

Contents

Selected Recent Publications	4
Cytochrome P450-based metabolic insecticide resistance in Anopheles and Aedes mosquito vectors: Muddying the waters	4
Decreased bioefficacy of long-lasting insecticidal nets and the resurgence of malaria in Papua New Guinea.....	4
Efficacy of Royal Guard, a new alpha-cypermethrin and pyriproxyfen treated mosquito net, against pyrethroid-resistant malaria vectors.....	5
After those nets are torn, most people use them for other purposes”: an examination of alternative bed net use in western Kenya.....	5
Semi-field evaluation of freestanding transfluthrin passive emanators and the BG sentinel trap as a “push-pull control strategy” against Aedes aegypti mosquitoes	5
Evaluating Over-the-Counter Household Insecticide Aerosols for Rapid Vector Control of Pyrethroid-Resistant Aedes aegypti.....	5
Male swarming aggregation pheromones increase female attraction and mating success among multiple African malaria vector mosquito species	6
Emergence and clonal expansion of in vitro artemisinin-resistant Plasmodium falciparum kelch13 R561H mutant parasites in Rwanda	6
The potential public health consequences of COVID-19 on malaria in Africa.....	7
Vector genetics, insecticide resistance and gene drives: An agent-based modeling approach to evaluate malaria transmission and elimination.....	7
A multiphase program for malaria elimination in southern Mozambique (the Magude project): A before-after study.....	7
Combining next-generation indoor residual spraying and drug-based malaria control strategies: observational evidence of a combined effect in Mali	7
New Mosquitocide Derived from Volcanic Rock	8
Risk factors for malaria infection prevalence and household vector density between mass distribution campaigns of long-lasting insecticidal nets in North-western Tanzania.....	8
A greener vision for vector control: The example of the Singapore dengue control programme.....	8
Status and outlook for acaricide and insecticide discovery.....	9
Climate change could shift disease burden from malaria to arboviruses in Africa	9
Efficacy of Fludora® Fusion (a mixture of deltamethrin and clothianidin) for indoor residual spraying against pyrethroid-resistant malaria vectors: laboratory and experimental hut evaluation.....	10
Efficacy of factory-treated and dip-it-yourself long lasting insecticide-treated bednets against cutaneous leishmaniasis vectors in the sub-Andean region of Colombia: results after two years of use	10
Comparative functional survival and equivalent annual cost of 3 long-lasting insecticidal net (LLIN) products in Tanzania: A randomised trial with 3-year follow up	11
Evaluating effectiveness of screening house eaves as a potential intervention for reducing indoor vector densities and malaria prevalence in Nyabondo, western Kenya	11
Rapid reduction of malaria transmission following the introduction of indoor residual spraying in previously unsprayed districts: an observational analysis of Mopti Region, Mali, in 2017	12
Community-level impacts of spatial repellents for control of diseases vectored by Aedes aegypti mosquitoes	12
New insecticide screening platforms indicate that Mitochondrial Complex I inhibitors are susceptible to cross-resistance by mosquito P450s that metabolise pyrethroids	13
A new malaria vector in Africa: Predicting the expansion range of Anopheles stephensi and identifying the urban populations at risk.....	13
A cohort study to identify risk factors for Plasmodium falciparum infection in Burkinabe children: implications for other high burden high impact countries.....	14

Anopheles gambiae (s.l.) is found where few are looking: assessing mosquito diversity and density outside inhabited areas using diverse sampling methods 14

WHO News and Publications 15

Africa eradicates wild poliovirus 15

Malaria and COVID-19: country perspectives 15

Twelfth meeting of the WHO Vector Control Advisory Group 15

Webinars, websites and other resources 15

Recent Webinars 15

ASEAN Panel: dengue in the age of pandemics, a new era 15

Syngenta teams up with Goodbye Malaria to rethink IRS in times of COVID-19 17

Webinar: Emerging Issues and New Tools to Fight Mosquito-Borne Diseases in Africa 17

New Online Course Launched on the Control of Vector Borne Diseases 18

In the news and social media 18

A drug-resistant strain of the parasite that causes malaria has been identified by scientists in Rwanda 18

World Mosquito Program’s Wolbachia method dramatically reduces dengue incidence in randomised controlled trial in Yogyakarta, Indonesia 19

Singapore battles record dengue outbreak with more mosquitoes 19

New Asian mosquito could bring malaria to African cities, warn scientists 19

Volcanic Rock Yields a New Kind of Insecticide for Mosquitoes 19

GOODBYE MALARIA MASKS INITIATIVE - FOR COMMUNITIES BY COMMUNITIES 20

The UCSF's DISARM project commemorates four years of impact 20

In memory of
Daniel Strickman

"How lucky am I to have something that makes saying goodbye so hard."

Winnie the Pooh

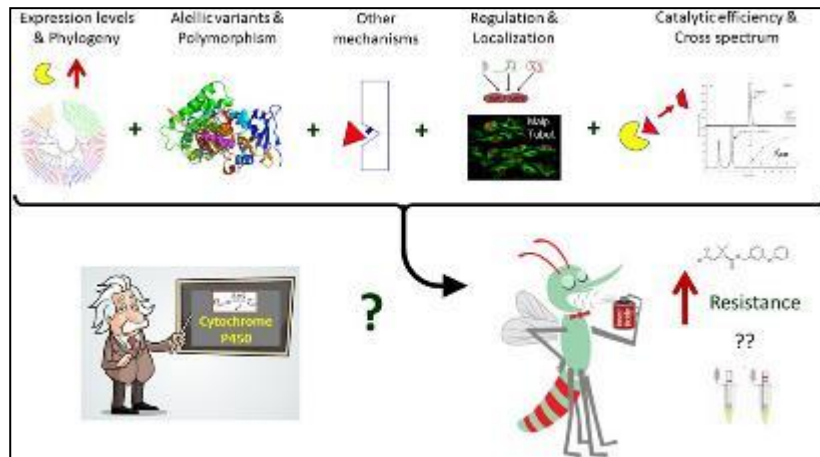


Selected Recent Publications

[Cytochrome P450-based metabolic insecticide resistance in *Anopheles* and *Aedes* mosquito vectors: Muddying the waters](#)

Pesticide Biochemistry and Physiology 26 July 2020

Despite the substantial progress achieved in the characterization of cytochrome P450 (CYP) -based resistance mechanisms in mosquitoes, a number of questions remain unanswered. The goal of this review is to critically summarise the current knowledge and the gaps of the CYP-based metabolic insecticide resistance in *Anopheles* and *Aedes* mosquito vectors. The progress and limitations of the protein and the reverse/forward genetic approaches, the understanding and importance of molecular and physiological aspects, as well as the current and future exploitation routes of CYP research are discussed.



[Decreased bioefficacy of long-lasting insecticidal nets and the resurgence of malaria in Papua New Guinea](#)

Nature Communications 20 July 2020

Papua New Guinea (PNG) has the highest malaria transmission outside of Africa. Long-lasting insecticidal nets (LLINs) are believed to have helped to reduce average malaria prevalence in PNG from 16% in 2008 to 1% in 2014. Since 2015 malaria in PNG has resurged significantly. Here, we present observations documenting decreased bioefficacy of unused LLINs with manufacturing dates between 2013 and 2019 collected from villages and LLIN distributors in PNG. Specifically, we show that of 167 tested LLINs manufactured after 2013, only 17% are fulfilling the required World Health Organisation bioefficacy standards of $\geq 80\%$ 24 h mortality or $\geq 95\%$ 60 min knockdown in bioassays with pyrethroid susceptible *Anopheles farauti* mosquitoes. In contrast, all (100%, n = 25) LLINs with manufacturing dates prior to 2013 are meeting these bioefficacy standards. These results suggest that decreased bioefficacy of LLINs is contributing to the malaria resurgence in PNG and increased scrutiny of LLIN quality is warranted.

