cameroon in August 2019 and October 2022. PCR was performed on the specific microsporidia 18s ribosomal RNA gene and positive samples for PCR microsporidia MB were confirmed by sanger sequencing and phylogenetic analysis. We found a low prevalence of microsporidia MB in *Anopheles gambiae s.l* mosquitoes. A total of 1317 mosquitoes were screened out of which 22 (1.67%) were found infected with microsporidia MB. The prevalence of microsporidia MB was lower in An. gambiae s.s (3/548, 0.5%) than in An. coluzzii (18/761, 2.36%). Phylogenetic analysis revealed that microsporidia MB from Cameroon cluster together with the strains of microsporidia MB isolated in other parts of the world. This study provides a field-based evidence of the presence of

microsporidia MB in Anopheles gambiae s.l in Cameroon. In addition to these results, the vertical transmission and the impact of this microsporidian symbiont on Plasmodium development should be investigated.

Keywords: Malaria, Anopheles, Microsporidia MB, Genetic diversity, Cameroon

ABS-276

Species composition and insecticide resistance in malaria vectors in Ellibou, southern Côte d'Ivoire and first finding of *Anopheles arabiensis* in Côte d'Ivoire

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Knowing the species composition and insecticide resistance status of the target vector population is important to guide malaria vector control. The aim of this study was to characterize the malaria vector population in terms of species composition, insecticide susceptibility status and potential underlying resistance mechanisms in Ellibou, southern Côte d'Ivoire. In 2015, a 1-year longitudinal entomological survey was conducted, using light traps and pyrethroid spray catches to sample adult mosquitoes in combination with larval sampling. The susceptibility status of *Anopheles gambiae sensu lato* (s.l.) to bendiocarb, deltamethrin, DDT and malathion was assessed using the WHO insecticide susceptibility test. Additionally, non-exposed *An. gambiae s.l.*(n=141) were subjected for molecular specie identification and screened for knockdown (kdr) and acetylcholineesterase (ace1) target site resistance alleles. Overall, 2,383 adult mosquitoes from 12 different taxa were collected with *Culex quinquefasciatus* and *An. gambiae* being the predominant taxa. Molecular identification of *An. gambiae s.l*. revealed the presence of *An. arabiensis*, *An. coluzzii*, *An. gambiae sensu stricto (s.s.)* and *An. coluzzii/An. gambiae s.s.* hybrids.

Anopheles gambiae s.l from Ellibou were resistant to all insecticides except malathion. PCR diagnostics revealed the presence of ace1-G280S and the kdr L995F, L995S and N1570Y target-site mutations. This is the first documented presence of *An. arabiensis* in Côte d'Ivoire. Its detection – together with a recent finding further north of the country – confirms its existence in the country, which is an early warning sign, as *An. arabiensis* shows a different biology than the currently documented malaria vectors. While being multi-resistant, the local Anopheles population is still susceptible to malathion, suggesting that organophosphates could be an alternative insecticide class for IRS in the Ellibou area.

Keyword: *Anopheles arabiensis*, *Anopheles gambiae*, Côte d'Ivoire, insecticide resistance, metabolic resistance, malaria

ABS-165

The excito-repellent activity of five essential oils extracted from local plants against dengue and malaria vectors in Burkina Faso

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Using chemical insecticides is the main way to prevent and manage dengue and malaria, two mosquito-borne diseases. However, the vectors of these diseases have developed resistance to chemical insecticides. Essential oils (Eos) could be used as alternatives because

besides their larvicidal and adulticidal properties, they have repellent properties. In Burkina Faso studies on the repellent properties of essential oils on mosquitoes remained limited. The 5 Eos extracted from five plants collected in Ouagadougou were tested on populations of *Aedes (Ae.) aegypti* and *Anopheles gambiae s.l* collected in Bobo-Dioulasso and the Kou Valley, respectively. Susceptible strains were also tested. DEET and permethrin were used as positive controls. Most of the 5 Eos (Cymbopogon citratus, Cymbopogon nardus, Eucalyptus camaldulensis, Lippia multiflora, and Ocimum 505urrent505505m) tested produced irritant effects on adults of Ae. Aegypti and An. gambiae. The irritant effects on mosquito adults were significantly influenced by the concentration of the Eos and species of mosquitoes. On *An. gambiae s.l*, the repellent-irritant effects of C. citratus, C. nardus, and E. camaldulensis Eos were very close to that of DEET. On *Ae. Aegypti*, all our Eos had higher repellent-irritant effects for some and very close, for the others, to DEET. Eos could be used as alternative repellents to pyrethroids in vector control.

Keyword: Resistance, essential oil, repellence, *Anopheles gambiae, Aedes aegypti*

ABS-566

Stegomyia indices of *Aedes aegypti* during dengue transmission season in Kassala city, eastern Sudan

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The *Aedes* mosquito is a vector for transmitting many arboviruses including dengue, Rift valley fever, chikungunya, and other emerging arboviruses. Knowledge of the breeding habitat and status of this vector is vital for implementing appropriate interventions. Thus, this study was conducted to investigate the breeding habitats and presence of Aedes mosquito species during dengue transmission season in Kassala city, eastern Sudan. Entomological surveys of water-holding containers for immature stages of *Aedes* were carried out from September to December 2019 in Kassala city through a random sampling method. A total of 450 houses distributed in 6 districts were surveyed monthly for three months across the city. Overall, 1244 potential larval habitats were surveyed. *Aedes aegypti* was collected across the city with an overall high prevalence of *Ae. aegypti* (n = 2405, 96.8%). The study showed that *Ae. aegypti* was more abundant (n = 2405, 96.8%) in Kassala city. Breeding containers, especially clay pots and Water barrels were the most strongly preferred productive larval habitat for *Ae. aegypti* with the prevalence of 12.38% and 5.39% respectively. Globally, the house index (HI), Breteau index (BI), and container index (CI) were high for *Ae. aegypti* (26.6%, 38.4% and 22.6% respectively) and compared to the transmission risk threshold (5%, 5% and 20% respectively) established by the WHO/PAHO. The findings of this study suggest a risk for transmission of

arbovirus diseases in Kassala and call for an urgent need to implement vector control strategies against these vectors in Kassala, Eastern Sudan.

Keywords: *Aedes aegypti*, house index, Breteau index, container index, Kassala, Breeding container, house index (HI), Breteau index (BI), and container index (CI), *Aedes aegypti* , Kassala

ABS-115

Efficacy of dual-active ingredient long-lasting insecticidal nets relative to standard nets, against highly pyrethroid-resistant *Anopheles* mosquitoes in Tanzania: an experimental hut trial

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The global fight against malaria vectors has been threatened by widespread insecticide resistance across multiple chemical classes. There is a need for new vector control tools with different modes of action to combat the issue of resistance. This study aimed to evaluate the bio-efficacy of Olyset Plus (combining PBO and permethrin), Interceptor G2 (chlorfenapyr and alpha-cypermethrin), Royal Guard (pyriproxyfen and alpha-cypermethrin) long-lasting insecticidal nets (LLINs), compared to a standard pyrethroid-only net (Interceptor) across their operational lifespan in experimental hut trials. A total of thirty nets were withdrawn from the community at 12, 24 and 36 months, as part of a large-scale cluster-randomized controlled trial. Hole size and number were recorded. A Latin square design was used to rotate net type and sleepers between huts. The following morning mosquitoes were collected, and mortality monitored every day up to 72 hours. Live, blood fed female *Anopheles* at 72 hours, collected from the huts with Royal Guard, Interceptor and untreated nets were dissected to assess the effect of pyriproxyfen on egg development. Interceptor G2 LLIN induced significant superior 72-hour mortality compared to standard LLINs at 12 months (43% vs 13%); 24-hour mortality was also higher with Royal Guard LLINs compared to

standard LLINs (21% vs 13%), and marginally higher also with Olyset Plus (19%). Seventy-two-hour mortality was still slightly higher at 24 months for Interceptor G2 LLINs compared to standard LLIN (24% vs 11%). None of the other nets showed higher mortality at 24 months. The effect of the second active ingredient or synergist was not observed at 36 months for any of the LLINs. The effect of pyriproxyfen on Anopheles mortality was not observed at any of the time point. All dual active ingredient (dual-A.I.) LLINs performed better than standard Interceptor nets up to 12 months of field use.

Keywords: Insecticide resistance, malaria vectors, LLIN, active ingridient, experimental hut

ABS-242

The development and testing of substrates for evaluating insecticide efficacy for Indoor Residual Spraying (IRS).

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Indoor residual spraying (IRS) has contributed to a substantial global reduction of malaria between 2000 and 2015. However, reduced residual efficacy of IRS continue to threaten malaria control efforts . There is a great need for innovations that would improve the residual efficacy of the current IRS products or the development of novel and effective products. The Innovative Vector Control Consortium is interested in developing new IRS products for improved IRS implementation, but this requires a good understanding of the properties of mud. By mixing different proportions of the UK commercially available soil samples, this study produced mud formulations that mimicked the physical characteristics of African soils from Benin, Tanzania, and Burkina Faso and developed a technique for assessing the capillary action of soils that is readily transferrable to the field. This was an experimental study designed to test the porosity using the RILEM test and capillary action test. Before testing, 10 different mud substrates were developed in the IVCC laboratory to create mud formulations with different porosities. Mud formulations were compared to the African muds with known porosities to determine which combination would mimic either one of the African muds. The RILEM test showed that mud formulations with a high sand content and low clay content absorbed more water than with low sand content and high clay content. Similar results were also observed for the capillary action test. This study recommended that mud composition and porosity should be considered when planning IRS application programs. More research is needed that will help us understand different mud substrates for designing novel IRS formulations that will revolutionize mosquito control. To facilitate studies on mud in the field, the capillary action test (simple than the RILEM test) could be used but more robust studies in the field and laboratory are recommended.

