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Selected Recent Publications

<u>A Review of Studies Evaluating Insecticide Barrier Treatments for Mosquito Control From 1944</u> <u>to 2018</u>

Environ Health Insights – 26 June 2019

For more than 70 years, MCPs have taken advantage of the mosquito's resting behavior to target vegetation with residual applications of insecticides. This paper is a review of forty-four studies that evaluated 20 active ingredients (AIs) and 21 formulated products against multiple mosquito species. Insecticides investigated for efficacy included organochlorines (dichlorodiphenyltrichloroethane [DDT], β -hexachlorocyclohexane [BHC]), organophosphates (malathion), and pyrethroids (bifenthrin, deltamethrin, permethrin, lambda-cyhalothrin) as AIs. Study design varied with multiple methods used to evaluate effectiveness of barrier treatments. Barrier treatments were effective at lowering mosquito populations although there was variation between studies and for different mosquito species. Factors other than AI, such as exposure to rainfall and application equipment used, also influenced control efficacy.

CONCLUSIONS:

Many of the basic questions on the effectiveness of barrier insecticide applications have been answered, but several important details still must be investigated to improve precision and impact on vector-borne pathogen transmission. Recommendations are made to assist future evaluations of barrier treatments for mosquito control and to limit the potential development of insecticide resistance.

Bio-efficacy and physical integrity of piperonylbutoxide coated combination net (PermaNet[®] 3.0) against pyrethroid resistant population of Anopheles gambiae s.l. and Culex auinquefasciatus mosquitoes in Ethiopia.

Malaria Journal – 4 July 2019

PermaNet[®] 3.0 is a deltamethrin-treated combination long-lasting insecticidal net with the addition of synergist piperonylbutoxide (PBO) on its roof section. It is designed to overcome the challenge posed by pyrethroid resistant vector populations against mainstream long-lasting insecticidal nets impregnated with pyrethroids only. The objective of this study was to determine insecticide resistance status of Anopheline and Culicine mosquitoes, to evaluate the bio-efficacy of PermaNet[®] 3.0 nets and to assess household factors affecting the physical integrity of PermaNet[®] 3.0 after 3 years of use.

Evidence of insecticide resistance selection in wild Anopheles coluzzii mosquitoes due to

agricultural pesticide use Infect Dis Poverty – 15 July 2019

We investigated for the first time the resistance levels of *Anopheles coluzzii* mosquitoes to neonicotinoids, insecticides used exclusively for crop protection in Côte d'Ivoire. The study was conducted in two agricultural regions (Tiassale and Gagnoa) and one non-agricultural region (Vitre) between June and August 2017 using clothianidin, acetamiprid and imidacloprid.

Results - Mosquito populations from Tiassale and Gagnoa (agricultural settings) were determined to be resistant to acetamiprid with mortality rates being < 85% at 24 h post-exposure. In Vitre (non-agricultural area) however, the mosquito population was susceptible to acetamiprid. In all three localities, mosquito populations were resistant to imidacloprid (mortality rates were 60% in Vitre, 37% in Tiassale, and 13% in Gagnoa) and





completely susceptible to clothianidin (100% mortality). *An. coluzzii* represented 100% of mosquito collected in Gagnoa, 86% in Tiassale and 96% in Vitre.

Conclusions - This study provides strong evidence that agricultural use of insecticides can cause insecticide resistance in malaria vector populations. Insecticide resistance driven by agrochemical usage should be considered when vector control strategies are developed.

Diagnostic dose determination and efficacy of chlorfenapyr and clothianidin insecticides against Anopheles malaria vector populations of western Kenya.

Malaria Journal – 17 July 2019

The aim of this study was to estimate a diagnostic dose for chlorfenapyr (class: pyrrole) and clothianidin (class: neonicotinoid) and assess the baseline susceptibility of three major Anopheles malaria vectors of western Kenya to these two insecticides. When exposed to the diagnostic dose of each insecticide, Anopheles malaria vector populations in western Kenya were susceptible to both insecticides with 100% mortality observed after 72 h. Mortality of mosquitoes exposed to deltamethrin increased over time but did not reach 100%.

What is community engagement and how can it drive malaria elimination? Case studies and stakeholder interviews

Malaria Journal – 17 July 2019

Community engagement is often confused with simply providing information, education, and communication (IEC) to the community; the malaria community have only recently begun to consider the significance and potential of community engagement for malaria elimination. Empowering districts and communities in planning and executing community-based interventions is necessary. Communities affected by the disease will ultimately achieve malaria elimination. For this to happen, the community itself must define, believe in, and commit to strategies to interrupt transmission.

