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**Selected Recent Publications**

[Prediction of mosquito species and population age structure using mid-infrared spectroscopy and supervised machine learning](#)

Wellcome Open Res. 16 Sep 2019

Mosquito age is a key parameter to monitor as an entomological end-point relevant to vector control intervention effectiveness but methods and tools to help estimate mosquito age are limited. Here is a paper exploring one method using mid-infrared spectroscopy.

[Management of insecticide resistance in the major Aedes vectors of arboviruses: Advances and challenges.](#)

PLoS Negl Trop Dis. Published 10 Oct 2019

This Review first aims to (i) identify the main factors affecting the evolution of resistance, (ii) define the principles and concepts underlying IRM, and (iii) evaluate the value of existing monitoring tools and the implementation of resistance monitoring in control programs. Then, the different IRM strategies applicable for Aedes mosquito vectors are reviewed with examination of available data and lessons from IRM strategies

used for other vector species and agricultural pests. Finally, a roadmap toward a global plan for IRM in *Aedes* spp. is proposed.

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### [Combined sterile insect technique and incompatible insect technique: The first proof-of-concept to suppress \*Aedes aegypti\* vector populations in semi-rural settings in Thailand](#)

PLoS Negl Trop Dis. 28 Oct 2019

This paper follows the report in our last issue of a similar trial against *Ae. albopictus* in China (see [Incompatible and sterile insect techniques combined eliminate mosquitoes](#), Nature – 17 July 2019). In this study, the authors report on the pilot trial of an alternative, safe, and environmental friendly approach to suppress *Ae. aegypti* mosquito populations. This alternative method involves the release of sterile *Ae. aegypti* males that were infected with, naturally-occurring, insect bacteria *Wolbachia*, and were irradiated at low doses to obtain full sterilization. The pilot trial involved the release of 100–200 sterile males per household in a treated area over a 6-month period. High efficacy of this approach was evidenced from a significant reduction in the numbers of wild *Ae. aegypti* females and an increase in sterility by reduction in the egg hatch rate of wild *Ae. aegypti* females in the treated area.

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### [Effect of metofluthrin-impregnated spatial repellent devices in combination with new long-lasting insecticidal nets \(Olyset® Plus\) on pyrethroid-resistant malaria vectors and malaria prevalence - Field trial in south-eastern Malawi](#)

Jpn J Infect Dis. 31 October 2019

Although this paper raises more questions than it answers, those of you interested in volatile pyrethroids will find it interesting. It presents results of a village trial in Malawi which measured the effect of metofluthrin impregnated spatial repellent devices (MSRD) in combination with LLINs on the density of pyrethroid-resistant mosquitoes and malaria prevalence in children.

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### [Efficacy of a spatial repellent for control of malaria in Indonesia: a cluster-randomized controlled trial](#)

Preprint available 5 Nov 2019

A cluster randomized, double-blinded, placebo-controlled trial was conducted to estimate protective efficacy of a spatial repellent against malaria infection at Sumba, Indonesia. Following radical cure in 1,341 children aged  $\geq 6$  months -  $\leq 5$  years in 24 clusters, households were given transfluthrin or placebo passive emanators. Monthly blood screening and biweekly human-landing mosquito catches (HLC) were performed during 10-months baseline (June 2015 to March 2016) and a 24-month intervention period (April 2016 to April 2018). Screening detected 164 first-time malaria infections and an accumulative total of 459 infections in 667 subjects in placebo-control households; and 134 first-time and 253 accumulative total infections among 665 subjects in active intervention households. The 24-cluster protective effect of 27.7% and 31.3%, for time to first-event and overall (total new) infections, respectively, was not statistically significant. Purportedly, **this was likely due in part to zero to low incidence in some clusters, undermining the ability to detect a protective effect from spatial repellent intervention**. Subgroup analysis of 19 clusters where at least one malaria infection occurred during the baseline showed **36.0% and 40.9%** (statistically significant at 1-sided 5% significance level;  $p = 0.0236$ ) protective effect to first-infection and overall infections, respectively. **Among 12 moderate- to high-risk clusters, a statistically significant decrease on infection by the spatial repellent was detected (60% protective efficacy)**.