Keywords: Indoor residual spraying, residual efficacy, innovation, porosity,

ABS-435

Overabundance of Asaia and Serratia Bacteria Is Associated with Deltamethrin Insecticide Susceptibility in *Anopheles coluzzii* from Agboville, Côte d'Ivoire

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Insecticide resistance among mosquito species is now a pervasive phenomenon that threatens to jeopardize global malaria vector control efforts. The mosquito microbiota consists of the bacterial, archaeal, viral, and fungal communities which inhabit the mosquito cuticle and internal structures. It is implicated in mosquito longevity, growth, oviposition, vector competence and, more recently, insecticide resistance. Evidence of links between the mosquito microbiota and insecticide resistance is emerging, with significant enrichment of insecticide degrading bacteria and enzymes in resistant populations. *Anopheles coluzzii* from Agboville in Cote d'Ivoire were tested for resistance to deltamethrin using CDC bottle bioassays. Using 16S rRNA amplicon sequencing, we characterized and compared the microbiota of *An. coluzzii* in relation to their deltamethrin resistance and exposure profiles. Comparisons between 2- and 3-day-old deltamethrin-resistant and -susceptible mosquitoes demonstrated significant differences in microbiota diversity. Ochrobactrum, Lysinibacillus, and Stenotrophomonas genera, each of which comprised insecticide-degrading species, were significantly enriched in resistant mosquitoes. Susceptible mosquitoes had a significant reduction in alpha diversity compared to resistant individuals, with Asaia and Serratia dominating microbial profiles. There was no significant difference in deltamethrin-exposed and -unexposed 5- to 6-day-old individuals, suggesting that insecticide exposure had minimal impact on microbial composition. Serratia and Asaia were also dominant in

5- to 6-day-old mosquitoes, which had reduced microbial diversity compared to 2- to 3-day-old mosquitoes. Our findings revealed significant alterations of *Anopheles coluzzii* microbiota associated with deltamethrin resistance, highlighting the potential for identification of novel microbial markers for insecticide resistance surveillance.

Keywords: *Anopheles Coluzzi*, microbiota, resistance, deltamethrin

Poster Abstracts Day 4

ABS-386

Characterization of genotypic resistance to pyrethroids in *Anopheles coustani*, a secondary malaria vector in the Vallée du Kou, Burkina Faso

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Malaria is a vector-borne disease. The vectors involved are essentially the major vectors and the secondary vectors. Vector control, one of the main control mechanisms against these vectors in Burkina Faso, is hampered by resistance phenomena. Thus, despite the importance of secondary vectors in the maintenance of malaria transmission, very few studies have sought to verify the presence of resistance genes within these vectors. The objective of this study was to characterize the kdr mutation in *Anopheles coustani* in the Vallée du Kou. It was an experimental study of four components, namely collection, breeding, bioassays and molecular tests carried out in the Hauts-Bassins region between September and October 2021. Adult females of *Anopheles coustani* gorged were collected using a single net trap. Breeding was done at the insectary and the first generation was used for bioassays with permethrin 0.75. The Molecular tests were used to identify mosquitoes and to characterize kdr mutation. A total of 164 *Anopheles coustani* females were tested with permethrin 0.75. A mortality of 79.79% was recorded. The Kdr L1014F mutation was tested in 232 mosquitoes previously identified molecularly as *Anopheles coustani*. The distribution of this mutation was as follows: 132 (56.90%) homozygous resistant, 88 (37.93%) heterozygous and 12 (5.17%) homozygous susceptible. The frequency of expression of this mutation was 0.76. The frequency of expression of the Kdr L1014F mutation

in *Anopheles coluzzii* in the Vallée du Kou ranged from 0.66 to 0.98 compared to 0.76 for *Anopheles coustani*. *Anopheles coustani* develops phenotypic resistance associated with a high frequency of the kdr mutation, the main mechanism of pyrethroid resistance. The selection pressure for pyrethroid resistance in the Vallée du Kou is not only on the major vectors but also on the secondary vector *Anopheles coustani*.

Keywords: *Anopheles coustani*, kdr mutation L1014F, Vallée du Kou

ABS-387

Preliminary study on malaria active case investigation in chainda township of Lusaka district, in Zambia, November 2021

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The confirmed Malaria cases reported at Chainda Urban Health Centre was 100. Most Malaria cases in Lusaka are imported from other district across the country. The main objective was to trace travel history of the contacts of the patients and their contacts in Chainda Township. A cross section study was conducted in Chainda Township. The first case of malaria was reported at Chainda Urban Health Centre in November 2021. This case was identified through the Malaria Case Hard Copy Register and SmartCare App. An Interview was conducted using a questionnaire. The questionnaire contained questions on travel history, date of onset, symptoms, test conducted, use of ITNs and date of admission to sick register. Contact tracing was also conducted. It was noted that the patient had travelled to Mpika and spent about 2 months there. The onset date of symptoms was 17th November 2021 within a week of arrival. The symptoms included fever and body pains. On 19th November 2021 she was admitted to sick register at Chainda Urban Health Centre, she tested with the RDT and was positive for Malaria. She admitted to not sleeping under a mosquito net the whole period she was in Mpika. Only one contact was traced at her Household, (the Husband) but he was not tested for Malaria. Neighbors from 10 surrounding households were not traced

because at the time of investigation there was no person of consent age available. The primary risk factor for malaria infection in the low transmission district of Lusaka is travel. There is a very high chance that the patient had contracted the disease from outside Lusaka district from the travel History. Increasing and enhancing surveillance systems will ensure better outcomes when carrying out Case investigations.

Keywords: Malaria, Case investigation, Elimination, Prevalence

ABS-393

Are malaria vectors breeding in polluted waters in the city of Accra, Ghana?

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The increasing adaptation of malaria vectors to breeding in polluted and other unexpected habitats in many Sub-Saharan African cities is an emerging threat to public health. Historically, Anopheles mosquitoes breed in clean, unpolluted waters, and have shunned breeding in effluents from households and industries. However, this seems to be changing in urban settings. This study characterized the Anopheles mosquito habitat types, and species composition in the city of Accra, Ghana. Larval surveys and collections were undertaken in fifteen sites within the city of Accra (5° 36' 53.3448'' N, 0° 12' 21.1464'' W), Ghana. These sites were categorized into five sectors (three sites per sector) including: Irrigated Urban Farming (IUF), Lower (LS), Middle (MS) and High (HS) socioeconomic status, and Peri-urban (PU) sites. Physicochemical parameters were measured, and species identification done using morphological and molecular methods. A total of 727 breeding habitats were found, of which [65.34%, n = 475/727] were positive for Anopheles larvae. Drainage ditches were the most abundant [48.21%, n = 229/475] habitat type. Overall, the abundance of An. gambiae s.l. was highest in IUF sites [6,244/22,919], and in the rainy season (77.01%; 17,650/22,919), (R2 = 3.46, P = 0.000. Malaria vectors were found to breed in polluted waters including effluents from households. Polluted waters had on average dissolved oxygen of 17.6% compared to unpolluted (26.1%). Other parameters that distinguished polluted breeding habitats from unpolluted were conductivity (7332.5 uS/cm vs 2932.0 uS/cm); total dissolved solids (4567.0mg/L vs 1780.2mg/L); NH4-N (11.9 mg/L vs 4.9 mg/L). The predominant species was *An. coluzzii* 54.4% (368/677). The invasive

An. stephensi, which has not yet been reported in Ghana was detected. Findings in this study provide more evidence for the consideration of environmental management for malaria control in urban Accra.

Keywords: *An. stephensi*, Physicochemical properties, larval survey, polluted, unpolluted

ABS-613

Malaria Transmission in Hospital Environment: Parasite Prevalence among In-patients and Sporozoite Rate in Malaria Vector

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Malaria remains a major public health challenge in Nigeria, and is being transmitted through the bite of female Anopheles mosquitoes. Hospital patients are vulnerable to other infectious diseases while they are being treated for the ailment they are admitted for. This study was carried out to determine the occurrence of malaria parasite infection among in-patients and sporozoites rate in Anopheles mosquitoes from hospitals in Abeokuta, Nigeria. Two hospitals were visited from which intravenous blood samples were collected for microscopic detection of malaria parasite. Mosquitoes from the wards were manually aspirated, morphologically identified, and classified based on their gonotrophic and parity stage using the dissecting microscope. The blood meal source were determined using anti-human globulin test while mosquito infectivity was determined using Enzyme-linked immunosorbent assay (ELISA) for Plasmodium falciparum sporozoites. Data obtained were analysed using Chi-square tests in SPSS version 20.0. A total of 133 in-patients were screened for malaria in which 77% were positive. Twenty-nine percent were admitted for malaria. Prevalence of malaria among in-patients admitted for severe malaria (95%) was significantly higher ($p<0.05$) than those admitted for other ailments (70%). A total of 714 mosquitoes comprising Anopheles and Culicines were collected. However, 80(11.2%) were female Anopheles gambiae mosquito (FAGM) with 65(81.3%), 11(13.7%), 4(5%) been freshly fed, half gravid and gravid respectively while the parity rate was 6.3%. Ninety-five of the FAGM had human blood and sporozoite rate was 2.5%. This study has shown the occurrence of malaria parasite in patients and malaria parasite infective stage in mosquitoes from the hospital. Therefore, there is need for effective management of malaria within the hospital environment which will require program that includes malaria screening, treatment and mosquito control.