[Identifying the fitness costs of a pyrethroid-resistant genotype in the major arboviral vector *Aedes aegypti*](#)

Parasit Vectors 20 July 2020

Little is known about the fitness costs associated with specific insecticide-resistant genotypes and their implications for the management of resistance. The authors evaluated the fitness cost of two co-occurring, homozygous mutations (V1016G and S989P) by back-crossing a resistant strain of *A. aegypti* from Timor-Leste into a fully susceptible strain from Queensland. These results suggest specific and significant fitness costs associated with the double homozygous V1016G/S989P genotype in the absence of insecticides. The susceptibility of a population may recover if the fitness costs of resistant genotypes can be emphasised through the use of insecticide rotations and mosaics or the presence of untreated spatial or temporal refuges.

[Efficacy of Royal Guard, a new alpha-cypermethrin and pyriproxyfen treated mosquito net, against pyrethroid-resistant malaria vectors.](#)

Sci Rep. 22 July 2020

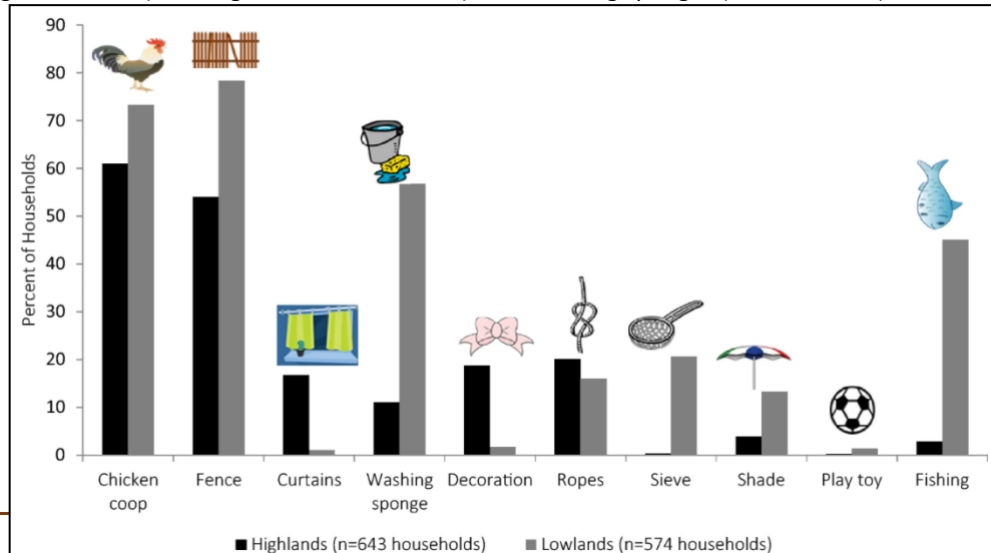
Royal Guard is a new insecticide-treated bed-net incorporated with a mixture of alpha-cypermethrin and pyriproxyfen (an insect growth regulator). This paper reports the results of efficacy and wash-resistance tests in laboratory and experimental hut studies following WHO guidelines. Royal Guard has the potential to improve malaria vector control and provide better community protection against clinical malaria in pyrethroid-resistant areas compared to standard pyrethroid-only LLINs.

[After those nets are torn, most people use them for other purposes”: an examination of alternative bed net use in western Kenya](#)

Malaria Journal Published 29 July 2020

In this cross-sectional survey of 1217 households in an epidemic highland site and an endemic lowland site in western Kenya, the authors collected information on alternative use of LLINs. Households describe repurposing nets when they are torn and/or old. Repurposed nets were observed in 8.1% (52/643) highlands households and 33.0% (184/574) lowlands households. Repurposed nets served as chicken coops (33% highlands, 20% lowlands), fences (37% highlands, 25% lowlands), tree covers (22% lowlands), curtains (3% highlands), covering bathrooms (1.5% highlands, 9% lowlands), and washing sponges (13% lowlands). No

association was found between repurposing and universal access or household net use. Misuse was rare. Of 379 repurposed nets, 4 (1.06%) were in good condition with no holes. Of 1,758 active nets, 13 (0.74%) were misused.



[Semi-field](#)

[evaluation of freestanding transfluthrin passive emanators and the BG sentinel trap as a “push-pull control strategy” against Aedes aegypti mosquitoes](#)

Parasites & Vectors 31 July 2020

In this study, semi-field experiments were conducted to evaluate whether a push-pull system could be used to reduce bites from *Aedes* mosquitoes. The push and pull under investigation consisted of two freestanding transfluthrin passive emanators (FTPE) and a BG sentinel trap (BGS) respectively. The FTPE contained hessian strips treated with 5.25 g of transfluthrin active ingredient. Two FTPE had a protective efficacy (PE) of 61.2% against the human landing of *Ae. aegypti*. The BGS did not significantly reduce mosquito landings. The three-month protection against *Ae. aegypti* bites suggests that FTPE would be a useful additional control tool during dengue outbreaks, that does not require regular user compliance.

[Evaluating Over-the-Counter Household Insecticide Aerosols for Rapid Vector Control of Pyrethroid-Resistant Aedes aegypti](#)

Am J Trop Med Hyg. 3 August 2020

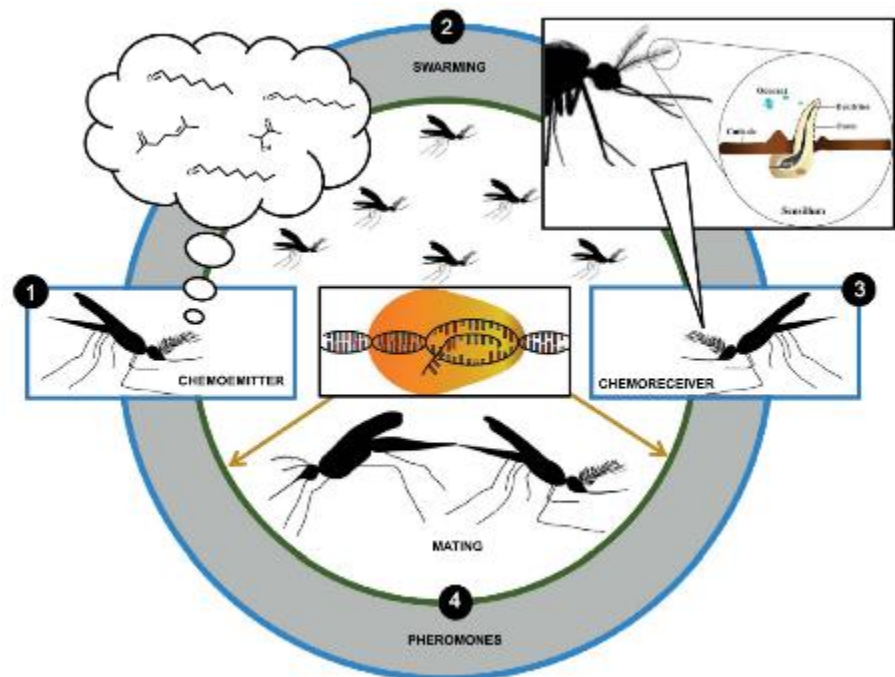
Given the lengthy development timelines required to develop new vector control tools, there is great interest and need to improve delivery of existing tools. Here the authors explore one such idea as they test the potential for currently available and popular household insecticide products to help prevent dengue transmission. They investigated whether one person using a handheld aerosolized insecticide could achieve efficacy levels comparable to targeted indoor residual spraying (TIRS), using pyrethroid-resistant *Aedes aegypti*

in a semi-field setting with experimental houses in Mexico. The insecticide product (H24, a carbamate and pyrethroid mixture), available over-the-counter locally, was sprayed only on known *Ae. aegypti*-resting surfaces, for example, walls less than 1.5 m and dark hidden areas. Results demonstrate that the immediate impact of TIRS can be delivered by one person using existing products, at an estimated cost for the average household in Mexico of under US\$3 per month.

[Male swarming aggregation pheromones increase female attraction and mating success among multiple African malaria vector mosquito species](#)

Nature Ecology & Evolution Published 3 August 2020

Accumulating behavioural data indicate that aggregation pheromones may mediate the formation and maintenance of mosquito swarms. However, chemical cues possibly luring mosquitoes to swarms have not been adequately investigated, and the likely molecular incitants of these complex reproductive behaviours remain unknown. Here we show that males of the important malaria vector species *Anopheles arabiensis* and *An. gambiae* produce and release aggregation pheromones that attract individuals to the swarm and enhance mating success. Our results not only narrow a conspicuous gap in understanding a vital aspect of the chemical ecology of male mosquitoes but also demonstrate fundamental roles of rhythmic and metabolic genes in the physiology and behavioural regulation of these vectors. These identified aggregation pheromones have great potential for exploitation against these highly dangerous insects. Manipulating such pheromones could increase the efficacy of malaria-vector control programmes.