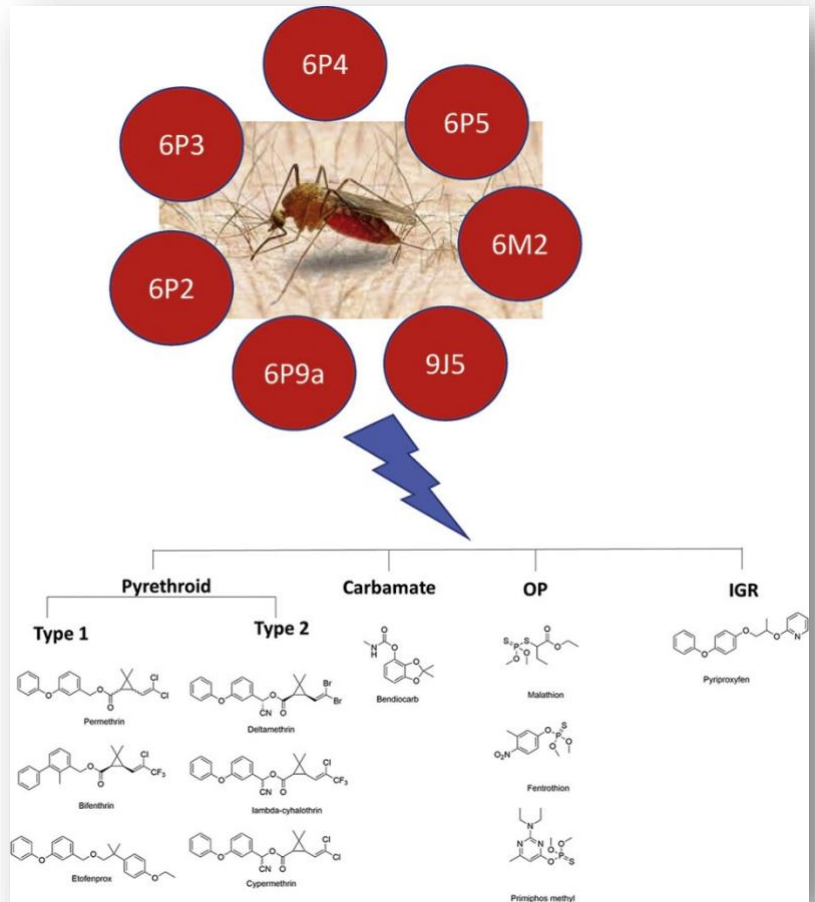
In addition to the encouraging results, the authors point out that this study highlights several challenges for consideration in future spatial repellent trials as well for new vector control intervention classes more broadly: the importance of having 'adaptive' study designs, especially for evaluation of interventions in low to moderate malaria transmission settings and/or settings with inherently large cluster-to-cluster variance on transmission intensity; and defining and identification of the 'key' entomological correlates of protection.

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### [Cross-resistance profiles of malaria mosquito P450s associated with pyrethroid resistance against WHO insecticides](#)

Pestic Biochem Physiol. Nov 2019

Extensive use of pyrethroids for malaria control in Africa has led to widespread pyrethroid resistance in the two major African vectors of malaria *An. gambiae* and *An. funestus*. This is often associated with constitutively elevated levels of cytochrome P450s involved with pyrethroid metabolism and detoxification. P450s have the capacity to metabolise diverse substrates, which raises concerns about their potential to cause cross-resistance. A bank of seven recombinant P450s from *An. gambiae* and *An. funestus* commonly associated with pyrethroid resistance were screened against twelve insecticides representing the five major classes of insecticides recommended by WHO for malaria control. The results suggest that P450s present at elevated levels in two major Anopheline vectors of malaria in Africa have the capacity to metabolise a diverse range of pyrethroid and organophosphate insecticides as well as pyriproxyfen that could impact vector control.