Keywords: Malaria, Mosquito, Hospital, Anopheles, sporozoite rate, Infection

ABS-623

Species diversity and human biting rates of mosquitoes collected from a tourist island in Mombasa County, Kenya

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Mosquito-borne viruses are spread worldwide due to ecological, environmental, human factors. Vectors with anthropogenic activities facilitates emergence of mosquito-borne diseases due to human-mosquito's interactions. Foreigners who lack immunity for exotic diseases, are at greater risk of infection with vector-borne disease agents. Therefore, the present study was conducted in Mombasa County, a global outreach tourist destination at risk of emergence of vector-borne diseases. This is a cross-sectional study conducted during long rain season in Mombasa county. The mosquitoes were collected using co2 baited BG sentinel traps during the night and also systematic sampling approach to directly measure attractiveness of Ae. aegypti to human odors using human landing collection (HLC). The data was captured in Microsoft excel and analyzed in Rstatistics software. A total of 4185 mosquitoes were collected by HLC. *Aedes aegypti* (n=2216; 60%) was the most abundant, followed by *Ae. vittatus* (n=1438; 40%) and other species (n=3,435; 40%). For the anthropogenic vectors *Ae aegypti* population had 3.2 bite per person per hour (bph) followed by *Ae. vittatus* 2.1 bph Cx. pipiens 0.4 bph and other species 0.3 bph. For the BG sentinel method a total of 7250 mosquitoes were collected comprising five genera; Aedes, Culex, Anopheles, Eretmophidites and Mansonia. *Culex pipiens* were most abundant followed by *Ae. vittatus* and *Ae. aegypti*. High abundance of competent Dengue and chikungunya vectors with a high proclivity to bite humans makes county at high risk of exposure to chikungunya and dengue virus. The presence of vectors known to exhibit opportunistic feeding may potentiate the risk of human exposure to zoonotic pathogens via spillover transmission events aided by the vector. Our findings useful baseline for planning, prevention and control of vector-borne diseases, which have been reported regularly to minimize the risk of transmission.

Keywords: *Aedes aegypti*, human biting rate, abundance, mosquito species

ABS-625

Exploring the epidemiological impact of heterogeneity in insecticide resistance in mosquitoes using a malaria transmission dynamics mathematical model

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Insecticide resistance is a major threat to the effectiveness of vector control tools against malaria. A better characterisation of this resistance is important to understanding its impact. Intensity bioassays quantify the strength of resistance and can generate dose-response relationships. These relationships can illustrate different resistance patterns: curves with flatter gradients imply more heterogeneity in the sample and vice versa. We theoretically explored the implications of population-level heterogeneity of resistance on the efficacy of vector control and recreate realistic levels of population variability seen in field settings in Burkina Faso. Scenarios ranging from no heterogeneity in resistance (i.e. the mosquito population homogeneously presents one level of resistance) to high levels of heterogeneity (i.e. half of the mosquito population is fully resistant and half is fully susceptible) were explored using an individual-based mathematical model of malaria transmission. The impact on malaria incidence, the EIR and insecticide-treated nets (ITNs) effectiveness were quantified using estimates of heterogeneity observed in the field. For the same overall level of resistance in the population (as measured by a susceptibility bioassay), settings exhibiting high heterogeneity in resistance had decreased ITN effectiveness of up to half compared to fully homogeneous settings. The epidemiological and entomological impact of different levels of heterogeneity observed in mosquitoes in two nearby villages in Burkina Faso was estimated and used to assess ITN efficacy. Studies should quantify both the magnitude of pyrethroid resistance and the heterogeneity within the population to understand the epidemiological impact of pyrethroid ITNs. These methods can be combined with observed longitudinal changes in resistance over time to explore the selection pressure and possible fitness costs associate with resistant phenotypes.

Keywords: Insecticide resistance, modelling, heterogeneity, intensity bioassay, vector control

ABS-629

Breeding site preferences and insecticide resistance profiles of three major Aedes species from yellow fever outbreak localities in Nigeria

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Since 2017, Yellow fever (YF) epidemic has become a recurrent health burden in Nigeria, including in Ebonyi State. Having a Case Fatality Ratio of 31% at some point, longitudinal surveillance was done in the State to understand the breeding site preferences and insecticide resistance profiles of major Aedes species in areas with high burden. Ovitraps were set and retrieved monthly on the ground and trees around human dwellings in three communities over a one-year period between 2020 and 2021. Larval sampling was carried out quarterly in the same area. Adult *Aedes aegypti*, *Ae. albopictus* and *Ae. luteocephalus* raised from the eggs and larvae/pupae collected were used for bioassay with permethrin, alphacypermethrin, deltamethrin and pirimiphos-methyl. Between 43% and 60% of all eggs collected hatched and developed into adults. A total of 6,911 *Ae. aegypti* (50%); 5,242 (38%) *Ae. albopictus*; 739 (5%) *Ae. luteocephalus* and 904 (7%) *Ae. simpsoni* complex were collected from ovitrap emergence and larval surveys. While 97% of the *Ae. aegypti* and *Ae. albopictus* were from ground traps, they also accounted for 25% of all tree collections. Although significantly more *Ae. luteocephalus* (71%) were collected from trees, it represented 3% of all ground collections. All the Aedes mosquitoes were pyrethroid susceptible, but marginal resistance was observed from pirimiphos-methyl exposure, with mortalities of 97%, 96% and 88%, respectively for *Ae. aegypti*, *Ae. albopictus*, and *Ae. luteocephalus*. Assays for metabolic and target site insensitivity resistance molecular mechanisms are ongoing. Understanding the nature of breeding sites and the insecticide resistance profiles of the major Aedes species in this area with a high burden of YF will support policymaking for the implementation of appropriate vector control interventions.

Keywords: Aedes mosquitoes, breeding, insecticide, resistance, yellow fever

ABS-630

Bionomics and Vectorial role of *Anopheles funestus* Giles, 1900 in Central Senegal.

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Anopheles funestus is one of the major vectors of malaria in sub-Saharan Africa. In Senegal, it is present in almost all the biogeographical areas, where it maintains malaria transmission, mainly in the dry season, supplanting the species of *An. gambiae* complex. However, its implication in malaria transmission remains poorly documented in central Senegal. The present study assesses the contribution of *An. funestus* in malaria transmission in two districts in the central region of Senegal. Adult mosquitoes were collected using Human Landing Catches (HLCs) and Pyrethrum Spray Catches (PSCs), from July 2018 to November 2019 in Nioro and Ndoffane health districts. Anopheline mosquitoes were morphologically identified using conventional keys and were identified to species level using polymerase chain reaction. The infection rates and blood meals sources were determined using ELISA techniques. Out of the 8,248 anopheles collected, 68.2% (5629/8248) were identified as *An. funestus s.l*. This was the predominant species for each collection method used. Mean biting rates and indoor resting densities were respectively 2.8 bites per person per night (b/p/n) and 17.9 females/room (F/R) in Nioro, and 12.4 b/p/n and 27 females/room in Ndoffane. The mean *Plasmodium falciparum* infection rates (sporozoite indices) were 0.27% (1/363) and 0.31% (5/1615) in Nioro and Ndoffane respectively, with corresponding entomological inoculation rates of 0.007 and 0.04 infected mosquito bites per person-night. The anthropophilic rate of *An. funestus* was relatively low with only 17% (98/575) blood fed on human. Molecular identification revealed the exclusive presence of *An. funestus s.s*,. This study demonstrated the predominance and the involvement of *An. funestus* in malaria transmission in central Senegal.