Incompatible and sterile insect techniques combined eliminate mosquitoes

Nature – 17 July 2019

The radiation-based sterile insect technique (SIT) has successfully suppressed field populations of several insect pest species, but its effect on mosquito vector control has been limited. The related incompatible insect technique (IIT)—which uses sterilization caused by the maternally inherited endosymbiotic bacteria *Wolbachia*—is a promising alternative, but can be undermined by accidental release of females infected with the same Wolbachia strain as the released males. Here we show that combining incompatible and sterile insect techniques (IIT–SIT) enables near elimination of field populations of the world's most invasive mosquito







species, *Aedes albopictus*. Millions of factory-reared adult males with an artificial triple-*Wolbachia* infection were released, with prior pupal irradiation of the released mosquitoes to prevent unintentionally



released triply infected females from successfully reproducing in the field. This successful field trial demonstrates the feasibility of area-wide application of combined IIT–SIT for mosquito vector control.

Read the related editorial of this approach here <u>Combining Sterile and Incompatible Insect</u> <u>Techniques for Aedes albopictus Suppression</u>

Mosquito feeding behavior and how it influences residual malaria transmission across Africa PNAS – 23 July 2019

Malaria transmission persists even when mosquito control is used effectively. This "residual transmission" measures all forms of transmission that are beyond the reach of standard insecticidal nets and indoor residual spraying of insecticides when used optimally. The effectiveness of LLINs and IRS depends on both the level of outdoor biting and physiological resistance. Estimates of the percentage of mosquito bites taken when people are indoors varies from ~40 to 100%. This difference in outdoor biting is predicted to reduce LLIN efficacy (at 100% coverage) from 66 to 54% (a 12% drop) in the site simulated in Fig. 5B. Conversely, the level of physiological resistance (survivorship measured in a discriminating dose bioassay) is seen to vary in the same dataset from 0 to 85% (Fig. 5A). This is predicted to have 3 times the public health impact, reducing LLIN efficacy by 36%. The scale of the problem must be understood to demonstrate the need for outdoor vector control tools. An additional 10.6 million clinical cases of malaria are predicted annually given the 10% higher level of outdoor biting observed here.

Mosquitoes cloak their legs to resist insecticides

Proc Biol Sci. – 24 July 2019

The role of detoxification enzymes and target site mutations has been documented in the major malaria vector *Anopheles gambiae*; however, the emergence of striking resistant phenotypes suggests the occurrence of additional mechanisms. By comparing legs, the most relevant insect tissue for



insecticide uptake, we show that resistant mosquitoes largely remodel their leg cuticles via enhanced deposition of cuticular proteins and chitin, corroborating a leg thickening phenotype. Moreover, we show that **resistant female mosquitoes seal their leg cuticles with higher total and different relative amounts of cuticular hydrocarbons, compared with susceptible ones**. The structural and functional alterations in Anopheles female mosquito legs are associated with a reduced uptake of insecticides, substantially contributing to the resistance phenotype.

Effect of different habitat types on abundance and biting times of Anopheles balabacensis Baisas (Diptera: Culicidae) in Kudat district of Sabah, Malaysia

Parasites & Vectors - 25 July 2019

Keeping an eye on the growing threat of this "monkey malaria" species this paper presents work on the vector biology of *Anopheles balabacensis* (currently the only known vector for *Plasmodium knowlesi* in Sabah). The





finding contribute to a growing body of evidence implicating environmental changes due to deforestation, expansion of agricultural and farming areas, and development of human settlements near to forest fringes in the emergence of *P. knowlesi* in Sabah.

Also see Panel 5: Zoonotic knowlesi malaria on page 22 of The Lancet Commission on Malaria Eradication

Whole-genome sequencing reveals high complexity of copy number variation at insecticide resistance loci in malaria mosquitoes

Genome Research – 25 July 2019

The Anopheles gambiae 1000 Genomes Project has recently published a new paper on insecticide resistance gene copy number variation.

Alistair Miles also wrote <u>a blog post about the paper</u>, providing an introduction for non-geneticists and explaining why it is potentially relevant to decisions about procurement and distribution of next-generation LLINs.

Autocidal gravid ovitraps protect humans from chikungunya virus infection by reducing Aedes aeavpti mosauito populations.

PLoS Negl Trop Dis. – 25 July 2019

Autocidal gravid ovitraps (AGO traps) have been shown to sustainably reduce Aedes populations by >80%. After chikungunya virus was introduced into Puerto Rico, we conducted serosurveys in communities with and without AGO traps. We observed a twofold lower prevalence of chikungunya virus infection among residents of communities with AGO traps compared to communities without. Among infected residents of communities with traps, a significant proportion likely had been infected while outside their community. These findings indicate that AGO traps are an effective tool that protects humans from infection with pathogens transmitted by Aedes mosquitos.