[Emergence and clonal expansion of in vitro artemisinin-resistant Plasmodium falciparum kelch13 R561H mutant parasites in Rwanda](#)

Nature Medicine 3 August 2020

Artemisinin resistance (delayed *P. falciparum* clearance following artemisinin-based combination therapy), is widespread across Southeast Asia but to date has not been reported in Africa. Here we genotyped the *P. falciparum* K13 (*Pfkelch13*) propeller domain, mutations in which can mediate artemisinin resistance, in pretreatment samples collected from recent dihydroartemisinin-piperaquine and artemether-lumefantrine efficacy trials in Rwanda. While cure rates were >95% in both treatment arms, the *Pfkelch13* R561H mutation was identified in 19 of 257 (7.4%) patients at Masaka. Phylogenetic analysis revealed the expansion of an indigenous R561H lineage. Gene editing confirmed that this mutation can drive artemisinin resistance in vitro. **This study provides evidence for the de novo emergence of *Pfkelch13*-mediated artemisinin resistance in Rwanda, potentially compromising the continued success of antimalarial chemotherapy in Africa.**

[*The potential public health consequences of COVID-19 on malaria in Africa*](#)

Nature Medicine 7 August 2020

This paper presents modeling work focused on quantifying the potential impact of the spread of COVID-19 on Plasmodium falciparum malaria morbidity and mortality in Nigeria and across sub-Saharan Africa using mathematical models of COVID-19 and malaria.

Note: As this paper was published in August and the pandemic and malaria prevention activities have progressed for three months since publication, many of the conditions and assumptions from that period have already changed.

[*Vector genetics, insecticide resistance and gene drives: An agent-based modeling approach to evaluate malaria transmission and elimination*](#)

PLoS Comput Biol. 14 August 2020

Abstract

Understanding the evolution and propagation of insecticide resistance is imperative to mitigating loss of intervention effectiveness. Additionally, accelerated research and development of new tools that can be deployed alongside existing vector control strategies is key to eradicating malaria in the near future. Methods such as gene drives that aim to genetically modify large mosquito populations in the wild to either render them refractory to malaria or impair their reproduction may prove invaluable tools. Mathematical models of gene flow in populations, which is the transfer of genetic information from one population to another through migration, can offer invaluable insight into the behavior and potential impact of gene drives as well as the spread of insecticide resistance in the wild. Here, the authors present **the first 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 gene flow, and the propagation of gene drives in Anopheline populations**. This model is embedded within a large scale individual-based model of malaria transmission representative of a high burden, high transmission setting characteristic of the Sahel. Results are presented for the selection of insecticide-resistant vectors and the spread of resistance through repeated deployment of insecticide treated nets (ITNs), in addition to scenarios where gene drives act in concert with existing vector control tools such as ITNs. The roles of seasonality, spatial distribution of vector habitat and feed sites, and existing vector control in propagating alleles that confer phenotypic traits via gene drives that result in reduced transmission are explored. **The ability to model a spectrum of vector species with different genotypes and phenotypes in the context of malaria transmission allows us to test deployment strategies for existing interventions that reduce the deleterious effects of resistance and allows exploration of the impact of new tools being proposed or developed.**

[*A multiphase program for malaria elimination in southern Mozambique \(the Magude project\): A before-after study*](#)

PLoS Medicine 14 August 2020

This paper reports the results of the Magude project (a multiphased malaria elimination project) to interrupt Plasmodium falciparum malaria transmission in a rural district of southern Mozambique. In summary, an estimated 76.7% of expected cases were averted throughout the project (38,369 cases averted of 50,005 expected). The authors conclude:

- Results from this project indicate that the implementation of a package of interventions in sub-Saharan Africa cannot interrupt malaria transmission, and therefore malaria elimination in these areas remains a long-term goal for which new tools and strategies may be required.
- In spite of this, the Magude project revealed that an intensive implementation of currently available tools recommended by WHO can achieve major reductions in malaria transmission and burden of disease.

[*Combining next-generation indoor residual spraying and drug-based malaria control strategies: observational evidence of a combined effect in Mali*](#)

Malaria Journal 15 August 2020

In this study a non-randomized, quasi-experimental time series approach was used to analyse monthly trends in malaria case incidence at the district level. Evaluating the impact of IRS with an organophosphate and seasonal malaria chemoprevention (SMC) on reducing incidence rates of passive RDT-confirmed malaria cases

suggests that combining the interventions had a greater effect than either intervention used individually in this high-burden region of central Mali with pyrethroid-resistant vectors and high rates of household access to LLINs.

[New Mosquitocide Derived from Volcanic Rock](#)

J Med Entomology 18 August 2020

Abstract

...Insecticides are critical for mosquito control and disease prevention, and insect insecticide resistance is on the increase; new alternatives with potentially different modes of action from current chemistry are needed. During laboratory screening of industrial minerals for insecticide activity against *Anopheles gambiae* we discovered a novel mechanical insecticide derived from volcanic rock (MI_{VR}) with potential use as a residual spray. In modified WHO cone tests, the time to 50% mortality was 5 h under high-humidity conditions. MI_{VR} treated surfaces demonstrated no mosquito repellency. In field studies where the mechanical insecticide was applied to wood using standard spray equipment and then placed under stilt homes in New Orleans, LA, the residual activity was >80% after 9 wk against *Aedes aegypti*, *Aedes albopictus* and *Culex quinquefasciatus* (with similar efficacy to a positive chemical insecticide control). In scanning electron microscopy studies, the MI_{VR} was transferred as particles mostly to the legs of the mosquito. This wettable powder made from volcanic rock is a mechanical insecticide representing a potential new mode of action different from current chemistry for mosquito control and is in commercial development under the trade name Imergard™WP as an indoor and outdoor residual spray.

[Risk factors for malaria infection prevalence and household vector density between mass distribution campaigns of long-lasting insecticidal nets in North-western Tanzania](#)

Malaria Journal 20 August 2020

This study explored LLIN coverage indicators three years after the universal coverage campaign of 2011 and whether standard pyrethroid-only LLINs still provide protection against malaria vectors and infection prevalence in an area of intense pyrethroid resistance in Northwest Tanzania. It also explored other household and individual risk factors for malaria infection and vector density. Three years after the mass distribution campaign and despite top-ups, LLIN usage had declined considerably. About 53% of the nets which were still in use had holes and around 35% of the nets were badly torn. While children living in households with access to LLINs were at lower risk of malaria, infection prevalence remained high even among users of LLINs in good condition. While effort should be made to maintain high coverage between campaigns, distribution of standard pyrethroid-only LLINs appears insufficient to prevent malaria transmission in this area of intense pyrethroid resistance.

[A greener vision for vector control: The example of the Singapore dengue control programme](#)

PLOS NTD 27 August 2020

Author summary

Infections due to dengue and other viruses transmitted by *Aedes* mosquitoes are on the rise worldwide as a result of urbanisation, trade, population movement, and climate change. Contemporary vector control programmes have struggled to control *Aedes*-borne diseases, but the Singapore dengue control programme provides a success story. Key to the success is consideration of dengue as an environmental disease, with a corresponding focus on removal of water containers from in and around homes, solid waste management, and limited use of insecticides. The programme relies on close collaboration with other government and nongovernment actors including communities. Community engagement campaigns to ensure high awareness are supported by house-to-house inspections for mosquito habitats and a legislative framework including penalties for noncompliance. The Singapore dengue control programme provides important lessons that can be applied to other *Aedes* control programmes and vector control programmes more widely.