Keywords: Plasmodium falciparum, *An. funestus*

ABS-634

Mapping species distribution, abundance and infection rate of schistosoma vector snails in Nkhotakota north, Malawi

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Schistosomiasis is a freshwater snail-transmitted parasitic disease with devastating effects seconded from malaria. Almost 200 million people are infected globally and 97% are in Africa. almost 40% of the total Malawian population is at risk of schistosomiasis. While much has been done to controlling schistosomiasis using school MDA of praziquantel, schistosomiasis is still endemic in Malawi, hence a need for Malawi to map schistosomiasis snail vectors. The study Aim to map specie distribution, abundance, and infection rate of Schistosoma vector snails Nkhotakota north, Malawi. A total of 17 sites were visited for snail sampling, sampling was done using handpicking and

scooping methods. Schistosome vector snails from each site were separated by species. Some sampled snails were screened for cercaria. environmental-physiochemical parameters and GPS were collected on each sampling site. Data was analyzed using SPSS and Microsoft excel. Almost 65% of all the sites sampled had schistosome vector snails. Irrigated canals recorded the highest schistosome snail abundance than lakes and rivers. Snail vector species from the Bulinus, Biomphalaria and melanoides genus were sampled throughout the study. *Bulinus globosuss* was the most abundant species. The distribution of snails was clustered with few sites accounting for most of the snails sampled. The overall snail infection rate was 12.7 %. Almost 70% of all sites sampled had snails shedding cercaria. The highest snail infection (32.2%) was recorded at Illovo sugarcane irrigation canals. Bulinus snail species abundance negatively correlated with PH and water depth. The presence of schistosome intermediate vector snail species from the Bulinus and Biomphalaria genus which were shedding cercaria, constitutes a potential schistosomiasis health risk to communities surrounding these water bodies. The status of some physiochemical water parameters was favorable for some schistosome vector snail's abundance and distribution

Keywords: Mapping, species

ABS-635

Schistosomiasis In Northern Malawi, An Assessment Of Mass Drug Administration And Community Perceptions Of The Disease.

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Vector control, identification of at-risk populations, and the encapsulation of community perceptions remain a prerequisite to planning and designing as well as implementation of control measures. Mass Drug Administration (MDA) is the gold stand technique in the control of schistosomiasis in Africa. Hence the objectives of this study were to investigate community perceptions towards the disease as well as to determine the prevalence and Risk factors of schistosomiasis in Northern Malawi. The study took place in 4 districts, Rumphi, Nkhotakota, Karonga and Mzimba. A total of 1841 in depth interview (IDIs) were conducted between April 2022 and May 2023. Malacological surveillance (snail survey) also took place during this period in the aim of analyzing species distribution, abundance and infection rates. Infected snails were found in 85% of the water bodies with highest presence being found in irrigation canals, rice fields and cattle-feeding man-made dams showing evidence of active disease transmission in the North. Malacological surveillance also showed significant increase of infected snail populations during the rainy season. The interviews showed little to no evidence of the disease with superstition and lack of knowledge being the main reasons MDA is rejected in the Northern part of Malawi. These are underlying factors and could contribute significantly to increase in disease prevalence in Norther Malawi.

Keywords: Schistosomiasis, MDA, vector control, NTDs

ABS-641

"After a long day of play, I get tired and forget to unfurl my bed net: exploring barriers to and facilitators of Long -lasting insecticidal treated bednets (LLINs) in eastern Uganda

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Insecticide-treated bednets are the most common form of malaria prevention worldwide, and understanding the factors that affect their use is critical. Self-reported use may not accurately measure actual practice due to social desirability bias and temporal variations in usage. Electronic bednet monitors can provide more precise measures of use. Households in Tororo district, enrolled in an ongoing study with electronic bednet monitors were systematically selected and underwent in-depth interviews about bednet use. Household members aged 8 and older were eligible. A survey guide was developed using an Information-Motivation-Behavioral (IMB) framework. A simplified guide was used for children under age of 15. The IMB framework was used to categorize the data according to barriers and facilitators of use. Thirty five participants from 12 households were interviewed from a total of 15 with SmartNet devices installed. A total of 20 adults and 15 children. A total of 23 of 35 participants (65.7%) were female. Facilitators of bednet use included knowledge of bednets as a low-cost way to prevent malaria, more rooms in a house and more stable sleeping arrangements. Electronic monitoring devices were noted to promote bednet use, as were habits such as unfurling the bednet before bedtime. Age was a moderating factor, with older people more likely to use bednets than younger children. Barriers to the use of bednets included ignorance about the cost of treatment, excessive heat and tiredness after a long day of play for the children. Children depended on parents for bednet use, leading to non-adherence when parents were unavailable. Despite participant knowledge about the spread and control of malaria, using LLINs consistently remains a challenge. Continuous reminders influence behaviour change regarding bednet use, especially among children. Parental support in unfurling LLINs may help reduce the risk of malaria among children.

Keywords: electronic monitoring, LLIN use, behavior change

ABS-644

Pyrethroids and DDT resistance in *Anopheles gambiae s.s.* in semi-urban and rural areas of the Moyen Ogooué province, Gabon

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Pyrethroids are the main insecticides used in vector control for malaria. However, their extensive use has led to the development of resistance that are threatening the success of this control measure. Baseline data prior to large scale distribution of bed nets are important for the implementation of efficient strategies. However, no data on the susceptibility of malaria vectors is available in the Moyen Ogooué Province. Therefore, the aim of this study was to assess the susceptibility to pyrethroids and organochlorides of malaria vectors from a semi-urban and rural areas of the province and to determine the frequency of insecticide resistance genes. Larvae were collected from breeding sites in Lambaréné and Zilé and reared to adults. Three to five-day old females mosquitoes were used in cone tube assays following the WHO susceptibility tests protocol for adult mosquitoes. A subsample was molecularly identified and the frequency of L1014F and 1014S resistance genes were determined. *Anopheles gambiae sensu stricto* was the sole species present in both Lambaréné and Zilé. Mosquito populations from the two areas were resistant to pyrethroids and organochlorides. Resistance was more pronounced for permethrin and DDT with mortality rates lower than 7% for both insecticides in the two study areas. Deltamethrin engendered higher mortality rates in Zilé (76%) compared to Lambaréné (51%) ($P < 0.0001$). All the mosquitoes tested were heterozygous or homozygous for L1014F and L1014S with a higher proportion of L1014F homozygous in Lambaréné (76.7%) compared to Zilé (57.1%). We provide here evidence that *An. gambiae s.s.,* the main malaria vector, in the Moyen Ogooué Province is resistant to pyrethroids. This study points to the need to further investigate the mechanisms underlining the resistance of *Anopheles gambiae s.s*. to pyrethroids to implement appropriate insecticide resistance management strategies.

Keywords: *Anopheles gambiae s.s.*, Deltamethrin, Permethrin, DDT

ABS-646

Evaluation of s-hydroprene and leaf extracts of *Azadirachta indica* (A. Juss, 1830) on larvae of *Culex quinquefasciatus* (Say, 1823) and *Aedes aegypti* (Linn., 1762)

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This study seek to evaluate the effect of S-Hydroprene and leaf extracts of Azadirachta indica on first and third instar larvae *of Culex quinquefasciatus* and *Aedes aegypti*. Serial concentrations (10 mg/L to 60 mg/L) were tested on third instar larvae for mortality effects, survival and morphological deformation on first instar of the medically important Cx. *quinquefasciatus* and *Ae. aegypti* mosquitoes under laboratory conditions. N-Hexane extract killed more larvae of *Cx. quinquefasciatus* at 60 mg/L 11.2 (37%) while a similar value was obtained from the same solvent extract for *Ae. aegypti* larvae at 50 mg/L 11 (37%). S-Hydroprene had more deleterious effect on *Cx. quinquefasciatus* third instar larvae at 60 mg/L 2.8 (9%) when compared with methanolic extract. S-Hydroprene had no significant effect on the mortality of *Ae. Aegypti.* Since extracts of *Az. indica* had less toxic effect, they allowed for the survival of *Cx. quinquefasciatus* and *Ae. aegypti* but extended the larval stages and prevented ecdysis. The first instar larval stage was maintained for sixteen (16) days which is at variance with the regular three (3) to four (4) days larval existence. The leaf extracts of *Az. indica* and S-Hydroprene caused morphological deformations such as larval-pupal intermediate, decomposing head and body on *Cx. quinquefasciatus* and *Ae. aegypti* larvae. The leaf extracts of *Az. indica* therefore could be considered and utilized in population management of noxious mosquito species to reduce their rate of disease transmission.

Keywords: Growth inhibition, *Aedes aegypti*, *Culex quinquefasciatus*, Mosquito control, *Azadirachta indica,* Vector control, larva control.

ABS-650

The role of geographic information systems in the implementation of an entomological monitoring system in Burkina-Faso

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Malaria surveillance in Burkina-Faso is principally based on clinical data collected by the health system, while the disease is controlled through both treatment and vector control. This is a vital element in controlling the disease. The WHO's Global Technical Strategy for Malaria Control 2016-2030 aims to make malaria surveillance a core intervention in all countries. That is why Burkina Faso has decided to set up its own entomological surveillance system. The aim of this study is to demonstrate the contribution of GIS to entomological surveillance in Burkina Faso. Geographic Information Systems combined with multi-criteria analysis using data from various sources permitted the selection of 140 surveillance sites spread across the 70 districts between the three malaria transmission zones of Burkina Faso. Entomological surveys were used to collect mosquitoes in the selected sites. Analysis of the data showed that the distribution and spatial dynamics of these malaria vector species are non-random. More detailed analyses will enable us to understand the spatial and temporal distribution of these species across the country. Interpretation of the results will enable proper planning of genetic vector control.

Keywords: Surveillance, Geographic Information System, Genetic vector control, Malaria, Burkina Faso

ABS-651

Analysis of the spatial disparity of *Aedes aegypti*, the vector of dengue fever, and the prospects of the disease evolving into an epidemic in the city of Bobo Dioulasso.