Technical and operational underpinnings of malaria elimination from Sri Lanka

Malaria Journal – 29 July 2019

Malaria was eliminated from Sri Lanka in 2012, and the country received WHO-certification in 2016. The objective of this paper is to describe the epidemiology of malaria elimination in Sri Lanka, and **the key technical and operational features of the elimination effort**, which may have been central to achieving the goal, even prior to schedule, and despite an ongoing war in parts of the country.

Map of Sri Lanka showing districts, which were served by Regional Malaria Officers. Districts are colour coded on the basis of population per RMO. Districts depicted in white had no RMOs since they were not endemic for malaria. The red dots represent Government health institutions which served as diagnosis and treatment centres for malaria.







<u>Susceptibility testing of Anopheles malaria vectors with the neonicotinoid insecticide</u> <u>clothianidin; results from 16 African countries, in preparation for indoor residual spraying with</u> new insecticide formulations

Malaria Journal – 1 August 2019

In 2017, more than 5 million house structures were sprayed through the U.S. President's Malaria Initiative, protecting more than 21 million people in sub-Saharan Africa. New IRS formulations, SumiShield[™] 50WG and Fludora Fusion[™] WP-SB, became World Health Organization (WHO) prequalified vector control products in 2017 and 2018, respectively. Both formulations contain the neonicotinoid active ingredient, clothianidin. The target site of neonicotinoids represents a novel mode of action for vector control, meaning that cross-resistance through existing mechanisms is less likely. In preparation for rollout of clothianidin formulations as part of national IRS rotation strategies, baseline susceptibility testing was conducted in 16 countries in sub-Saharan Africa. One-hundred percent mortality was reached with all susceptible insectary strains and with wild *An. gambiae s.l.* from all sites in 11 countries. However, tests in at least one location from 5 countries produced mortality below 98%. While this could potentially be a sign of clothianidin resistance, it is more likely that the diagnostic dose or protocol requires further optimization. Repeat testing in 3 sites in Ghana and Zambia, where possible resistance was detected, subsequently produced 100% mortality. Results showed susceptibility to clothianidin in 38 of the 43 sites in sub-Saharan Africa, including malaria vectors with multiple resistance mechanisms to pyrethroids, carbamates and organophosphates.

Aedes aegypti Males as Vehicles for Insecticide Delivery

Insects – 1 August 2019

Aedes aegypti continues to spread globally and remains a challenge to control, in part due to its 'cryptic behavior' in that it often deposits eggs (oviposits) in larval habitats that are difficult to find and treat using traditional methods. Auto-dissemination strategies target these cryptic breeding sites by employing mosquitoes to deliver lethal doses of insecticide. This report describes the initial field trials of an application known as Autodissemination Augmented by Males (ADAM), utilizing *A. aegypti* males dusted with pyriproxyfen (PPF). Findings presented here are drawn from both caged and field trial studies. Together, these trials examined for the ability of *A. aegypti* males to disseminate PPF and to impact field populations. PPF-dusted males were able to effectively deliver lethal doses of PPF to oviposition sites under the conditions tested. Results from field trials in Florida and California demonstrated reduced *A. aegypti* populations in treated areas, compared to areas where PPF-treated males were not released. These results indicate that the release of PPF-dusted *A. aegypti* males can impact *A. aegypti* populations as measured by both reduced larval survival and lower numbers of adult female *A. aegypti*. We propose the ADAM approach as an addition to existing mosquito control techniques targeting *A. aegypti* and other mosquitoes that utilize cryptic larval habitats.

Integrated vector management with additional pre-transmission season thermal fogging is associated with a reduction in dengue incidence in Makassar, Indonesia: Results of an 8-year observational study.

PLoS Negl Trop Dis. – 5 August 2019

Dengue virus transmission is endemic in Makassar, Indonesia, with the majority of cases reported soon after the start of the annual rainy season. Before 2006, larval source reduction, larvaciding, and reactive routine, outdoor, insecticide fogging campaigns did not result in a reduction in seasonal dengue incidence. Beginning in 2006, village volunteers conducted comprehensive surveys for immature *Aedes* during the dry season, when vector populations were at their lowest. Based on this pre-season vector data, a **single additional pre-emptive outdoor fogging with Malathion was conducted once annually before the rains began in villages** with a predefined proportion of sampled houses positive for *Aedes* immatures. **This additional procedure was associated with reduced temporal larval indices as well as an 83% reduction in reported cases** during the transmission season over the 8-year period of implementation. Two cities adjacent to Makassar experienced substantial but smaller reductions in dengue incidence; while other cities further from the intervention area did not. This represents the first time an integrated intervention strategy has been coupled with substantially reduced dengue transmission in Indonesia.