[Emergence of behavioural avoidance strategies of malaria vectors in areas of high LLIN coverage in Tanzania](#)

Nature Research Science Reports 3 Sept 2020

Whilst insecticide resistance has been widely investigated, there is poorer understanding of the emergence, dynamics and impact of mosquito behavioural adaptations. We conducted a longitudinal investigation of

malaria vector host choice over 3 years and resting behaviour over 4 years following a mass long-lasting insecticidal nets (LLINs) distribution in Tanzania. By pairing observations of mosquito ecology with environmental monitoring, we quantified longitudinal shifts in host-choice and resting behaviour that are consistent with adaptation to evade LLINs. The density of *An. funestus s.l.*, declined significantly through time. In tandem, *An. arabiensis* and *An. funestus s.l.* exhibited an increased rate of outdoor relative to indoor resting; with *An. arabiensis* reducing the proportion of blood meals taken from humans in favour of cattle. By accounting for environmental variation, this study detected clear evidence of intra-specific shifts in mosquito behaviour that could be obscured in shorter-term or temporally-coarse surveys. This highlights the importance of mosquito behavioural adaptations to vector control, and the value of longer-term behavioural studies

Status and outlook for acaricide and insecticide discovery

Pest Management Science 4 Sept 2020

To guarantee sustainability and progress, the agrochemical industry is faced with several major challenges. Currently, loss of active ingredients due to consumer perception, changing grower needs and ever-changing regulatory requirements is far higher than the number being introduced into the market. Therefore, there is a need to develop new products that can provide improved efficacy, selectivity and favorable environmental profiles. Strategies to achieve these goals are the search for acaricides and insecticides with new modes of action, or the discovery of novel molecules with activity on the most attractive target sites having resistance breaking properties against pest species. In this context, the introduction of halogen atoms or asymmetric centers into an active ingredient remains an important tool to modulate their properties, but so too is the pro-pesticide concept. This review gives an overview of agrochemicals launched over the past 8 years, reflects on new insights into known mechanisms of action, and describes the status and outlook for acaricide and insecticide discovery.

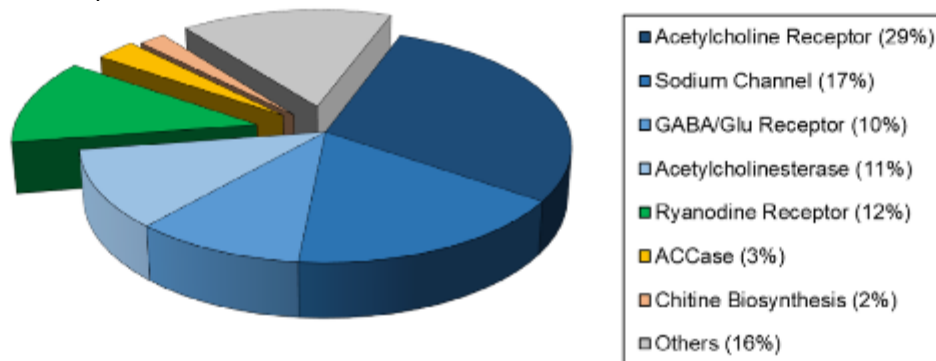


Figure 1. Central nervous system and muscle physiology of insects are common targets for commercial products. The majority of the a.i.s act on nerves (blue) and muscle physiology (green) with fewer compounds acting on respiration, growth and development, midgut, on unknown target or they act non-specific. Based on distribution of insecticide sales by IRAC MoA main groups on 2018 End-user sales data (total = \$19.8 billion USD) (Agranova, 2019).³

Climate change could shift disease burden from malaria to arboviruses in Africa

Lancet Public Health 4 Sept 2020

Malaria is a long-standing public health problem in sub-Saharan Africa, whereas arthropod-borne viruses (arboviruses) such as dengue and chikungunya cause an under-recognised burden of disease. In this Personal View, we argue that the direct effects of warming temperatures are likely to promote greater environmental suitability for dengue and other arbovirus transmission by *Aedes aegypti* and reduce suitability for malaria transmission by *Anopheles gambiae*.

Key messages

- Effect of temperature on malaria and arbovirus transmission**
 Malaria transmission by *Anopheles gambiae* peaks at 25°C, whereas dengue transmission by *Aedes aegypti* peaks at 29°C, based on mechanistic transmission models parameterised and validated by laboratory and field data. Warming temperatures in the tropics are expected to favour transmission of dengue over malaria.
- Non-linear effect of temperature on disease incidence**
 Independent data on human infections of malaria and dengue support the predicted non-linear effect of temperature on disease incidence. In tropical regions, where temperatures are consistently around

25°C, warmer temperatures correspond to a decrease in malaria incidence and an increase dengue and chikungunya incidence.

- Arboviruses are an under-recognised public health problem in sub-Saharan Africa**
 Dengue, chikungunya, and their *Ae aegypti* mosquito vector are already widespread but under-recognised in Africa, based on studies of vector abundance, human serology, and acute infections from across the continent. As climate suitability increases for arboviruses, these diseases could expand and overtake the public health burden of malaria.

[Efficacy of Fludora® Fusion \(a mixture of deltamethrin and clothianidin\) for indoor residual spraying against pyrethroid-resistant malaria vectors: laboratory and experimental hut evaluation](#)

Parasites & Vectors 11 September 2020

Fludora® Fusion is a new IRS insecticide containing a mixture of deltamethrin and clothianidin, a neonicotinoid. Here the efficacy of Fludora® Fusion IRS was evaluated over 11–12 months on concrete and mud substrates in laboratory bioassays and experimental huts against wild free-flying pyrethroid-resistant *Anopheles gambiae* (*sensu lato*) in Cové, Benin. A comparison was made with the two active ingredients of the mixture; clothianidin and deltamethrin, applied alone. CDC bottle bioassays were also performed to investigate resistance to clothianidin in the wild vector population. Indoor residual spraying with Fludora® Fusion induced high and prolonged mortality of wild pyrethroid-resistant malaria vectors for 7–10 months mostly due to the clothianidin component and substantial early exiting of mosquitoes from treated huts due to the pyrethroid component.

[Efficacy of factory-treated and dip-it-yourself long lasting insecticide-treated bednets against cutaneous leishmaniasis vectors in the sub-Andean region of Colombia: results after two years of use](#)

Mem Inst Oswaldo Cruz 11 Sept 2020

Although focused on sand fly control, this study offers a reminder of the potential for self-treated nets to help control mosquitoes.

This paper reports the results of a matched-triplet cluster-randomised study of 21 rural settlements, matched by pre-intervention. Sand fly (*L. longiflocosa*) indoor density was used to compare three interventions: dip it yourself (DIY) lambda-cyhalothrin LLIN, deltamethrin LLIN, and untreated nets (control). Sand fly indoor density, feeding success, and parity were recorded using CDC light trap collections at 1, 6, 12, and 24 months post-intervention.

Both LLINs reduced significantly (74–76%) the indoor density and the proportion of fully engorged sand flies up to two years post-intervention without differences between them. Residual lethal effects of both LLINs and the use of all nets remained high throughout the two-year evaluation period.

CONCLUSIONS: Both LLINs demonstrated high efficacy against *L. longiflocosa* indoors. Therefore, the deployment of these LLINs could have a significant impact on the reduction of CL transmission in the sub-Andean region. **The DIY lambda-cyhalothrin kit may be used to convert untreated nets to LLINs increasing coverage.**

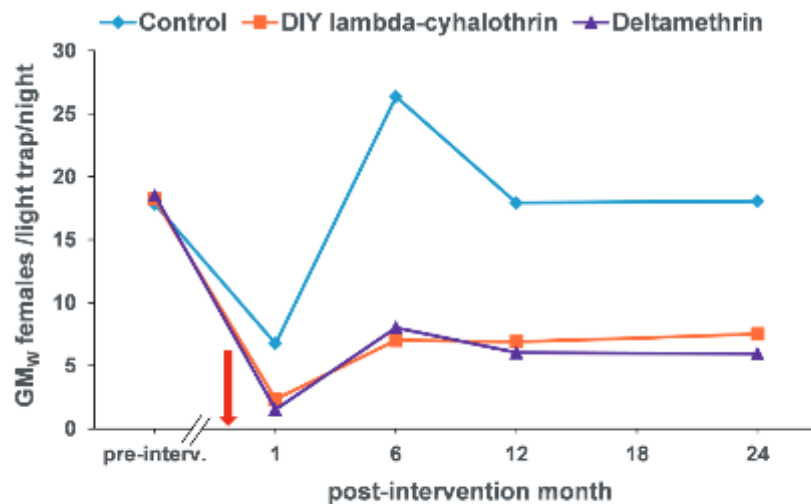


Fig. 4. effect of the long lasting insecticide-treated nets (LLINs) on *Lutzomyia longiflocosa* indoor density, geometric mean of Williams (GM_w) of females/CDC light trap/night. Pre-intervention (pre-interv.) survey was carried out from July to September 2010 and deployment of nets, showed by the red arrow. From July to August 2012.