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Vector control appears nowadays as the best strategy to fight arboviruses. The knowledge of their living environment as well as their spatio-temporal dynamism becomes therefore essential for an efficient vector control. Thus, through two different living standard environments in the city of Bobo Dioulasso, we set ourselves the objective to study the spatial disparity of *Aedes aegypti*. To achieve this, geographic and entomological data were collected and analysed in a geographic information system (GIS). First, a multi-criteria analysis

of data from remote sensing, meteorology and existing databases was used to determine the zones favourable to *Aedes aegypti* reproduction. Then, based on the entomological survey data, the spatio-temporal evolution of the vector during one year was established and the risks of dengue epidemics were assessed on the basis of the indicators. And finally, through a KAP survey, we assessed the level of knowledge, attitudes and preventive practices of the population with regard to dengue fever, with a view to strengthening epidemiological surveillance systems. The results show that the city of Bobo Dioulasso has environmental factors that favour the emergence of *Aedes aegypti*. Over a period of one year, the presence of the dengue vector is almost permanent, with a dizzying peak during the dry season. As for the population, 49% of the peripheral district have never heard about dengue, compared to 18% for the residential district, and overall, for those who know about the disease, more than 75% claim to have never contracted the disease, nor any of their family and friends. All this demonstrates paradoxically the reduced number of cases of dengue in the city of Bobo Dioulasso despite the conditions favourable to its emergence.

Keywords: Bobo-Dioulasso, GIS, *Aedes aegypti*, dengue, Epidemic, Spatial analysis

ABS-659

Distribution of Knock Down Resistance Mutation of Deltamethrin in Wild Population of *Anopheles gambiae s.l.* from Rural and Peri-Urban Communities of Gombe, Nigeria.

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Malaria vector control relies principally on the use of chemical-based control strategies of LLINs and IRS at the community level. However, mosquitoes have developed insecticide resistance to chemical insecticides in several malaria endemic countries including Nigeria and Gombe specifically. Here, we characterized populations of major malaria vector *Anopheles gambiae s.l.* from communities in Akko and Kaltungo LGAs to detect and determine target site mutation and frequencies respectively. Wild Anopheles gambiae larvae were collected using the standard dipper of 350ml in eight communities from January, 2022 to January, 2023 and reared to adulthood in the laboratory. Susceptibility status of 2-5 days old glucose fed female *An. gambiae s.l.* to four insecticides (Deltamethrin 0.05%, DDT 4%, Bendiocarb 0.1% and Pirimiphos-methyl 0.25%) were evaluated following the WHO protocol. A total of 96 sub-samples of 53 alive and 41 deaths mosquitoes exposed to deltamethrin 0.05% insecticide were identified morphologically and subsequently to molecular species using

specific primer targeting the rDNA ITS2 biomarker. The frequencies of Kdr L1014F alleles of the species was also evaluated. The results revealed *An. gambiae s.l.* is the major malaria vector in the study communities and highly resistant to deltamethrin insecticides. The molecular genotyping identified 37.5% were *An. gambiae s.s,* 52.78% were *An. coluzzii* and 9.72% *An. arabiensis.* Voltagated sodium channel revealed allele frequency of L1014F Kdr mutation (0.194) in An. coluzzii. Establishment of insecticides resistance in the study site can be associated with the presence of L1014F Kdr mutation and dominance of *An. coluzzii* combined with high allele frequency of L1014F mutation can threaten the efficacy of pyrethroid LLINs currently deployed for malaria vector control in Gombe. Hence, the result would guide state holder in implementing appropriate vector control interventions.

Keyword: *An. gambiae s.l.*, Deltamethrin, L1014F mutation, Insecticides Resistance.

ABS-661

Impact of improved diagnostic tools, practices, training and communication on acute fever case management and antibiotic prescriptions for patients presenting at outpatient facilities in Uganda.

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Antibiotic prescribing practices are the leading cause of antimicrobial resistance. The study explored the key drivers and barriers to adherence to prescribing instructions by patients/caregivers. As part of a randomized trial, a qualitative assessment explored drivers and barriers to prescription adherence. Focus group discussions (FGDs) were conducted with patients who sought care from the health facility and in-depth interviews (IDIs) were conducted with health workers based on their roles. From the findings, a training and communication package (T&C) was developed consisting of training in communicating prescription messages for healthcare workers and a set of communication messages for patients and caregivers, which were pretested for clarity with a sample of patients. The T&C was incorporated into the RCT intervention package, which was implemented in three Health centres in Uganda. Aduku in Northern region, Kihihi in the West, and Nagongera in the East. Health workers were trained on the package for use with the intervention patients. Meetings were held with policymakers to discuss the capacity, opportunity and motivational COM-B/TDF framework and behaviour change technique. Content analysis was used to analyze the FGDs and IDIs, to identify key drivers and barriers. 1) Key drivers included: drug

availability, health worker knowledge and communication and opportunities such as 1) good support network, 2) capability of the health workers, 3) cognition and interpersonal skills, 4) awareness from the training and communication package increased positive social and environmental factors to tackle poor adherence. 2) Barriers included the inability to buy drugs The training and communication package was instrumental in changing behaviour and ensuring adherence to prescription. The training and communication package with developed guidelines should be rolled out across the health facility.

Keywords: Social science, antimicrobial resistance, training and communication package

ABS-665

Resting habits of malaria vectors in iron sheets houses in Inhambane, southern of Mozambique

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Despite efforts to control malaria it continues to have a major impact on public health in Mozambique. The main vectors are: *An. gambiae ss*, *An. arabiensis* and *An. funestus ss*. Although the challenges to implement Indoor Residual Spraying (IRS) due to lack of resources, it constitutes one of the important vector control strategies in Mozambique. To IRS be effective, target structures must have surfaces which retain insecticide. Apparently Iron sheets wall don't retain insecticide and his ability to quickly absorb ambient temperature making them inhospitable for mosquitoes rest. The study aims to verify if internal surfaces of unsprayed iron sheets houses provide resting for mosquitoes. The study was conducted in Inhambane and Maxixe districts in March, August and September 2020. Mosquitoes were collected once a month from 10 houses per site using procopack aspiration on clothing/objects, under furniture, iron sheets wall, ceiling, wooden wall and ceiling support. Next, the collection was done by the PSC to ensure that the majority of mosquitoes were collected. Identification were done by morphological characters. A total of 60 *An. funestus sl.* mosquitoes were collected from all surfaces, 40 from bedrooms (65.2%) and 20 from the living room. Highest density of mosquitoes (0.3/room) was found resting on iron sheets walls, followed by 0.2 under furniture and 0.1 on clothing/objects, wooden wall support and wooden ceiling support. The presence of

mosquitoes inside this type of house suggests that malaria transmission may occur. Although these results are preliminary, are relevant to malaria transmission. The possible transmission of malaria in iron sheets houses has serious implications for malaria control considering that these types of houses, which are expanding in southern of Mozambique are not being sprayed. More extensive studies to confirm the significance of these results and the residual efficacy of insecticides in these surfaces are planned.

Keywords: Malaria, Vectors, Resting, Iron sheets houses

ABS-666

Investigating the role of insect-specific flaviviruses (ISFVs) in arbovirus transmission blocking in mosquitoes

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Dengue (DENV) and Wesselsbron (WSLV) viruses are among the mosquito-borne flaviviruses that cause significant health and socioeconomic burdens to humans, particularly in sub-Saharan Africa. Vector control, the core measure of controlling such arboviruses, is facing challenges due to behavioural changes and insecticide resistance in mosquitoes. Thus, there is a need for alternative methods to control arbovirus transmission. While Wolbachia endosymbionts have been used to block arbovirus transmission, the potential of many other endosymbionts as biological tools remains unexplored. Insect-specific flaviviruses (ISFVs) are closely related to the afore mentioned flaviviruses but infect insects only, are vertically transmitted and endemic in some Kenyan ecologies, making them potential candidates for arbovirus transmission-blocking. Trapping and Processing of Mosquitoes which were then homogenized. Viral RNA extraction - RT-PCR then the positive samples were cultured for virus isolation in Insect cell lines (*Aedes albopictus* C6/36, *Anopheles gambiae* Sua5B cells and culex cell lines) were cultured in Leibovitz's L-15 Medium for C6/36 and Cx cell lines and Schneider's Drosophila Medium for Sua5b cells. Co infection and superinfection will be done using both ISFVs and DENV and WSLV. We Isolated the following viruses, Aedes Insect Specific Flavivirus SML 494, Mwea AnFV- SPL 14, Mwea AnFV- SPL 33, Ahero AnFV- 1GM, Ahero AnFV-5GF, in Cell culture, Dengue virus titers in cell lines with and without AeFV showed that Dengue virus titers are increasing in the dengue-only and not in AeFV-coinfection. Isolated Aedes-specific flavivirus (AeFV) and Anopheles-specific flavivirus (AnFV) cultures. Established *Aedes aegypti* mosquito lines infected with AeFV.Aedes-specific flavivirus (AeFV) can modulate dengue replication in C6/36 cells on days 5 and 7. Aedes-specific flavivirus (AeFV) can modulate dengue replication in C6/36 cells on days 5 and 7.