[Characterisation of Anopheles strains used for laboratory screening of new vector control](#)

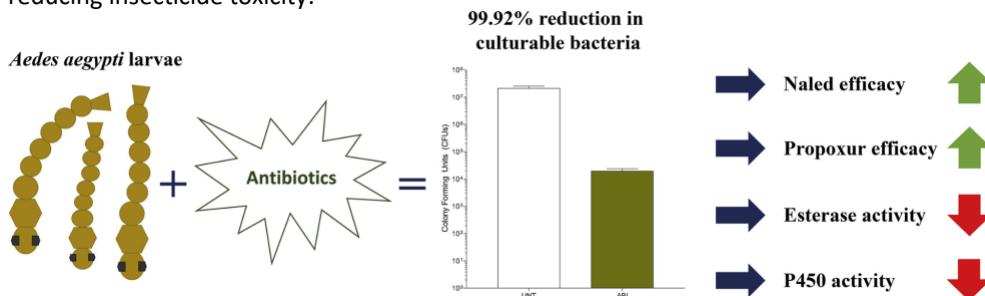
Parasites & Vectors - 5 November 2019

Potential new insecticides must be screened against a range of characterized mosquito strains to identify potential resistance liabilities. The Liverpool School of Tropical Medicine maintains three susceptible and four resistant *Anopheles* strains that are widely used for screening for new insecticides. The properties of these strains are described in this paper.

[Bacteria-mediated modification of insecticide toxicity in the yellow fever mosquito, Aedes aegypti.](#)

Pestic Biochem Physiol. Nov 2019

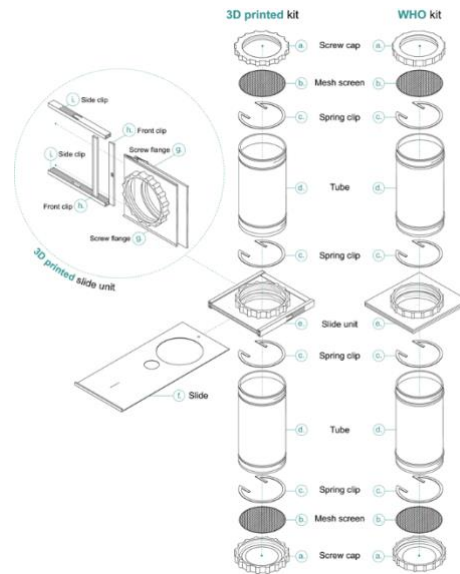
Reduction of bacteria in *Aedes aegypti* larvae using broad-spectrum antibiotics was found to decrease the metabolic detoxification of propoxur and naled, suggesting that the bacteria themselves may be contributing to the in vivo metabolic detoxification of these insecticides. This was supported by in vitro assays using culturable gut bacteria isolated from mosquito larvae which demonstrated that the bacteria were capable of reducing insecticide toxicity.



## [Open source 3D printable replacement parts for the WHO insecticide susceptibility bioassay system](#)

Parasites & Vectors - 14 November 2019

Malaria vector control and research rely heavily on monitoring mosquito populations for the development of resistance to public health insecticides. One standard method for determining resistance in adult mosquito populations is the World Health Organization test (WHO bioassay). The WHO bioassay kit consists of several acrylic pieces that are assembled into a unit. Parts of the kit commonly break, reducing the capacity of insectaries to carry out resistance profiling. Since there is at present only a single supplier for the test kits, replacement parts can be hard to procure in a timely fashion. The authors were able to design and print functional replacements for each piece of the WHO bioassay kit. The designs can be used to produce replacement parts for the WHO bioassay kit in any facility with a 3D printer, which are becoming increasingly widespread. 3D printing technologies can affordably and rapidly address equipment shortages and be used to develop bespoke equipment in laboratories.



## [Vector population monitoring tools for insecticide resistance management: Myth or fact?](#)

Pestic Biochem Physiol. Nov 2019

Abstract

Insecticide resistance is a large and growing problem for the control of mosquito disease vectors. The World Health Organization (WHO) established the Global Plan for Insecticide Resistance Management (GPIRM) in 2012. In that context, both classical and molecular tools, as well as entomological databases and decision support platforms have been developed and used for IRM. Despite major advances in the molecular elucidation of resistance mechanisms and the development of diagnostic tools, their impact on disease control programs has been limited. In most cases diagnostic tools provide a retrospective examination of changes imposed by insecticides rather than a prospective analysis to guide vector control strategies. The uncertainty of the predictive value of markers, the assay robustness and the common misconceptions in resistance diagnosis terminology are continuing challenges in monitoring vector resistance. Furthermore, an often logistics, as opposed to systematic scientific evidence, based approach to decision for the use of the very few alternative chemicals in vector control, has reduced the value of resistance monitoring in practice. **The current deployment of new insecticidal active ingredients should necessitate the application of companion diagnostics (CDx) and the development of modern ways for interpretation and management of the data by trained programme managers.** This will establish their real value for use in decision-making, in line with evidence based choice of chemicals in agriculture and medical applications.