<u>Field testing of a lightweight, inexpensive, and customisable 3D-printed mosquito light trap in</u> the UK

Sci Rep. – 6 August 2019

Mosquito surveillance is a fundamental component of planning and evaluating vector control programmes. However, logistical and cost barriers can hinder the implementation of surveillance, particularly in vector-borne disease-endemic areas and in outbreak scenarios in remote areas where the need is often most urgent. The increasing availability and reduced cost of 3D printing technology offers an innovative approach to overcoming these challenges. In this study, we assessed





the field performance of a novel, lightweight 3D-printed mosquito light trap baited with carbon dioxide (CO2) in comparison with two gold-standard traps, the Centers for Disease Control and Prevention (CDC) light trap baited with CO2, and the BG Sentinel 2 trap with BG-Lure and CO2. Traps were run for 12 nights in a Latin square design at Rainham Marshes, Essex, UK in September 2018. The 3D-printed trap showed equivalent catch rates to the two commercially available traps. The 3D-printed trap designs are distributed free of charge in this article with the aim of assisting entomological field studies across the world.

Larviciding to prevent malaria transmission

Cochrane Database Syst Rev. – 14 August 2019

The findings of this review indicate low-certainty evidence of benefit from controlled studies. Further evidence on the effects of larviciding should be generated through monitoring and evaluation of programmatic implementation using concurrent control areas, perhaps in pragmatic stepped wedge designs. Although not evaluated or discussed in this review, evaluation of new technologies for identifying aquatic habitats (such as high resolution imaging) and aerial application of larvicides in malaria endemic areas may well be relevant to further refine larviciding strategies.

Larviciding versus no larviciding where mosquito aquatic habitats are < 1 $\,km^2$

Patient or population: people at risk of malaria

Setting: areas where mosquito aquatic habitats are < 1 km² (one RCT carried out in Sri Lanka, and two CBA studies carried out in Kenya and Tanzania (Yapabandara 2001; Fillinger 2009; Maheu-Giroux 2013a)). Intervention: larviciding

Comparison: no larviciding

Outcomes	Anticipated absolute effects* (95% Cl)		Relative effect (95% Cl)	Number of participants (studies)	Certainty of the evi- dence	Comments			
	Rate or risk with no lar- viciding	Rate or risk with larvi- ciding			(GRADE)				
Malaria incidence	23 episodes per 100 person-years	5 episodes per 100 per- son-years	Rate ratio 0.24	4649 person-years (1 cluster-RCT)	⊕⊕⊖⊖ Low ^{a,b} due to imprecision	Larviciding may de- crease malaria inci- dence			
Parasite prevalence	4 per 100	1 per 100	RR 0.26	5868 (1 cluster-RCT)	$\oplus \oplus \bigcirc \bigcirc$ Low ^c due to imprecision	Larviciding may de- crease parasite preva- lence			
	12 per 100	9 per 100 (9 to 11)	RR 0.79 (0.71 to 0.89)	70,902 (2 controlled before- and-after studies)	⊕⊕⊖⊖ Low ^d due to non-randomized design				
*The risk in the intervention group (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).									

* The risk in the intervention group (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI). Abbreviations: CI: confidence interval; RCT: randomized controlled trial; ICC: intracluster correlation coefficient; RR: risk ratio.





<u>Bacterial larvicides used for malaria vector control in sub-Saharan Africa: review of their</u> <u>effectiveness and operational feasibility</u>

Parasites & Vectors – 30 August 2019

The findings of this review indicated that, at low application rates, bacterial larvicide products based on *Bti* and/or *Bs* were efective in controlling malaria vectors. The larvicide interventions were found to be feasible, accepted by the general community, safe to the non-target organisms and the costs compared fairly well with those of other vector control measures practiced in SSA. Our review suggests that larviciding should gain more ground as a tool for integrated malaria vector control due to the decline in malaria which creates more appropriate conditions for the intervention and to the recognition of limitations of insecticidebased vector control tools.

<u>Semi-field evaluation of the cumulative effects of a "Lethal House Lure" on malaria mosquito</u> mortality

Malaria Journal – 30 August 2019

There is growing interest in the potential to modify houses to target mosquitoes with insecticides or repellents as they search for human hosts. One version of this 'Lethal House Lure' approach is the In2Care[®] EaveTube, which consists of a section of polyvinyl chloride (PVC) pipe fitted into a closed eave, with an insert comprising electrostatic netting treated with insecticide powder placed inside the tube. Preliminary evidence suggests that when combined with screening of doors and windows, there is a reduction in entry of mosquitoes and an increase in mortality. However, the rate of overnight mortality remains unclear. The current study used a field enclosure built around experimental huts to investigate the mortality of cohorts of mosquitoes over multiple nights.