[Comparative functional survival and equivalent annual cost of 3 long-lasting insecticidal net \(LLIN\) products in Tanzania: A randomised trial with 3-year follow up](#)

PLoS Medicine 18 Sept 2020

Author summary

Why was the study done?

- Over 2 billion long-lasting insecticidal nets (LLINs) have been procured for malaria control. Modelling has shown that longer-lasting LLINs would save stakeholders between US\$500 million and US\$700 million over a period of 5 years, yet LLIN tendering processes currently assume that all LLINs have the same lifespan.
- A functional LLIN must remain in the household, in good physical condition, and with adequate insecticidal activity to give good protection against malaria by preventing bites and killing mosquitoes.
- Before this study, only a few small studies in distinct geographical areas had compared the functional life of alternative LLIN products, mostly retrospectively.
- This 3-year randomised trial was designed to accurately compare the functional life of 3 leading LLIN brands, in order to help the Tanzanian government and other LLIN buyers to choose the most cost-effective LLINs.

What do these findings mean?

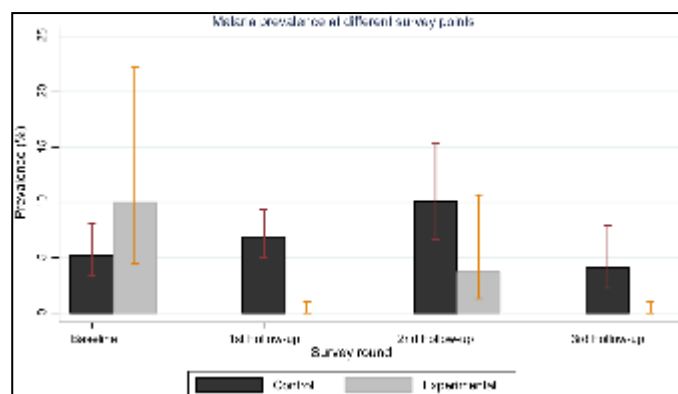
- Based on direct observation of a large number of nets in a range of study areas, our findings support previous studies suggesting that the functional life of LLINs may be less than 3 years.
- Our findings reveal that the lifespans of competing products can differ to a substantial and economically important degree.
- More durable LLINs would reduce the rate of loss of nets and the operational costs of malaria control, ultimately improving population access to this life-saving intervention.
- This study provides justification that measurement of the functional survival of new LLINs coming to market is an essential component of product evaluation for decision making. Functional survival affects LLIN cost; therefore, tendering processes should include a net durability component not just unit price.

As new LLIN products come on the market, especially those with new insecticides, it will be imperative to monitor their comparative durability to ensure that the most cost-effective products are procured for malaria control.

[Evaluating effectiveness of screening house eaves as a potential intervention for reducing indoor vector densities and malaria prevalence in Nyabondo, western Kenya](#)

Malaria Journal 19 Sept 2020

Mosquito-proofing of houses using wire mesh screens is gaining greater recognition as a practical intervention for reducing exposure to malaria transmitting mosquitoes. This study assessed the effectiveness of house eaves screening in reducing indoor vector densities and malaria prevalence in Nyabondo, western Kenya. 160 houses were selected for the study, with half of them randomly chosen for eaves screening and the other half left without screening. Results from cross-sectional parasitological surveys

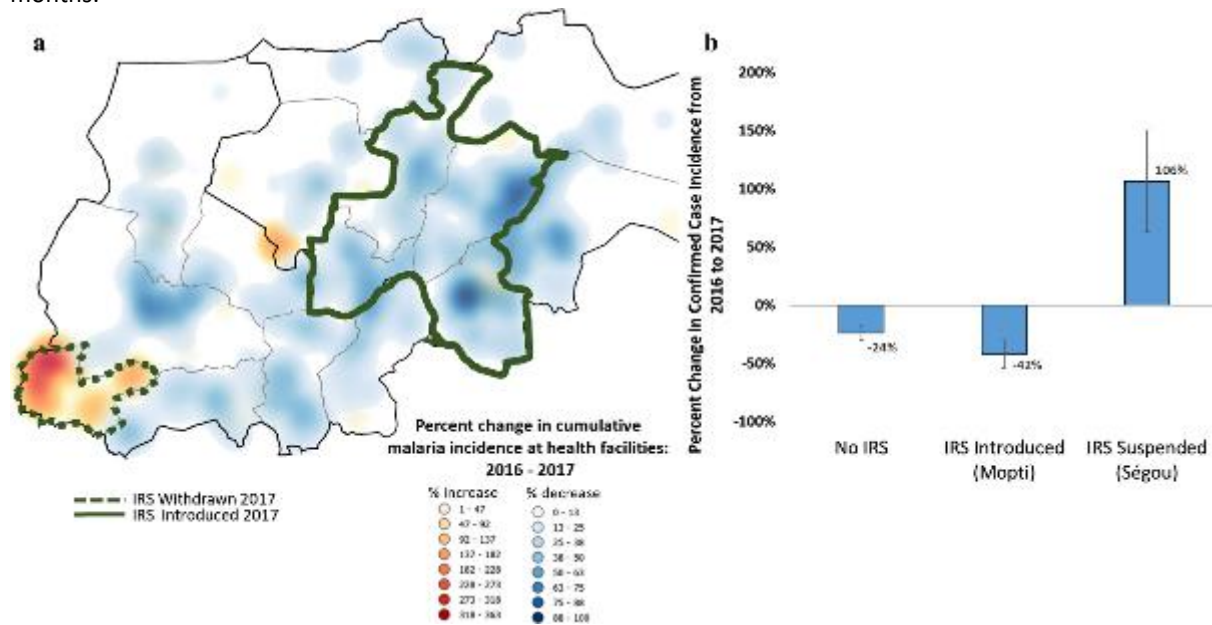


showed that screened houses recorded relatively low malaria parasite prevalence rates compared to the control houses. Overall, malaria prevalence was 5.6% n = 1,918, with baseline prevalence rate of 6.1%, n = 481 and 3rd follow-up survey prevalence of 3.6% n = 494. At all the three parasitological follow-up survey points, house screening significantly reduced the malaria prevalence by 100% (p < 0.001), 63.6% (p = 0.026), and 100% (p < 0.001) in the 1st, 2nd and 3rd follow-up surveys respectively.

[Rapid reduction of malaria transmission following the introduction of indoor residual spraying in previously unsprayed districts: an observational analysis of Mopti Region, Mali, in 2017](#)

Malaria Journal 19 Sept 2020

Here, the results of a series of observational analyses utilizing routine malaria indicators to evaluate the impact of beginning IRS in a new region of Mali are presented. Compared to communities with no IRS, cumulative case incidence rates in IRS communities were reduced 16% in Ségou Region during the 6 months following the 2016 campaign and 31% in Mopti Region during the 6 months following the 2017 campaign, likely averting a total of more than 22,000 cases of malaria that otherwise would have been expected during peak transmission months.