## [Pyriproxyfen treated surface exposure exhibits reproductive disruption in dengue vector \*Aedes aegypti\*](#)

PLoS Negl Trop Dis. 18 Nov 2019

Given the interest in using pyriproxyfen (PPF) in rotation with other insecticides, it is important to understand how PPF impacts mosquitoes. This study reports on the results of tarsal contact to PPF-treated surface. PPF exposure drastically influenced the fecundity, fertility and adult emergence of wild *Ae. aegypti* mosquitoes in India. Results suggest that a certain minimum concentration of PPF through contact exposure can reduce the abundance of vector mosquitoes to a considerable level. The formulations based on combination of PPF and other compatible insecticides may be an impactful approach where susceptible mosquitoes are killed by the insecticide component while resistant mosquitoes are sterilised by PPF.

### [Optimising systemic insecticide use to improve malaria control](#)

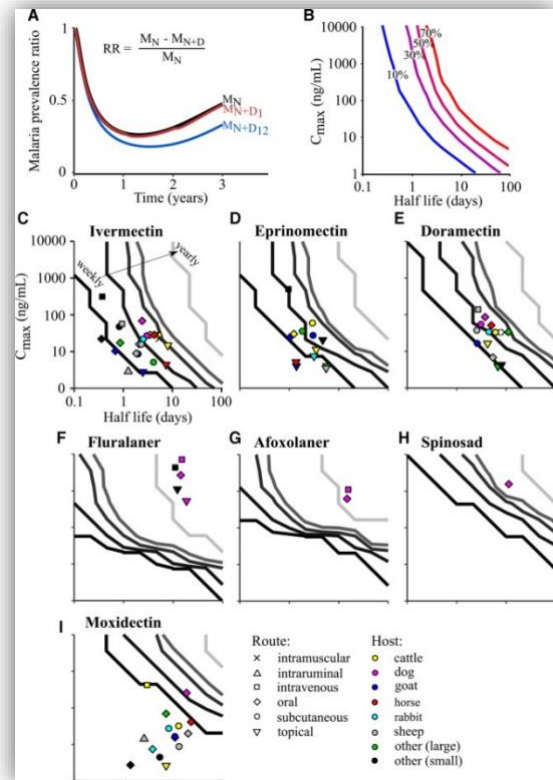
BMJ Glob Health. 11 Nov 2019

This review identifies systemic insecticide candidates and their pharmacokinetic/pharmacodynamic properties and explores the impact of alternative integrated vector control options and different dosing regimens on malaria transmission reduction through mathematical model simulation. The review identified drugs from four classes commonly used in livestock and companion animals: avermectins, milbemycins, isoxazolines and spinosyns. Simulations predicted that isoxazolines and spinosyns are promising candidates for mass drug administration, as they were predicted to need less frequent application than avermectins and milbemycins to maintain mosquitocidal blood concentrations.

### [Assessing the impact of the addition of pyriproxyfen on the durability of permethrin-treated bed nets in Burkina Faso: a compound-randomized controlled trial](#)

Malaria Journal - 2 December 2019

This paper presents results from a durability and bioefficacy trial of the PPF-permethrin net, Olyset Duo in Burkina Faso.



### [Barrier bednets target malaria vectors and expand the range of usable insecticides](#)

Nature Microbiology volume – online 2 December 2019

A team at the Liverpool School of Tropical Medicine (LSTM) have designed a new bednet that can kill mosquitoes more efficiently than existing nets, in a way that increases the choice of insecticide used, while minimising risk to the person inside the bednet. The barrier net design is simply an extra panel of netting



positioned above a standard bednet's roof, where mosquitoes collide with it as they fly back and forth above the net. The results from initial studies show that Barrier Bednets with an appropriate treatment were highly effective against wild insecticide resistant *Anopheles gambiae* vectors in Burkina Faso. Remarkably, this was the case even when the bednet was untreated and only the barrier carried insecticide. Also see the online news story below [Why I offered myself up as bait to blood-sucking mosquitoes](#)