Very few (0–0.4%) mosquitoes were able to enter huts fitted with insecticide-treated tubes and closed windows. In contrast, mosquitoes continually entered the control huts, with a cumulative mean of 50–80% over 2 to 4 days. Baseline mortality with control huts was approximately 2–4% per day, but the addition of insecticide-treated tubes increased mortality to around 25% per day. Overall cumulative mortality was estimated to be up to 87% over 4 days when huts were fitted with tubes.

Only 20–25% of mosquitoes contacted insecticide-treated tubes or entered control huts in a given night. However, mosquitoes continue to host search over sequential nights, and this can lead to high cumulative mortality over 2 to 4 days. This mortality should contribute to community-level reduction in transmission assuming sufficient coverage of the intervention.

Read news of the latest results in the news section below and in this news release: <u>vory Coast Trial with</u> <u>In2Care[®] EaveTubes shows almost 40% reduction in malaria cases on top of bednets</u>

<u>Evaluation of the residual effectiveness of Fludora™ fusion WP-SB, a combination of</u> <u>clothianidin and deltamethrin, for the control of pyrethroid-resistant malaria vectors on Bioko</u> Island, Equatorial Guinea

Acta Tropica – August 2019

Highlights

- Bioko Island malaria vector are phenotypically resistant to pyrethroids.
- Target site and metabolic resistance to pyrethroids have been implicated in the vectors.
- Bayer developed a combination of clothianidin and deltamethrin insecticides for IRS.
- The combination was effective in controlling the Bioko resistant vectors.
- The residual life of the combination on wooden surface for IRS was 8 months.





<u>Effect of Bacillus thuringiensis var. israelensis Sugar Patches on Insecticide Resistant</u> Anopheles gambiae s.l. Adults

J Med Entomol – 3 September 2019

This study explores a new approach for vector control. Patches containing *Bacillus thuringiensis var. israelensis* (Bti) solubilized Cry toxins mixed with sugar were developed and tested in the laboratory with pyrethroid-resistant *Anopheles gambiae* s.l. using tunnel tests.

<u>Reducing malaria burden and accelerating elimination with long-lasting systemic insecticides:</u> <u>a modelling study of three potential use cases</u>

Malaria Journal – 5 September 2019

This work explores the conditions under which long-lasting systemic insecticides would have a substantial impact on transmission and burden. Hypothetical long-lasting systemic insecticides with effective durations ranging from 14 to 90 days are simulated using an individual-based mathematical model of malaria transmission. The impact of systemic insecticides when used to complement existing vector control and drug campaigns is evaluated in three settings—a highly seasonal high-transmission setting, a near-elimination setting with seasonal travel to a high-risk area, and a near-elimination setting in southern Africa. Models predict that long-lasting systemic insecticides can play a critical role in reducing burden or eliminating malaria in a range of contexts with different target populations, existing malaria control methods, and transmission



Waterproof, low-cost, long-battery-life sound trap for surveillance of male Aedes aegypti for rear-and-release mosquito control programmes

Parasites & Vectors – 6 September 2019

Sterile male rear-and-release programmes are of growing interest for controlling *Aedes aegypti*, including use an "incompatible insect technique" (IIT) to suppress transmission of dengue, Zika, and other viruses. Under IIT, males infected with *Wolbachia* are released into the suppression area to induce cytoplasmic incompatibility in uninfected populations. These and similar mosquito-release programmes require cost-effective field surveys of both sexes to optimize the locations, timing, and quantity of releases. Unfortunately, traps that sample male *Ae. aegypti* effectively are expensive and usually require mains power. Recently, **an electronic lure was developed that attracts males** using a 484 Hz sinusoidal tone mimicking the female wingbeat frequencies, broadcast in a 120 s on/off cycle. When deployed in commercially available gravid *Aedes* traps (GATs), the new combination, sound-GAT (SGAT), captures both males and females effectively. Given its success, there is interest in optimizing SGAT to reduce cost and power usage while maximizing catch rates. Power- and costoptimized, waterproofed versions of male *Ae. aegypti* acoustic lures in GATs are now available for field use in areas with sterile male mosquito rear-and-release programmes.





Malaria eradication within a generation: ambitious, achievable, and necessary

The Lancet – 8 September 2019

This comprehensive must read has something for everyone:

Section 1: context, lessons from the past, and alternatives to malaria eradication

Section 2: modelling the trajectory for malaria

Section 3: management and operations

Section 4: biological challenges to eradication

Section 5: innovations and new tools

Section 6: financing malaria eradication

Section 7: leadership, governance, and accountability

Section 8: alignment with broader health and development goals

Section 9: conclusions and recommended actions

The Lancet Commission on Malaria Eradication (the Commission) was convened to consider whether malaria eradication is feasible, affordable, and worthwhile. In this report of the Commission, we synthesise existing evidence and new epidemiological and financial analyses to show that malaria eradication by 2050 is a bold but attainable goal, and a necessary one given the neverending struggle against drug and insecticide resistance and the social and economic costs associated with a failure to eradicate.