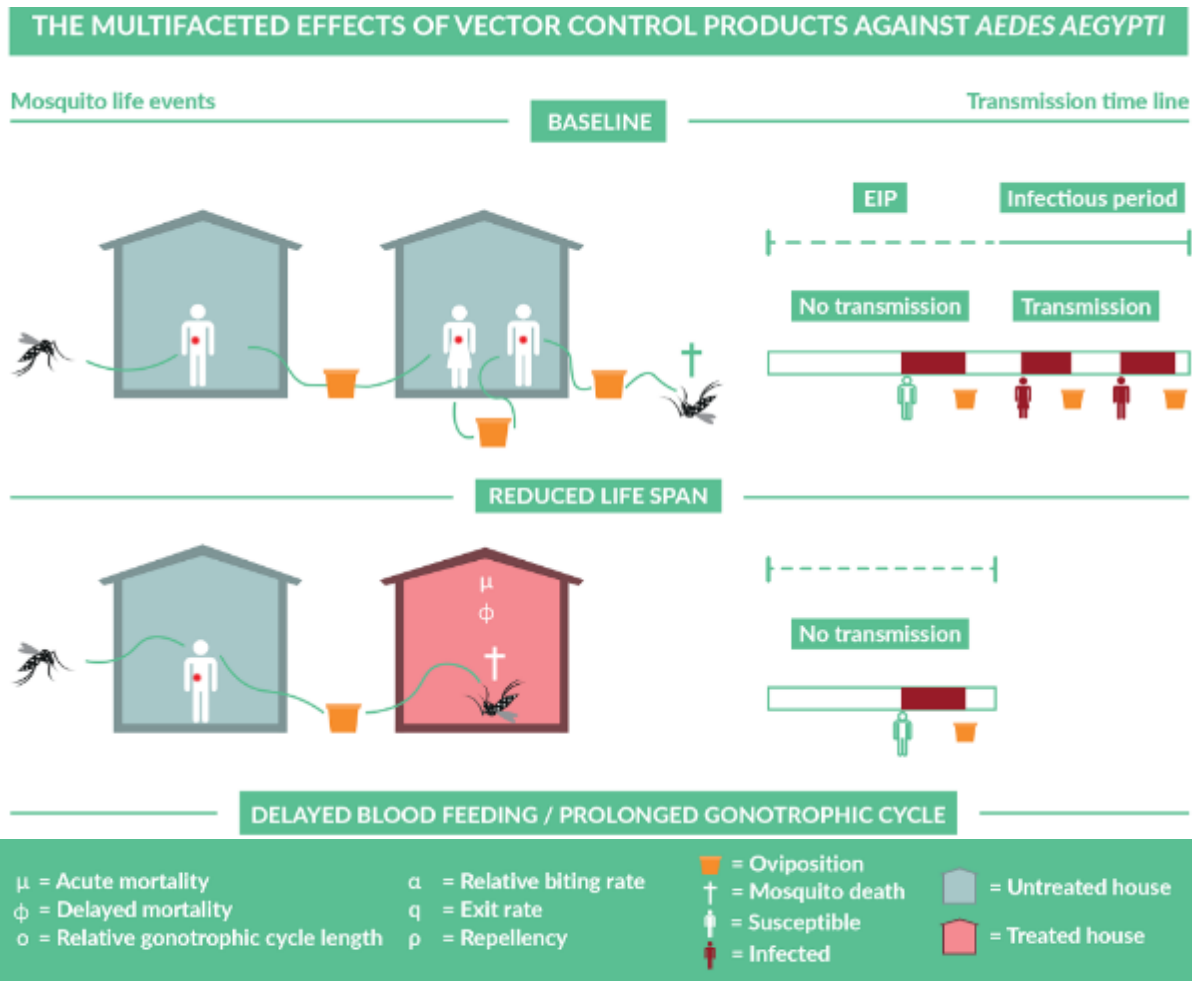
Results of the difference-in-differences analyses. **(a)** How peak (September–February) malaria case incidence rates changed from 2016 to 2017 at the health facility level in districts where indoor residual spraying (IRS) was removed (dotted line border), districts where IRS was introduced (solid green border), and the remaining comparator districts where there was no IRS in either year. At each health facility, blue indicates a drop in malaria incidence and red indicates an increase, and the intensity of the colour represents the magnitude of the change. **(b)** The results of Student's t-tests comparing the rates of changing incidence across the two IRS scenarios

[Community-level impacts of spatial repellents for control of diseases vectored by *Aedes aegypti* mosquitoes](#)

PLoS Computational Biology 25 Sept 2020

Author summary

Mosquito control strategies that reduce bites to humans through multiple, non-lethal modes of action may be important in controlling mosquito-borne diseases where insecticidal strategies are ineffective. Assessing how effective such tools are in reducing infections is not clear-cut due to the multiple ways these products affect mosquitoes' behavior and life cycle. We introduce a paired experimental and mathematical framework to analyze and combine data from experiments on the several effects of a transfluthrin formulation and assess its public health impact. We show that, while product-induced lethality accounts for the majority of the product's impact, delayed blood feeding can, through its negative impact on mosquito population sizes, elicit its own substantial impact. Adverse effects of increased partial blood-feeding and reduced exiting could offset gains achieved by other effects such as delayed blood feeding and lethality. Our model offers a way of synthesizing the results of feasible experiments at small scales to assess public health impact at large scales.



[New insecticide screening platforms indicate that Mitochondrial Complex I inhibitors are susceptible to cross-resistance by mosquito P450s that metabolise pyrethroids](#)

Nature Scientific Reports 1 Oct 2020

Fenazaquin, pyridaben, tolfenpyrad and fenpyroximate are Complex I inhibitors offering a new mode of action for insecticidal malaria vector control. However, extended exposure to pyrethroid based products such as long-lasting insecticidal nets (LLINs) has created mosquito populations that are largely pyrethroid-resistant, often with elevated levels of P450s that can metabolise and neutralise diverse substrates. To assess cross-resistance liabilities of the Complex I inhibitors, we profiled their susceptibility to metabolism by P450s associated with pyrethroid resistance in *Anopheles gambiae* (CYPs 6M2, 6P3, 6P4, 6P5, 9J5, 9K1, 6Z2) and *An. funestus* (CYP6P9a). All compounds were highly susceptible. **Overall, results suggest that in vivo and in vitro assays are a useful guide in the development of new vector control products, and that the Complex I inhibitors tested are susceptible to metabolic cross-resistance and may lack efficacy in controlling pyrethroid resistant mosquitoes.**

[A new malaria vector in Africa: Predicting the expansion range of Anopheles stephensi and identifying the urban populations at risk](#)

PNAS 6 October 2020

In 2012, an unusual outbreak of urban malaria was reported from Djibouti City in the Horn of Africa and increasingly severe outbreaks have been reported annually ever since. Subsequent investigations discovered the presence of an Asian mosquito species *Anopheles stephensi*, a species known to thrive in urban environments. Since that first report, *An. stephensi* has been identified in Ethiopia and Sudan,

and this worrying development has prompted the World Health Organization (WHO) to publish a vector alert calling for active mosquito surveillance in the region. Using an up-to-date database of published locational records for *An. stephensi* across its full range (Asia, Arabian Peninsula, Horn of Africa) and a set of spatial models that identify the environmental conditions that characterize a species' preferred habitat, we provide evidence-based maps predicting the possible locations across Africa where *An. stephensi* could establish if allowed to spread unchecked. Unsurprisingly, due to this species' close association with man-made habitats, our maps predict a high probability of presence within many urban cities across Africa where our estimates suggest that over 126 million people reside. Our results strongly support the WHO's call for surveillance and targeted vector control and provide a basis for the prioritization of surveillance.

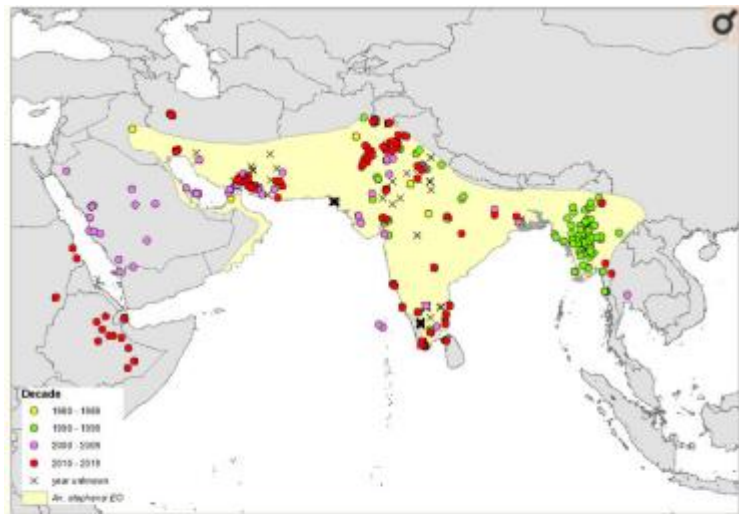


Fig. 1.