### [Active dispersal of Aedes albopictus: a mark-release-recapture study using self-marking units](#)

Parasites & Vectors volume : 12 December 2019

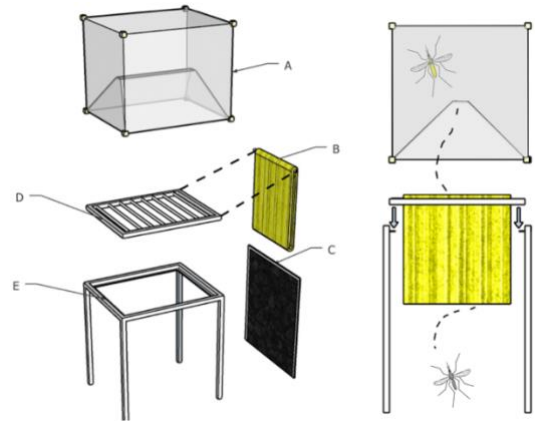
This method of marking *Aedes albopictus* provides a new tool to help estimate age and measure dispersal of wild mosquito populations.



### [The development and evaluation of a self-marking unit to estimate malaria vector survival and dispersal distance](#)

Malaria Journal - 23 Dec 2019

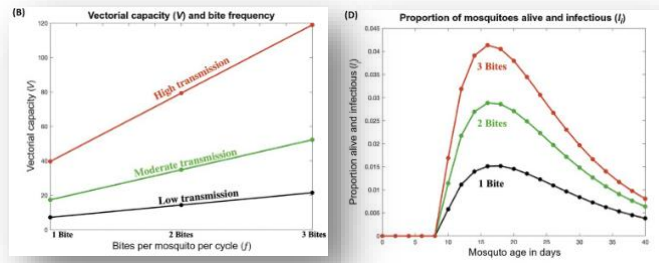
Similar to the above paper on *Ae. albopictus*, this study demonstrates the successful use of a self-marking device in an MMRR study with African malaria vectors. This method may be useful in investigating population structure and dispersal of mosquitoes for deployment and evaluation of future vector control tools, such as gene drive, and to better parameterize mathematical models.



### [Multiple Blood Feeding: A Force Multiplier for Transmission](#)

Trends in Parasitology – Published: December 2019

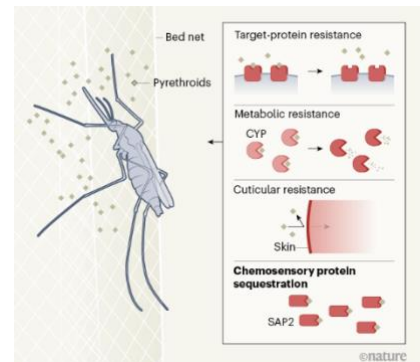
Gonotrophic discordance, the phenomenon of taking multiple blood meals per gonotrophic cycle, is also known as multiple blood feeding (MBF). This is distinct from interrupted feeding, where defensive behavior from the host causes temporary disengagement followed by a resumption of feeding. Multiple blood feeding appears to be beneficial for *Anopheles* females, increasing fecundity, longevity, and resistance to insecticides all of which could contribute to increased disease transmission. These factors notwithstanding, MBF directly increases the number of potentially infective bites, the impact of which we highlight here.



### [A sensory appendage protein protects malaria vectors from pyrethroids](#)

Nature - Epub 25 Dec 2019

Here the authors report that expression of a sensory appendage protein (SAP2), which is enriched in the legs, confers pyrethroid resistance in *Anopheles gambiae*. Mining of genome sequence data reveals a selective sweep near the SAP2 locus in the mosquito populations of three West African countries (Cameroon, Guinea and Burkina Faso) with the observed increase in haplotype-associated single-nucleotide polymorphisms mirroring the increasing resistance of mosquitoes to pyrethroids reported in Burkina Faso. The study identifies a previously undescribed mechanism of insecticide resistance that is likely to be highly relevant to malaria control efforts.