Semi-field and indoor setups to study malaria mosquito swarming behavior

Parasites & Vectors – 11 September 2019

The recent resurgence of interest in sterile insect techniques to control vector mosquitoes has renewed interest in novel methods for observing mating behavior. Malarial vectors of the Anopheles gambiae complex are known to mate in swarms at specific locations at dawn and dusk. Most knowledge of mosquito swarming behavior is derived from field observations and a few experimental studies designed to assess critical parameters that affect mosquito swarming. However, such studies are difficult to implement in the field because of uncontrollable environmental factors and mosquito conditions. Here, we present two experimental setups specifically designed to analyze mosquito swarming behavior and provide evidence that swarming behavior of mosquitoes can be generated and accurately assessed under both semi-field and laboratory conditions.

<u>Reduction of malaria vector mosquitoes in a large-scale intervention trial in rural Burkina Faso using</u> <u>Bti based larval source management</u>

Malaria Journal – 14 September 2019

Alongside the use of long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS), targeting the

vector larvae with biological larvicides, such as *Bacillus thuringiensis israelensis (Bti)* is gaining importance as a means of reducing the number of mosquito larvae before they emerge to their adult stage. This study presents data corroborating the entomological impact of such an intervention in a rural African environment.

Methods

The study extended over 2 years and researched the impact of biological larviciding with *Bti* on malaria mosquitoes that were caught indoors and outdoors of houses using light traps. The achieved reductions in female *Anopheles* mosquitoes were calculated for two different larviciding choices using a regression model.





Results

In villages that received selective treatment of the most productive breeding sites, the number of female *Anopheles* spp. dropped by 61% (95% CI 54–66%) compared to the pre-intervention period. In villages in which all breeding sites were treated, the number of female *Anopheles* spp. was reduced by 70% (95% CI 64–74%) compared to the pre-intervention period.



Conclusion

It was shown that malaria vector abundance can be dramatically reduced through larviciding of breeding habitats and that, in many geographical settings, they are a viable addition to current malaria control measures.

Windborne long-distance migration of malaria mosquitoes in the Sahel

Nature – 3 October 2019

Studies seeking to understand the paradoxical persistence of malaria in areas in which surface water is absent for 3–8 months of the year have suggested that some species of *Anopheles* mosquito use long-distance migration3. Here we confirm this hypothesis through aerial sampling of mosquitoes at 40–290 m above ground level and provide—to our knowledge—the first evidence of windborne migration of African malaria vectors, and consequently of the pathogens that they transmit. Ten species, including the primary malaria vector *Anopheles coluzzii*, were identified among 235 anopheline mosquitoes that were captured during 617 nocturnal aerial collections in the Sahel of Mali. Notably, females accounted for more than 80% of all of the mosquitoes that we collected. Of these, 90% had taken a blood meal before their migration, which implies that pathogens are probably transported over long distances by migrating females. The likelihood of capturing *Anopheles* species increased with altitude (the height of the sampling panel above ground level) and during the wet seasons, but variation between years and localities was minimal. Simulated trajectories of mosquito flights indicated that there would be mean nightly displacements of up to 300 km for 9-h flight durations. Annually,



Extended Data Fig. 3 | Photograph showing a tethered sticky-panel setup and attachment. A sticky panel (3 \times 1-m net) on a test helium balloon (of a lower volume and capacity), showing the attachment of the net covered with glue to the cord that tethers the balloon to the ground.

The four carbon poles and Velcro attachment points are shown. A close-up image of the attachment of the panel to the cord, and an image of preparations to launch a standard 3-m balloon, are also shown.





the estimated numbers of mosquitoes at altitude that cross a 100-km line perpendicular to the prevailing wind direction included 81,000 *Anopheles gambiae sensu stricto*, 6 million *A. coluzzii* and 44 million *Anopheles squamosus*. These results provide compelling evidence that millions of malaria vectors that have previously fed on blood frequently migrate over hundreds of kilometres, and thus almost certainly spread malaria over these distances. The successful elimination of malaria may therefore depend on whether the sources of migrant vectors can be identified and controlled.