Keywords: Dengue, arbovirus

ABS-671

Dynamics of Malaria Vectors in the North-western Lake Zone Regions in Tanzania

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Malaria is still a major public health problem in Tanzania. Indoor Residual Spraying to control malaria has been implemented for almost two decades in Tanzania. This study aimed at discerning dynamics and patterns of malaria vectors in the North-western Lake Zone Regions in relation to effectiveness of consistent two rounds of IRS. Longitudinal surveillance was conducted from October 2019 to September 2021. WHO cone wall and fumigant bioassays were conducted monthly for 24 months with insectary reared susceptible *An. gambiae s.s*. Kisumu strain on mud, oil or water painted, lime washed, unplastered cement and burnt bricks surfaces sprayed with either SumiShield 50WG, fludora fusion or p-methyl. Each month CDC light traps, Clay pots, Prokopack aspirators and CDC light traps with collection bottle rotators were used during mosquito collection in 10 districts (6 IRS and 4 without IRS). Collected mosquitoes were identified morphologically and sibling species processed by PCR. Mosquito infectivity was detected using the enzyme-linked immunosorbent assay. 39,418 and 19,318 female Anopheles mosquitoes were collected in 2019/2020 and 2020/2021 respectively post-IRS. A sub-sample of 23,204 and 15,564 female *An. gambiae s.l.* and *An. funestus s.l*. were analyzed for identification of sibling species; for two years the local malaria vector population was predominated by *An. funestus s.s.* (50.1%), *An. arabiensis* (32.6%), *An. gambiae s.s.* (11.1%) and *An. parensis* (0.9%). In sprayed sites, *An. funestus s.s*. were predominant before IRS and *An. arabiensis* after IRS. In sprayed sites, sporozoite rate lowered from 0.9 in 2019/2020 to 0.5 in 2020/2021. IRS with SumiShield 50WG, fludora fusion and p-methyl remained efficacious for two consecutive years during peak transmission season which led to the significant reduction of vector abundance, sporozoite rates and EIR in Anopheles vectors sprayed sites 2020/2021 compared to 2019/2020.

Keywords: Indoor residual spraying, female Anopheles mosquitoes, north-western Tanzania, *An. funestus s.s.*, sprayed sites.

ABS-672

Potential of the African senna plant (Senna didymobotyra) as a tick attractant

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Increasing resistance of ticks to acaricides and the expanding range of invasive tick species necessitate development of alternative interventions, such as the use of semiochemicals attractants, for sustainable tick control. However, the effectiveness of synthetic attractants is limited by their high cost and the requirement for specific tick sexes to respond. To address these challenges, researchers have advocated for the use of renewable plant extracts as attractants. Here, an olfactory based bioassay-guided approach was employed to screen and identify tick attractants in various parts of Senna didymobotrya, a plant known for its ability to alter the behaviour of ticks and other arthropods. Methanolic extracts of the plant's leaf, flower, seedpod, and twig branch were tested. It was found that adult ticks of both *Amblyomma variegatum* and *Rhipicephalus appendiculatus* were significantly more attracted to the crude methanol extract of the flower compared to other plant extracts. Fractionation of the active flower extract using solvents of increasing polarity revealed that the hexane and ethyl acetate fractions were the most attractive to *A. variegatum* and *R. appendiculatus*, respectively. The hexane fraction also attracted *R. appendiculatus*. Chemical analysis of the active extract and fractions, combined with a literature search, identified squalene and linoleic acid as potential attractants. Adults of *A. variegatum* and *R. appendiculatus* were significantly attracted by the squalene: linoleic acid blend (1: 1). These findings suggest that the methanol flower extract of S. didymobotrya and the squalene: linoleic acid blend (1:1) have the potential to attract *A. variegatum* and *R. appendiculatus* ticks. Consequently, they can be integrated with other control methods in an "attract and infect/kill" strategy to effectively manage tick populations. Further research should investigate activity of these attractants in field settings.

Keywords: Tick-plant chemical ecology, Semiochemical attractant, Integrated tick management

ABS-673

Physicochemical and environmental assessment of Anopheles breeding sites found in a sugar irrigation scheme, Chikwawa, Malawi

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Irrigation schemes are beneficial in places of unreliable weather patterns as they provide water for farmers all year round. Irrigation schemes create favorable microhabitats for vectors to thrive thereby increasing disease risk in areas adjacent to them. A preliminary survey was conducted to assess the aquatic habitats in the vicinity of the sugarcane irrigation scheme. The survey included the characterization of physicochemical factors and environmental assessment of these habitats. Mosquito larvae were sampled from sites positive for vectors using a standard 350ml dipper. The sampling sites were thoroughly examined, and different types of standing water pools were identified and classified. Measurements were taken for water temperature, pH, conductivity, and dissolved solids, while also recording the surrounding environment of each aquatic habitat. A survey was conducted on a total of 30 aquatic habitats to investigate the presence of Anopheles larvae. Out of these, 40% (n=12) were positive for Anopheles larvae. The majority of malaria vectors were discovered in irrigation drains and small water pools located in sunlit areas created by water running off from irrigation canals. Although the highest densities of Anopheles larvae were found in the irrigation drains, there was no significant difference in their habitat preference ($p>0.05$). Anopheles larvae were observed in habitats with varying temperatures, electro conductivity, and dissolved solids. Several environmental strategies can be implemented based on the preliminary survey, including ensuring proper maintenance of canals to prevent break-offs and the formation of pools and modifying or eliminating breeding sites within the irrigation schemes. Additionally, the clearing of vegetation and debris from irrigation drains will be utilized to discourage the formation of stagnant water.

Keywords: Anopheles breeding site characterization environmental control

ABS-679

Study of factors influencing vector density in Burkina Faso

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Malaria remains a major public health problem worldwide, and efforts to combat the disease are hampered by the resistance of vectors to insecticides. Although new vector control methods are being sought, a universal ITN distribution campaign has been launched in Burkina Faso in 2022. This study was carried out to determine the factors influencing malaria vector density in contexts of presence or absence of mosquito nets in human dwellings. Entomological surveillance was carried out by agents of the Ministry of Health from

September to November 2022 in three regions, each belonging to one of Burkina Faso's three eco-climatic zones. Collection sites were chosen according to several criteria, including the presence of impregnated mosquito nets. Ten collection houses were selected in each site. Adult mosquitoes were collected by capturing residual fauna, morphologically identified, classified, and counted before being preserved in 80% alcohol. The effect of habitat factors on mosquito density was compared in several contexts. A total of 300 houses were visited and 570 LLINs counted. A total of 935 people slept under mosquito nets and 259 did not. Overall, the number of mosquitoes collected was 6075, including 4701 female anopheles. and 57 front-roofed houses. The density of female anopheles was higher in houses without mosquitoes compared with those with mosquito nets in the 3 regions selected for this study. the large number of houses without eaves would explain the high density of anopheles in the houses. This study showed that there were more mosquitoes in houses without mosquito nets and front-roofed houses. The results of this study provide information on the influence of impregnated mosquito nets on mosquito density.

Keywords: ITNs, Vector density, Malaria, Burkina Faso

ABS-680

Evaluation of the performance of non-specialised collectors in entomological sampling techniques.

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Entomological surveillance to collect data on vectors involved in infectious disease transmission is an important tool for decision-making in malaria control. In Africa, the lack of entomological surveillance and data processing capacity in national malaria control programs is one of the obstacles to malaria vector control. We propose here to evaluate a malaria vector surveillance system based on Ministry of Health agents, following basic training in mosquito collection in Burkina Faso. Mosquito collection and identification by gender were carried out by Ministry of Health agents from September to November 2022 in three regions of Burkina Faso, including a total of sixteen health districts, with one agent per district. In each district, two sites of ten houses each were chosen for a series of mosquito collections. Anopheles were grouped by sex and females classified according to the state of digestion of the blood meal. The vector surveillance system was evaluated on the basis of agents' performance in collecting, processing, identifying, preserving and packaging adult mosquito samples

for transfer to the laboratory for analysis. A total of 300 batches of 6,477 mosquito samples collected by 16 agents on three occasions were thoroughly inspected by expert entomologists. Of these batches, 267 (89%) were of very good or good quality, i.e. the samples were well labeled, well preserved and in good specimen condition, while 31 (10%) were of poor quality, indicating that the agent had encountered difficulties, and only 2 (1%) batches were of very poor quality, meaning that they had not assimilated any knowledge. The work carried out enabled Ministry of Health agents deployed at the peripheral level of health districts to familiarize themselves with entomological concepts and acquire practical skills in mosquito collection. Our study thus contributed to the implementation of a new malaria vector surveillance system in Burkina Faso.

Keywords: Entomological surveillance, vectors, malaria, Burkina FasoEntomological surveillance, vectors, malaria, Burkina Faso

ABS-684

Temperature modulation and its effect on adult male *Anopheles gambiae* mosquitoes.