The new "out of range" occurrence of *An. stephensi* in the Arabian Peninsula and Horn of Africa showing the 358 *An. stephensi* site locations used in our final species distribution models (SDMs) color coded by the decade in which they were sampled. The yellow shaded area shows the 2011 expert opinion range based on data published up to 31 October 2009 (9). Data showing the presence of *An. stephensi* more westerly across the Arabian peninsula (sampled in 2005 to 2005) were published after 2010. Thus *An. stephensi* may have been present but unreported or been expanding its range into western areas of the Arabian peninsula over the last 30 years.

[*A cohort study to identify risk factors for Plasmodium falciparum infection in Burkina Faso children: implications for other high burden high impact countries*](#)

Malaria Journal Published: 16 October 2020

Progress in controlling malaria has stalled in recent years. Today the malaria burden is increasingly concentrated in a few countries, including Burkina Faso, where malaria is not declining. A cohort study was conducted to identify risk factors for malaria infection in children in southwest Burkina Faso, an area with high insecticide-treated net (ITN) coverage and insecticide-resistant vectors. Incidence of *Plasmodium falciparum* infection was measured in 252 children aged 5 to 15 years, using active and passive detection, during the 2017 transmission season, following clearance of infection.

Results - During the six-month follow-up period, the overall incidence of *P. falciparum* infection was 2.78 episodes per child (95% CI = 2.66–2.91) by microscopy, and 3.11 (95% CI = 2.95–3.28) by polymerase chain reaction (PCR). The entomological inoculation rate (EIR) was 80.4 infective bites per child over the six-month malaria transmission season. At baseline, 80.6% of children were reported as sleeping under an ITN the previous night, although at the last survey, 23.3% of nets were in poor condition and considered no longer protective.

Conclusions - Incidence of *P. falciparum* infection remains overwhelmingly high in the study area. The study findings suggest that because of the exceptionally high levels of malaria transmission in the study area, malaria elimination cannot be achieved solely by mass deployment of ITNs and additional control measures are needed.

[*Anopheles gambiae \(s.l.\) is found where few are looking: assessing mosquito diversity and density outside inhabited areas using diverse sampling methods*](#)

Parasites & Vectors Published: 15 October 2020

This paper explores an important topic of mosquito population movement and gene flow which impacts insecticide susceptibility and various vector control interventions targeting suppression or population replacement. Another interesting topic raised in the discussion is the challenge of sampling outdoor mosquitoes. The authors list a variety of sampling methods under evaluation or development for outdoor *Anopheles* sampling. This study assessed the presence and relative abundance of mosquitoes in a 6-km corridor between two villages in western Burkina Faso. Adult mosquitoes from six species of *Anopheles* and three other genera were found along the whole transect. Larvae of *Anopheles* spp. were found in small pools

of surface water along the whole transect, though their presence increased with human proximity. HLC and aspiration were the most efficient methods of collecting adult mosquitoes along the whole transect, indicating that there are both host-seeking and resting mosquitoes well away from core village areas. In contrast, swarms of male mosquitoes, thought to be the principle mating locations of *Anopheles* spp. mosquitoes in West Africa, were only found close to the core village areas.

Conclusions - This preliminary study indicates that *Anopheles* spp. mosquitoes are both present and breeding in low human-density areas along transit axes and provides both a relative evaluation of methods for use in these areas and evidence that gene flow between Sahelian population centres is likely. More robust and structured studies are nevertheless needed to come with stronger conclusions.

WHO News and Publications

News

[Africa eradicates wild poliovirus](#)

25 August 2020

Brazzaville – The independent Africa Regional Certification Commission (ARCC) for Polio Eradication officially declared on Tuesday that the World Health Organization (WHO) African Region is free of wild poliovirus. This marks the eradication of the second virus from the face of the continent since smallpox 40 years ago.



[Malaria and COVID-19: country perspectives](#)

7 September 2020 Departmental news

How have country-based malaria experts adapted to the double challenge of malaria and COVID-19? What successes have they achieved, and where are the remaining gaps? In a virtual forum on 3 September, 10 Ministry of Health representatives shared their experiences and reflections; you can [watch their presentations here](#).

WHO PUBLICATIONS

[Twelfth meeting of the WHO Vector Control Advisory Group](#)

27 August 2020

VCAG experts along with product developers, innovators and researchers and the VCAG Secretariat met virtually on 8–10 June 2020 for the 12th VCAG meeting. This report details the proceedings and outcomes of the meeting, including advice provided to the following applicants:

- spatial repellents;
- lethal house lures;
- auto-dissemination devices;
- pyrethroid plus insect growth regulator net and pyrethroid plus non-pyrethroid insecticide net; and
- housing modification

Webinars, websites and other resources

Recent Webinars

[ASEAN Panel: dengue in the age of pandemics, a new era](#)

Recorded 30 July 2020

Chaired by Kamran Rafiq from ISNTD this webinar starts with presentations giving dengue situation updates from three countries.

Dr. Siti Nadia Tarmizi – Indonesia

Dr. Norielyn Evangelista – Philippines

Dr. Rose Nani Mudin – Malaysia including a summary of Malaysia's Wolbachia project



International Society for Neglected Tropical Diseases (ISNTD) Bites 2020 Conference



Dengue In The Age Of Pandemics: A New Era

Department of Health – Philippines

ISNTD BITES 2020 CONFERENCE

DENGUE IN THE AGE OF PANDEMICS: A NEW ERA

DR ROSE NANI MUDIN
MINISTRY OF HEALTH MALAYSIA

30 July 2020

The Asia Pacific Leaders Malaria Alliance (APLMA) in collaboration with the RBM Partnership to End Malaria (RBM) and the Innovative Vector Control Consortium (IVCC), invite you to view the recording of the second roundtable of the ['Malaria Gamechangers: A Health Innovation Series'-Vector Control Tools for Asia Pacific.](#)

21 August 2020

Our panelists today

				
<p>Justin McBeath Market Segment Manager, Bayer CropScience</p>	<p>Dr Rose Nani Mudin Head of Vector Borne Disease Sector, Ministry of Health, Malaysia</p>	<p>Dr Siv Sovannaroeth Program manager for malaria, National Center for Parasitology, Entomology & malaria Control, Cambodia</p>	<p>Mr Takao Ishiwatari Senior Associate, Vector Control Business Development Sumitomo Chemical</p>	<p>Dr Tessa Knox WHO Advisor to Vanuatu Ministry of Health, Malaria and other Vector Borne Diseases</p>

In addition to the above panels members, the panel consisted of Dr. Afsana Alamgir Khan, Deputy Program Manager for the National Malaria Elimination & ATD program, CDC Bangladesh; John Vasanthan Paul from IVCC; Dr. Joel Aik, Deputy Director, Environmental Health Institute, NEA, Singapore; and Camilla Burkot from the Australian Government's Indo-Pacific Centre for Health Security. Dr. Ali Cameron from Unitaid provided a nice wrap up at the end of the session. Among the speakers' comments, Tess Knox spoke about the high community interest in resuming indoor Residual Spraying (IRS) in Vanuatu; Dr. Siv Sovannaroeth discussed the distribution of vector control products such as topical repellents and insecticide treated hammock nets as part of forest packs for forest goers launched in Cambodia; Dr. Rose also mentioned using spatial repellents, insecticide treated clothing and outdoor residual spraying.

[Syngenta teams up with Goodbye Malaria to rethink IRS in times of COVID-19](#)

29 July 2020

Recently, Syngenta partnered with Goodbye Malaria to host a webinar on how IRS practices should be adapted to provide effective vector control and keep teams and communities safe from COVID-19.