### [Mosquito Age Grading and Vector-Control Programmes](#)

Trends Parasitol. - Jan 2020

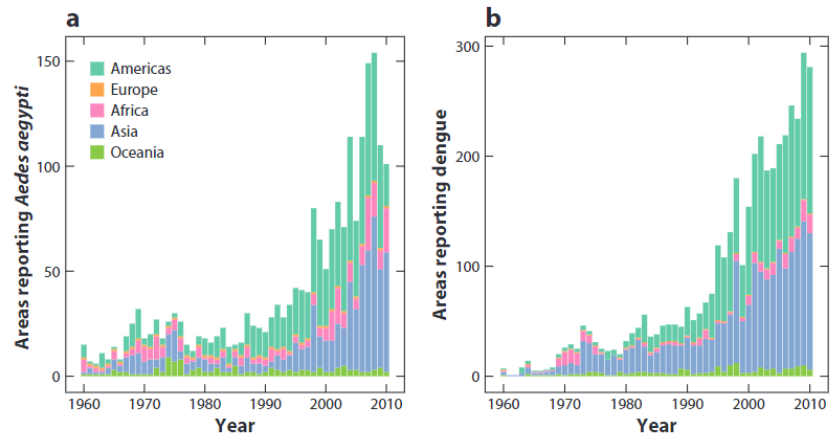
New guidelines on evaluating vector-control tools highlight the need for entomological-based measures that predict epidemiological outcomes. Mosquito survivorship is the key variable in epidemiological models of vector-borne disease, but existing morphological measures of age are technically demanding, subjective, and have little utility for arbovirus vectors. Emerging techniques in spectroscopy and existing transcriptional approaches may overcome many of the problems of conventional morphological techniques but their true utility has yet to be tested. Future studies on age grading must focus on the ability of the new technologies to estimate the age of wild-caught adults and provide convincing field validations, replicated across field sites. This will require blinded trials against existing correlates of age (e.g., parity, infection, or the recapture rates of released mosquitoes).

## [The Global Expansion of Dengue: How \*Aedes aegypti\* Mosquitoes Enabled the First Pandemic Arbovirus](#)

Annu Rev Entomol Published 7 Jan 2020

### Abstract

Dengue is an emerging viral disease principally transmitted by the *Aedes (Stegomyia) aegypti* mosquito. It is one of the fastest-growing global infectious diseases, with 100-400 million new infections a year, and is now entrenched in a growing number of tropical megacities. Behind this rapid rise is the simple adaptation of *Ae. aegypti* to a new entomological niche carved out by human habitation. This review describes the expansion of dengue and explores how key changes in the ecology of *Ae. aegypti* allowed it to become a successful invasive species and highly efficient disease vector. We argue that characterizing geographic heterogeneity in mosquito bionomics will be a key research priority that will enable us to better understand future dengue risk and design control strategies to reverse its global spread.



**Figure 2**

The rise in the global number of areas (first administrative level, e.g., state) reporting *Aedes aegypti* and dengue. Data taken from References 70 and 87.

## WHO News and Publications

### WHO Vector Control Updates

#### [New tools, technologies and approaches for vector control](#)

11 November 2019

This webpage provides an overview of new tools, technologies and approaches for vector control – collectively referred to as “interventions” – that have been submitted to WHO for evaluation. It is targeted at non-experts as an introduction to this rapidly evolving field. If the interventions under evaluation by WHO demonstrate efficacy in controlling diseases such as malaria, dengue, Zika virus disease, chikungunya and leishmaniasis, WHO will formulate new policy recommendations or amend existing ones to support their deployment.

### Eleventh meeting of the WHO Vector Control Advisory Group

29 January 2020 | [Meeting report](#)

Experts, innovators and other stakeholders met in Geneva on 11–13 November 2019 for the eleventh meeting of the WHO Vector Control Advisory Group (VCAG). This report details the proceedings and outcomes of the meeting, including advice provided to the following applicants:

- endectocides,
- lethal house lures,
- piperonyl butoxide-impregnated nets,
- spatial repellents and
- *Wolbachia* suppression.

## WHO PUBLICATIONS

### [2019 World Malaria Report](#) released

4 December 2019

The number of pregnant women and children in sub-Saharan Africa sleeping under insecticide-treated bed nets and benefiting from preventive medicine for malaria has increased significantly in recent years, according to the World Health Organization's World malaria report 2019. However, accelerated efforts are needed to reduce infections and deaths in the hardest-hit countries, as progress stalls. Last year, malaria afflicted 228 million people and killed an estimated 405 000, mostly in sub-Saharan Africa.