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Gene drive technology has been recommended as a promising complementary tool for malaria elimination. This technology allows the spread of specific genetic traits through a population. The success of this technology depends on the ability of male gene-driven mosquitoes to find and mate with wild female mosquitoes. Hence, the technique requires the rearing of gene-driven male mosquitoes en masse and transporting them to sites of deployment with little to no mechanical damage. Transporting male insects in vector control programmes for Cerititis capitata from the insectary to deployment sites was successfully done by exposing the insects to chilling temperatures that rendered them immobile. Identifying the optimum cooling temperature for *Anopheles gambiae* male mosquitoes ensures that their quality is retained to transfer the desired genes into the wild population. This study seeks to identify the optimum chilling temperature at which Anopheles gambiae male mosquitoes can be transported to sites of release with the least damage and adverse effect. Groups of 100 adult male *Anopheles gambiae s.l*. Giles (Diptera: Culicidae) were each exposed to different temperatures (2°C, 4°C, 6°C, 8°C, 10°C) in climate chambers at varying durations (20min, 1h, 4h, 8h, 24h). The experiment was repeated 3 times for each temperature and duration. The percentage of mosquitoes that were immobilised at each particular duration, recovery period, immediate mortality, and survival over 14 days were measured. All data were analysed with JMP statistical software. All mosquitoes were knocked down from 2°C to 10°C. Recovery rate increased with increasing temperature however survival rate decreased with decreasing temperatures at increasing time durations. The recommended temperature for transporting *Anopheles gambiae* mosquitoes for release with minimal damage and without affecting survival or longevity is 4°C to 10°C for a maximum of 24 hours.

Keywords: Temperature, Humidity, Gene Drive, *Anopheles gambiae* mosquito

ABS-685

Importance of accurate Anopheles species identification during malaria vector surveillance: quality assurance and ISO/IEC 17025:2017 accreditation maintenance

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The accurate identification of Anopheles vector species is essential for malaria vector control programs as it enables the assignment of key surveillance indicators (insecticide resistance, biting, breeding, feeding and resting behaviours) to correct malaria vector populations. This information is used for fine-scale tailoring of vector control interventions. Quality Assurance is key in producing consistent validated results. The Vector Control Reference Laboratory (VCRL) of the National Institute for Communicable Diseases is an ISO/IEC17025:2017 accredited for the following tests: *Anopheles gambiae* complex and *An. funestus* group species identification and Plasmodium falciparum infection. Here we present the development and maintenance of a first QA system for identification of African malaria vector. Quality Management systems (QMS) on accredited tests require the periodic assessment of personnel's competencies, calibration and maintenance of laboratory equipment, proficiency testing programmes, verification and reviewing of results. These quality assurance systems improve the quality of results and turn-around time for all accredited tests, and generation of reports for the malaria control programmatic decision making. The VCRL's accreditation systems passed annual internal audits as well as external audits performed by the South African National Accreditation System (SANAS). This resulted in accurate timeous results for decision making by the malaria control programs. By employing the above mentioned methods, the VCRL has maintained its ISO/IEC17025:2017 accreditation status for the past two years with the laboratory deemed complaint during the same period. Through this system, the VCRL provides a quality assured identification of Anopheles vector species of the sub-Saharan African region, an essential service to South Africa's malaria control programs and other stakeholders.

Keywords: Molecular diagnosis

ABS-688

Species composition and breeding habitat preferences of Aedes mosquitoes in peri-urban and urban areas in Ibadan, southwest Nigeria

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There is an insufficient knowledge of the aedes mosquito's habitat preference and abundance in Nigeria. The study aims to determine the larval productivity, breeding habitat preferences and species composition of aedes mosquitoes, and to estimate the risk of arbovirus transmission in Ibadan, Southwest Nigeria. A cross-sectional entomological survey was carried out between July 2017 and April 2020 in randomly selected houses in eight communities in Ibadan. Natural and artificial water holding containers were inspected for the presence of immature aedes mosquitoes using the WHO standardized sampling procedures. Larvae and pupae were collected and reared to adult stage in the laboratory for species morphological identification. Overall, 36213 potential containers from 5223 houses in 8 communities were inspected. Of these, 26672 (73.7%) were found to be positive for the aquatic stages of the mosquito. A total of 18071 water containers were inspected in four localities in peri-urban area. Of these, 79% (14279) were found to be positive for either larvae or pupae, while in urban settlements, only 67.3% (12583) of inspected containers were found positive. A total of 78067 larvae and 34651 pupae, and 104989 larvae and 43001 pupae were sampled from 15 and 14 containers in urban and peri-urban areas, respectively. Used tires, plastics, vehicles parts, concrete tanks, ditches, metal pots and ceramics were the key containers producing over 75% of aedes mosquito immatures, in both areas. All the stegomyia indices recorded in both urban and peri-urban areas were above the WHO threshold values. Seven aedes species were collected during the survey. Across all the communities and in most containers, aedes aegypti and aedes albopictus were the most abundant species. Conclusion: high infestation levels observed indicate significant risk of aedes-borne diseases, requiring immediate action to prevent potential outbreak in Ibadan.

Keywords: Breeding containers, *Aedes aegypti*, *Ae.albopictus*, urban and peri-urban areas

ABS-459

Comparing the durability of synergist long-lasting insecticidal nets (LLINs) PermaNet®3.0 and conventional LLINs Yorkool© in southeast Benin Republic after national mass campaign in 2020

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Long-lasting insecticidal nets (LLINs) based on pyrethroid-piperonyl butoxide (PBO) have been important in significantly reducing malaria cases in Africa. However, the longevity of PBO nets in Benin is not well known. To provide the National Malaria Control Program with evidence of physical and insecticidal durability, two of the LLIN brands deployed in similar districts, Massè (PermaNet®3.0), Adja-Ouèrè (Yorkool®) and Adingnigon (PermaNet®3.0) in the southeast during the 2020 mass campaign were evaluated. This is a prospective cohort study enrolling a representative sample of households six months after distribution. Over a 21-month period, all nets from the campaign in these households were marked and monitored. The primary outcomes were the "proportion of nets in good condition" based on measures of integrity and attrition in years. Insecticide results were determined by bioassay using the WHO cone test. A total of 1559 campaign nets (109% of target) from 546 households were included in the study. Final results could be determined for 70% of the nets in the cohort in Massè, 54% in Adja-Ouèrè and 74% in Adingnigon. After 21 months, all-cause attrition was 31% in Massè, 13% in Adja-Ouèrè and 37% in Adingnigon (p=0.199) and attrition due to wear and tear was 2% in Massè, 5% in Adja-Ouèrè and Adingnigon (p≥0.05). Survival in use at the last survey was 39% in Massè, 53% in Adja-Ouèrè and 45% in Adingnigon (p≥0.05). The multivariate Cox proportional hazards models suggest that the difference between sites was not primarily attributable to LLIN brand. Insecticidal efficacy was optimal for 100% of PermaNet®3.0 tested compared to 67% for Yorkool© after 21 months. In the southeast Benin environment, the PermaNet®3.0 polyester LLIN performed significantly better than the Yorkool LLIN, but both were below a three-year survival rate. Improved net usage behavior should lead to increased physical durability.

Keyword: LLIN, pyrethroid-piperonyl butoxide, durability, Benin

ABS-668

Clothianidin susceptibility and transcriptional profile of metabolic resistant gene in *An. coluzzii* collected from Sèdjè Rice field in southern Benin

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The insensivity to greater concentration of the mains classes of insecticides used to prevent mosquitos bites has conducted to the introduction of neonicotinoids, previously used in agriculture only, in public health. The study aimed to determine the susceptibility level to clothianidin of mosquito collected from rice farm and their transcriptional profile of metabolic resistant gene in Benin. Methods: *An. gambiae sl.* larvae collected from Sèdjè rice field in southern Benin were exposed to 4ug/mL of clothianidin (dissolved in acetone alone, and in acetone+MERO). Serial dilutions (1/2, 1/4, 1/8) were made from the diagnostic dose (4ug/mL) and were also tested following the CDC guidelines (Brogdon and McAllister, 1998; Horstmann, 2016). Samples were identified to species level using PCR as described by Santolamazza et al. (2008). The expression level of thirteen resistant candidates' genes previously reported to be associated with pyrethroid resistance in *An. gambiae sl.* were assessed by a qRT-PCR as described by Tepa et al. (2022). Results: *An. coluzzii* was the only species found in Sèdjè rice field. Full susceptibility was observed for all An. coluzzii populations with a mortality rate of 100% when exposed to clothianidin dissolved in acetone + MERO at a concentration of 4 µg/ml as recommended by WHO with a gradual decrease in mortality proportionally to the different dilutions made. Significant over-expression of three sensory appendage protein encoding genes with the following fold change (FC): sap1 (FC=9.45, P<0,0001); sap2 (5.61, P=0.025), sap3 (4.58, P=0.0001) and two cytochrome P450 CYP6M2 (6.89, P<0,0001) and CYP4G16 (2.59 P<0,0001) in clothianidin resistant mosquitoes compared to unexposed mosquitoes. Conclusion: This study revealed not only the evidence of *An. coluzzii* resistance to clothianidin in agricultural areas but also the restoring effect of MERO association. Metabolic resistance is involved in this neonicotinoids resistance observed.