WHO News and Publications

WHO Vector Control Updates

- Good laboratory practice (GLP) certification of vector control products efficacy testing sites The Institute of Medical Research (IMR), Kuala Lumpur and the Vector Control Research Centre (VCRU), Penang have received GLP compliance certification from Standards Malaysia.
- The next VCAG meeting is scheduled for 11-13 November 2019 at WHO headquarters in Geneva. An open session will be held on the first day of the meeting. The draft agenda for this session can be accessed <u>here</u>. Interested parties will be able to join the open session in person (space permitting) or by WebEx (online videoconferencing platform). All those interested in joining should notify the VCAG Secretariat by writing an email to <u>vcag@who.int</u> and indicating if they wish to attend in person or to join by WebEx.

• Vector alert: Anopheles stephensi invasion and spread

Anopheles stephensi, a highly competent vector of *Plasmodium falciparum* and *P. vivax*, is considered an efficient vector of urban malaria. Until 2011, the reported distribution of *An. stephensi* was confined to certain countries in South-East Asia and large parts of the Arabian Peninsula. Since then, the vector has been reported from Djibouti (2012), Ethiopia (2016), Sri Lanka (2017) and most recently from the Republic of the Sudan (2019). In the Horn of Africa, the vector seems to be spreading from its first site of detection (Djibouti) to neighboring countries.

Anopheles stephensi Map.

WHO considers the spread of *An. stephensi* to be a major potential threat to malaria control and elimination in Africa and southern Asia. This vector alert has been developed to urge WHO Member States and their implementing partners – especially those in and around the Horn of Africa, the Republic of the Sudan and surrounding geographical areas, and in Sri Lanka – to take immediate action.

This vector alert provides detailed information on:

- what African countries, especially those in and around the Horn of Africa, should do now;
- what countries should do in areas where the vector has been detected; and
- how interventions should be monitored and evaluated.

• WHO and International Atomic Energy Agency collaboration on Sterile Insect Technology

The Special Programme for Research and Training in Tropical Diseases (TDR) and Department of Neglected of Diseases (NTD) in collaboration with International Atomic Energy Agency (IAEA) are working together on exploring the requirements and feasibility of Sterile Insect Technique (SIT) for aedes-borne diseases. A Memorandum of Understanding has been signed between TDR and IAEA, to collaborate on testing the SIT technology. They also have:

1) developed a Guidance document to test the SIT against Aedes-borne diseases, it is planned to be released by end of September 2019; and



 released a Call for Application to select consortiums to test the Sterile Insect Technology (SIT) against diseases, with a focus on Aedes transmitted diseases. The deadline for submission is 27 September 2019. For more information please visit:

In addition, TDR have launched a study on the feasibility of the SIT in the Caribbean to prevent and control emerging arboviruses in the region.

The *report of the 10th VCAG meeting* is now online.

Overview

Experts from the WHO Vector Control Advisory Group (VCAG) and stakeholders convened in Geneva on 13-15 May 2019 for the tenth VCAG meeting. The following product classes were reviewed during the meeting:

- Off-cycle reviews
 - Sterile insect technique / incompatible insect technique
 - o Auto-dissemination devices
- Interventions reviewed during the meeting
 - Adulticidal oviposition and larvicidal traps new product
 - Endectocides new product
 - Spatial repellents review of data
 - Population reduction gene drive approach update
 - Attractive targeted sugar bait update

WHO PUBLICATIONS

- <u>Managing pesticides in agriculture and public health An</u> overview of FAO and WHO guidelines and other resources
- <u>WHO's Strategic Advisory Group on Malaria Eradication</u> (SAGme) report
- MPAC report

On 2-4 October 2019, the WHO Malaria Policy Advisory Committee (MPAC) convened to review updates, progress and to provide guidance with respect to specific areas of work carried out by the Global Malaria Programme. The meeting included eight sessions focused on 14 topics: (1) an update on the "High burden to high impact" approach and the "One WHO Africa malaria programme";

(2) an update on the RTS,S Malaria Vaccine Implementation Programme;

(3) an update from the Malaria Vaccine Advisory Committee;

(4) the use of non-pharmaceutical forms of Artemisia;

(5) an update on malaria elimination in the Greater Mekong Subregion;

(6) an update on the Strategic Advisory Group on malaria eradication;

(7) an update on the informal consultation to reconsider the formulation of malaria policy guidance;(8) a technical consultation to review the role of drugs in malaria prevention for people living in endemic settings;

(9) an update on the technical consultation on malaria case management in the private sector in highburden countries;

(10) an update on the technical consultation on institutionalizing integrated community case management;

- (11) an update on the technical consultation on genomic surveillance;
- (12) an update on the technical consultation on Anopheles stephensi;







(13) the revision of the WHO classification of glucose- 6-phosphate dehydrogenase variants and the International Classification of Diseases; and
(14) an update on Malaria Elimination 2020 and STOP-Malaria.