The event covered the following topics:

- Overview of the E8 malaria upsurges and the impact of COVID-19: *Dr. Chadwick Sikaala*, vector control specialist and entomologist, Elimination 8 Initiative (E8)
- Innovation in IRS spraying: *Iñigo Garmendia*, public health product manager, Goizper Spraying Garmendia provided updates on new equipment technology to help spray operators increase efficiency and accuracy when making vector control applications.
- Safety measures for IRS sprayers: *Dr. David Zinyengere*, regional training, monitoring and evaluation manager, Syngenta
- New approaches in IRS planning and training: *Francois Maartens*, co-CEO, Goodbye Malaria
- Spraying during the pandemic: *Djenam Jacob*, technical program manager, PMI VectorLink



[Webinar: Emerging Issues and New Tools to Fight Mosquito-Borne Diseases in Africa](#)

25 August 2020

Hosted by GBCHHealth and the Corporate Alliance for Malaria in Africa (CAMA). Held in observance of World Mosquito Day 2020, this virtual event presented the state of mosquito borne diseases in Africa; challenges and strategies for elimination and the latest updates on new innovations such as vector control tools to prevent and mitigate health risks associated with mosquito-borne diseases.



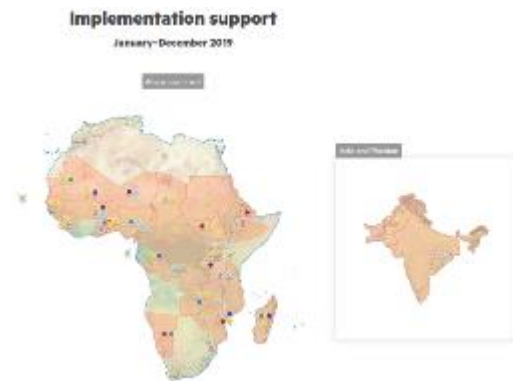
Featured Speakers include:

- Dr. Emmanuel Chanda, Project Officer Vector Control” WHO Regional Office for Africa
- Melinda Hadi, Head Market Access, Vestergaard
- Manuel F. LLuberas, Public Health Entomologist, Executive Director for Public Health, H. D. Hudson Manufacturing Company
- Dr. John Gimnig, Research Entomologist, Division of Parasitic Diseases, CDC
- Dr. Rose Peter, Commercial Head, Vector Control, Syngenta
- Ochuko Keyamo-Onyige, Nigeria Country Manager, GBCHHealth/CAMA (moderator)

ONLINE RESOURCES



The web version of the [2019 Annual Report from RBM](#) is available online. A pdf version is also available for [download here](#).



The first-ever "[National Plan of Action 2020-2024](#)" for sustainable management of Vector-borne diseases (VBDs) in Pakistan is now available. It describes the vision and priorities for control of VBDs of public health importance in Pakistan. The document can be a helpful tool for other countries facing issues with VBDs (malaria, dengue, chikungunya, leishmaniasis, Crimean Congo haemorrhagic fever, yellow fever, Japanese encephalitis, etc).

Please feel free to contact NMCP-Pakistan if you need any clarification or assistance (Mr Muhammad Mukhtar, mukhtarnih@gmail.com).



[New Online Course Launched on the Control of Vector Borne Diseases](#)

9 September 2020

The [London School of Hygiene & Tropical Medicine \(LSHTM\)](#) and its [ARCTEC](#) team, [IVCC](#) and [Liverpool School of Tropical Medicine \(LSTM\)](#) are launching a brand new free online course on the control of vector borne diseases such as malaria, dengue and Zika virus, to help fight these diseases, which remain as prevalent and dangerous as ever during the current COVID-19 pandemic.

This innovative and exciting six-week free online course will allow participants to explore the wide range of vectors and the diseases they transmit and learn about traditional and modern vector control. The course will cover state of the art vector control and importantly, participants will also learn about the suitability of vector control practices in the world today. The course is specifically designed

for anyone with an interest in vector borne diseases and public health. We particularly encourage those working in global and public health to enroll; including government stakeholders, health workers, those working on vector control programmes, vector researchers and industry employees.



In the news and social media

[A drug-resistant strain of the parasite that causes malaria has been identified by scientists in Rwanda.](#)

BBC News 6 August 2020

A study published in Nature has found that parasites were able to resist treatment by artemisinin - a frontline drug in the fight against the disease. This is the first time scientists have observed the resistance to the drug artemisinin in Africa. Scientists from the Institut Pasteur, in collaboration with the National Malaria Control Program in Rwanda (Rwanda Biomedical Center), the World Health Organization (WHO), Cochin Hospital and Columbia University (New York, USA) analysed blood samples from patients in Rwanda. They found one

particular mutation of the parasite, resistant to artemisinin, in 19 of 257 - or 7.4% - of patients at one of the health centres they monitored.

[World Mosquito Program's Wolbachia method dramatically reduces dengue incidence in randomised controlled trial in Yogyakarta, Indonesia](#)

August 2020

The World Mosquito Program ([WMP](#)) of Monash University, and its Indonesian partners the Tahija Foundation and Universitas Gadjah Mada have announced the first results of a cluster randomised controlled trial of its *Wolbachia* method, showing a 77% reduction in the incidence of virologically-confirmed dengue in *Wolbachia*-treated areas of Yogyakarta, Indonesia, compared to untreated areas.

- Data demonstrates 77% efficacy against virologically confirmed dengue
- Trial conducted over three years across area with population of 312,000
- First ever gold-standard trial to successfully target the *Aedes aegypti* mosquito and reduce dengue cases

Detailed results will be presented at an international scientific congress in November 2020 and published in a peer-reviewed journal.

[Singapore battles record dengue outbreak with more mosquitoes](#)

27 August 2020

This article discusses the *Wolbachia* release program in Singapore, a current dengue outbreak and challenges with mosquito control during the COVID-19 related shutdowns.

[New Asian mosquito could bring malaria to African cities, warn scientists](#)

14 September 2020

Unlike endemic species, *An. stephensi* is adapted to urban areas and is highly adapted to finding man-made water tanks or containers to lay its eggs, with larval site habits similar to *Aedes aegypti*, putting another 126 million people in danger. "This mosquito is unlike any other primary malaria vector found in Africa – it can live in urban areas that other species just don't like," says Dr Marianne Sinka from the University of Oxford.



"As about 40% of Africa's population live in urban areas, this means there are a lot of people who are currently protected by their environment that could become exposed – if the mosquito spreads."

[Volcanic Rock Yields a New Kind of Insecticide for Mosquitoes](#)

North Carolina State University's Jean M. Deguenon, Ph.D., R. Michael Roe, Ph.D., and colleagues tested a material derived from volcanic rock, perlite, as a potential non-chemical insecticide

against *Anopheles gambiae*, one of the primary mosquitoes that spreads malaria in Africa. In their [new report published in August in the Journal of Medical Entomology](#), they show that perlite has encouraging potential as a mechanical insecticide.



[GOODBYE MALARIA MASKS INITIATIVE - FOR COMMUNITIES BY COMMUNITIES](#)

4 Sept 2020

Unmasking the story by behind the "Every Mask Counts" initiative. This inspiring video from Goodbye Malaria discusses the link between their fight against malaria in Mozambique and their efforts to help the community respond to COVID-19. The masks are made by crafters who are unemployed due to the Coronavirus, completing an extraordinary circle of hope: providing lifesaving employment, by creating masks that prevent infection from COVID-19, to generate funds to prevent deaths from malaria.



[The UCSF's DiSARM project commemorates four years of impact](#)

During the past four years, the DiSARM project focused on building spatial analysis tools to support malaria programs in southern Africa. Led by the University of California, San Francisco's (UCSF) Malaria Elimination Initiative (MEI), in collaboration with Peoplesized and CHAI, the DiSARM team built algorithms to solve important problems facing malaria programs. To support the use, integration and extension of these algorithms by the wider community, including modelers and developers, an updated version of DiSARM's documentation site was just released. The DiSARM project also developed a user facing mobile and desktop app to support the planning, implementation and monitoring of indoor residual spray campaigns. As of 2018, the MEI partnered with Akros to integrate the functionality of the DiSARM app into a new app called Reveal, which is being rolled out to support IRS and mass drug administration for malaria and NTDs in several countries across Africa. [Read more on the MEI website.](#)

Note this issue covers the period from mid July through mid October 2020.

Disclaimer: Given the breadth of vector control related literature, we are unable to include all relevant work. This update is intended to focus primarily *Anopheles* vectors and a subset of control topics with global relevance. Any views expressed in this update do not necessarily reflect the views or opinions of IVCC. In many cases we directly quote abstracts and other sections of published work. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by IVCC or its funders.