Keywords: *Anopheles gambiae*, neonicotinoids, resistance, metabolic mechanism, P450 genes

ABS-253

Assessing the susceptibility and efficacy of three public health, insecticides, chlorfenapyr, clothianidin and pyriproxyfen, on wild pyrethroid-resistant populations of *Anopheles gambiae s.l.* from southern Benin

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The impact of vector control tools is potentially limited by the emergence and spread of mosquito resistance to insecticides. The objective of this study was to determine the susceptibility of wild *Anopheles gambiae s.l.* from southern Benin to new insecticides such as chlorfenapyr (CFP), pyriproxyfen (PPF) and clothianidin (CTD) currently approved for insecticide resistance mitigation. Wild populations of *Anopheles gambiae s.l.* from larval collections in the Beninese communes of Allada, Ifangni, Akpro-Missérété, and Porto-Novo from April to May 2022 were tested for susceptibility to CFP and PPF using WHO bottle tests, and to pyrethroids (alpha-cypermethrin, deltamethrin, and permethrin) and CTD using WHO tube tests. WHO cone tests were used to evaluate the efficacy of Interceptor®, Interceptor® G2 and Royal Guard® nets. Ovaries of *Anopheles gambiae s.l*. from Ifangni exposed to Royal Guard® were dissected and egg development status was examined using Christopher stages. Oviposition inhibition rates were calculated from blood-fed *Anopheles gambiae s.l.* placed in oviposition chambers after PPF exposure. In all four mosquito populations, pyrethroid mortality ranged from 5% to 80%, while chlorfenapyr and clothianidin mortality ranged from 98% to 100%. In Ifangni, all mosquitoes exposed to Royal Guard® nets were sterile (100%), while the majority (74.9%) of mosquitoes exposed to Interceptor® nets had developed their eggs to the Christopher V stage. The rate of oviposition inhibition after exposure of mosquitoes to PPF was 99% for the wild population of *Anopheles gambiae s.l.* and for the susceptible laboratory strain, *Anopheles gambiae* Kisumu. The results of this study suggest that pyrethroid-resistant *Anopheles gambiae s.l.* from communes in southern Benin are susceptible to chlorfenapyr, clothianidin and pyriproxyfen.

Keywords: Insecticide resistance, Chlorfenapyr, Pyriproxyfen, Clothianidin, *Anopheles gambiae s.l,* Benin

ABS-428

Progress made by the South African sterile insect technique project in developing genetic sexing systems for the malaria vector *Anopheles arabiensis*

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South Africa has begun initiatives to eliminate malaria transmission within its borders. This requires additional vector control interventions to supplement existing strategies. The release of irradiated sterile males (so-called “sterile insect technique (SIT)”) to

control the major malaria vector *Anopheles arabiensis* was proposed and field trials have started. Only males are released because unlike females they are not capable of biting, blood-feeding, and transmitting Plasmodium pathogens. The current methods for separating *An. arabiensis* sexes are inefficient and should be improved. This gap can be bridged by developing sexing strains using classical genetics and transgenic approaches. Classical genetics is used to develop genetic sexing strains (GSSs) that require two main components: (1) Identification of a selectable marker (e.g., insecticide resistance, morphological body/colour variations, temperature-sensitive lethal (tsl) mutations, etc.) and (2) linking the wild-type allele of the selectable marker to the male sex. This will allow separation between sexes based on their phenotypic differences. Transgenic approaches include the integration of foreign genes (e.g., fluorescent markers) into a sex chromosome. Mutagenic agents (ethyl methanesulfonate and gamma irradiation) are being used to induce various selectable markers. Transgenic fluorescent strains are being developed through a series of cross-matings. So far, a tsl mutant strain has been isolated. Two fluorescent strains have been developed, one has the fluorescence linked to the X-chromosome while the other is linked to the Y-chromosome. For the tsl mutant strain to be useful, a visible selectable marker linked to both the sex-determining locus and the tsl mutation is required and currently under development. Combining the two developed fluorescent sexing strains enables the sorting and release of non-transgenic males.

Keywords: Malaria control; sterile insect technique; genetic sexing strains; *Anopheles arabiensis*

ABS-433

An assessment of the efficacy of different mosquito larvicieds used in America vs used in Africa

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Even though mosquito control is advanced in malawi, with the use of nets, and indoor residual spray as the gold standard tools for vector control, malaria and other mosquito-borne diseases transmission curves still stagnate. Among the concerns related to larviciding is the feasibility of implementation in tropical areas with large numbers of habitats and the need for frequent application. Formulated products of Spinosad (used in america) and bacterial-derived larvicides bacillus thuringiensis israelensis (used in africa) designed to be effective for several weeks may mitigate some of these concerns. However, literature shows that there could be differences between larvicides used in Africa and those used in america hence the need to conduct an experiment to compare them. Larvae were collected using shallow skim and simple scoop methods. In a laboratory study, three natular formulations with Spinosad as the active ingredient, (dt, t30 and xrt) and bti were tested in comparison to untreated control. Larvae were introduced into treatment larval trays in two reps each consisting of two weeks and monitored. Both natular formulations dt and bti had a mortality of 100% in the first week of both reps while natular formulations xrt and t30 had low mortality rates in both reps. Upon comparison of all treatments it was seen that their differences were

statistically significant and control had the highest probability of survival at any point in time. Bti and the natular formulations are effective against larval culex mosquitoes for up to four weeks and may be an effective tool as part of larval source management programs for reducing adult mosquito density and malaria transmission. However, as the difference between all treatments was statistically significant, it shows that African products and American products are truly different but they should all be used concurrently to ensure maximum control of mosquitoes in malawi.

Keywords: Retention rate, mortality rate, efficacy, natular formulations, BTi

ABS-196

Malaria transmission pattern across the Sahelian, humid savanna, highland and forest eco-epidemiological settings in Cameroon

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Malaria remains a major public health concern in Cameroon. Understanding vector distribution and malaria transmission dynamics is of paramount importance for evaluating the performance of control strategies. This study assesses patterns of malaria transmission in four eco-epidemiological settings in Cameroon. Adult mosquitoes were collected using Human Landing Catches (HLC) once every 4 months from August 2019 to November 2021 in Kaélé, Tibati, Santchou and Bertoua. Mosquitoes were sorted by genus and *Anopheles gambiae sensu lato (s.l.)* species complex were identified using PCR. The presence of Plasmodium falciparum circumsporozoite protein (CSP) was measured by ELISA; the entomological inoculation rates (EIR) was estimated in each locality. A total of 23,536 mosquitoes were collected. *Anopheles gambiae* and/or *Anopheles coluzzii* were the main malaria vectors in all sites. *Anopheles arabiensis* was recorded in low frequency in Kaélé and Tibati. Other species collected included *Anopheles funestus*, *Anopheles pharoensis* and *Anopheles ziemmani*. High anopheline biting rates were recorded outdoor in all sites except in Kaélé. Important differences in species biting dynamics were observed between sites. The sporozoite infection rate varied from 0.36 to 4%. The daily EIR was found to vary from 0.07 in Santchou to 0.26 infected bites/man/night (ib/m/n) in Kaélé). The study suggests heterogeneous patterns of malaria transmission in different ecoepidemiological settings across the country. The findings stress the need to improve malaria vector control strategies.

Keyword: Malaria, Transmission, Anopheles, eco-epidemiological settings, Cameroon

ABS-475

Rapid expansion of insecticide resistance and patterns of pesticides usage in agriculture in the city of Yaoundé, Cameroon

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Agricultural pesticides have been found to play a significant role in the selection of insecticide resistance in urban malaria vectors. However, most urban settings continue to lack adequate information on pesticide use. The present study aims to assess the evolution of *An. gambiae s.l.* population susceptibility to insecticides and patterns of pesticide usage in agriculture in the city of Yaoundé. WHO bioassays and synergist PBO tests were conducted on F0 field *An. gambiae s.l.* mosquitoes aged 3 to 5 days emerging from larvae collected from 34 study sites. Insecticides belonging to the 4 classes of insecticides recommended by WHO were evaluated. The presence of target site mutation conferring knock down (kdr) resistance was investigated using TaqMan assay and mosquito species were identified using SINE-PCR. Surveys on 81 retailers and 232 farmers were conducted to assess knowledge and practices regarding agricultural pesticides usage. High frequency of the kdr allele 1014F and low frequency of the kdr 1014S allele were observed with elevated resistance intensity to pyrethroids. The susceptibility level of *An. gambiae s.l*. to pyrethroids and carbamates was found to decrease with time (from >34% in 2017 to < 23% in 2019 for deltamethrin and permethrin and from 97% in 2017 to < 86% in 2019 for bendiocarb). Both *An. gambiae s.s.* and *An. coluzzii* were recorded. Over 150 pesticides and fertilizers were sold by retailers for agricultural purposes in the city of Yaoundé. The majority of farmers do not respect safety practices. Poor practices including extensive and inappropriate application of pesticides, poor management of perished pesticides and empty pesticide containers were also documented. The study indicated rapid evolution of insecticide resistance and uncontrolled usage of pesticides by farmers in agriculture. There is an urgent need to address these gaps in order to improve the management of insecticide resistance.

Keywords: Vector control, *Anopheles gambiae*, insecticide resistance, pesticide management, Yaoundé, Cameroon