Useful websites and resources



<u>MESA Track</u> is as an open and online platform for sharing information on current projects relevant to malaria elimination and eradication research agenda. Help the community and Submit Your Project. **MESA welcomes your inputs about other projects**. If you would like to include your project in the MESA Track

database, kindly contact directly Ms Maria Tusell, maria.tusell@isglobal.org

Monthly MESA highlights are also available online.

- 10/28/2019 Our October highlights
- 09/20/2019 Our September highlights
- 08/26/2019 <u>Our August highlights</u>
- 07/31/2019 <u>Our July highlights</u>

The report of the <u>*RBM Vector Control in Humanitarian Emergencies*</u> meeting hosted by the UN Foundation in Washington DC on 27 September 2019 is now available.

Mission Statement

To reduce human suffering and death from vector-borne diseases in Humanitarian Emergencies by:

- a) improving delivery, uptake, integration and evaluation of existing vector surveillance and control tools;
- b) facilitating the development of an evidence-base and uptake of supplementary and emerging tools.

Convened through the VCWG Integrated Vector Management Work Stream and led by led by RBM, UNICEF, MSF and MENTOR, this was the first large meeting of the initiative that included significant Industry engagement.

On September 30th, a new course was launched "MalariaX: Defeating Malaria from the Genes to the Globe" which is free, open-access and will run from September 30–March 31, 2020. Enroll today here



APMEN Resources

10/07/2019 - LIVESTREAM: Lancet Commission on Malaria Eradication Asia-Pacific Launch 09/16/2019 - APMEN Newsletter - September 2019 07/16/2019 - APMEN Newsletter July 2019



Pan-African Registration Landscape for Vector Control Tools

Innovation to Impact is proud to present a newly developed database on the registration of Vector Control products in Sub-Saharan Africa. Over the past 9 months i2i and its partners have worked to





define regulatory systems throughout Sub-Saharan Africa through a series of over 130 interviews and 'deep dive' in-country visits. The results provide an overview of regulatory practices throughout the continent and insights into the successes and challenges experienced by manufacturers and regulators. See document below for:

- High-level view of registration authorities for 48 countries and registration requirements for 20 countries
- Summary of registration challenges for VC products across the continent based on over 130 interviews and in-country visits
- Summary table of the VC registration authorities, process, and requirements for 12 focus countries

Pan-African Registration Landscape for Vector Control Tools Panorama Pan-Africano de registo para os Produtos de Controlo Vectorial Le paysage panafricain d'enregistrement des outils de lutte anti-vectorielle

Recent and upcoming events of note



The <u>85th Annual Meeting</u> of the American Mosquito Control Association will be held March 16-20, 2020 in Portland, Oregon.

AMCA 86TH ANNUAL MEETING





<u>PAMCA</u>

The 6th Pan-African Mosquito Control Association (PAMCA) Annual Conference was held last month in Yaoundé, Cameroon. Thanks to the MESA Correspondents who covered the conference and reported daily updates and other meeting related materials.

PAMCA highlights from MESA

<u>ASTMH 2019 Workshop about spatial intelligence and digital mapping to optimize disease surveillance and</u> <u>response by Akros</u>, deadline November 20, 2019

In the news

The Lancet: Malaria can and should be eradicated within a generation, declare global health experts Official Press Release

9 September 2019, London -- A future free of malaria, one of the world's oldest and deadliest diseases, can be achieved as early as 2050, according to a new <u>report published today by The Lancet Commission</u> on malaria eradication.

Authored by 41 of the world's leading malariologists, biomedical scientists, economists, and health policy experts, this seminal report synthesizes existing evidence with new epidemiological and financial analyses to demonstrate that – with the right tools, strategies, and sufficient funding – eradication of the disease is possible within a generation. The Commission's report is the first peer reviewed, academic document of its kind.





<u>New book details the battle between man and</u> <u>mosquitoes</u>

CBS This Morning Published: 3 Aug 2019 The image to the right will take you to a short video review of the book with some interesting footage and interviews with several of our collegues.



Ivory Coast Trial with In2Care[®] EaveTubes shows almost 40% reduction in malaria cases on top of bednets

Malaria case incidence was reduced by 38% in villages that had the In2Care® EaveTube intervention in comparison to control villages that received only bednets. A community effect was also demonstrated when the intervention coverage was above 60%. Dr. Raphael N'Guessan revealed that the highly resistant mosquito population was halved, and that the Entomological Inoculation Rate was reduced with 60%.

Final results will be published later this year. In2Care is now expanding its malaria control efforts to Tanzania. Together with local partners from TPRI and CUHAS, In2Care[®]



EaveTubes will be installed in accommodations of Kagera Sugar Limited. With over 10,000 on-site employees and family members, this sugar manufacturer is struggling with increasing malaria cases and reduced productivity.

More on EaveTubes in Africa here

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.