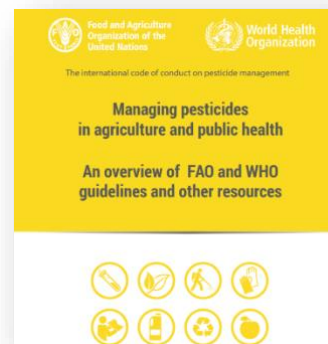


### [Managing pesticides in agriculture and public health -- An overview of FAO and WHO guidelines and other resources - The International Code of Conduct on Pesticide Management](#)

2019

This brochure describes the technical guidelines, toolkits, databases and other resources for pesticide management developed by FAO and WHO. It is a comprehensive resource covering a range of pesticide related topics including:

- Guidelines on Pesticide Legislation
- Guidance on Pest and Pesticide Management Policy Development
- Guidance on Policy-making for Integrated Vector Management
- Pesticide Registration Toolkit
- Guidelines for the Registration of Pesticides



### [The malaria eradication challenge](#)

The Lancet Published: 8 September 2019

In this letter Tedros Adhanom Ghebreyesus, Director-General of the WHO, discusses the conclusions of the Lancet Commission on Malaria Eradication and those of the WHO Strategic Advisory Group on malaria eradication.

## Useful websites and resources

### The MESA Correspondents program 2020

Don't miss any of the science presented at malaria conferences this year. The MESA Correspondents program will cover all of these meetings:

- The [16th Biology and Pathology of the Malaria Parasite \(BioMalPar\) conference](#), in Heidelberg, Germany on May 18 - 20;
- The [8th Genomic Epidemiology of Malaria conference](#), in Hinxton, United Kingdom on June 8 - 10;
- The [20th International Congress for Tropical Medicine and Malaria](#), in Bangkok, Thailand on September 20 - 24;
- The [7th Pan - African Mosquito Control Association \(PAMCA\) Annual Conference](#), in Accra, Ghana on September 21 - 23; and
- The [69th American Society of Tropical Medicine and Hygiene \(ASTMH\) Annual Meeting](#), in Toronto, Canada on November 15 - 19.

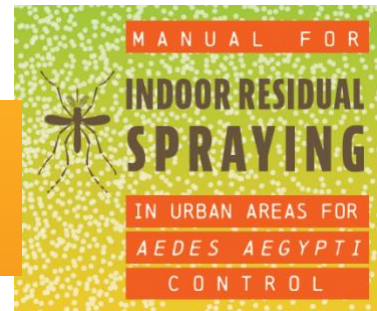
**If you are interested in being a correspondent, do not miss these opportunities!**

[Apply here](#)



[Manual for Indoor Residual Spraying in Urban Areas for Aedes aegypti Control](#)

The Manual for Indoor Residual Spraying in Urban Areas for Aedes aegypti Control is intended not only for operational personnel and middle and senior management of programs responsible for the prevention and control of Aedes-borne diseases, but also for the academic community involved in Aedes research, private pest control personnel, and the general public.



[IVCC January Newsletter](#) is available online. if you haven't already signed up please do to not miss future editions. You can do so at [www.ivcc.com](http://www.ivcc.com)



[APMEN VCWG launches ORENE](#)



APMEN Vector Control Working Group (VCWG) is delighted to announce the launch of the Online Resource Exchange Network for Entomology (ORENE) - a tool supporting the development of a community of practice for vector control in the region and enabling access to information and resources easily and effectively.

**Recent and upcoming events of note**

[Global Fund Replenishment](#)

US\$14 Billion to Step Up the Fight Against the Epidemics

The Global Fund's Sixth Replenishment Conference pledged US\$14.02 billion for the next three years – the largest amount ever raised for a multilateral health organization, and the largest amount by the Global Fund.

President Emmanuel Macron electrified the conference with a stirring appeal for partners to deliver the next



generation a better and healthier world, fighting inequality and strengthening social justice. President Macron called on all donors to increase their commitments to the Global Fund. During the pledging session that followed, donors answered that urgent call to step up the fight – many making last-minute increases on top of their original pledges.

[APMEN Joint Vector Control and Surveillance & Response Working Group Annual Meeting](#)

23-26 Mar 2010, Bangkok, Thailand

[Science of Eradication: Malaria](#) 21-26 Jun 2020, Basel Switzerland



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[DJI - Fighting Malaria in Zanzibar with Drones](#)



DJI - Fighting Malaria with Drones

346,200 views · Jan 6, 2020

9.7K 116 SHARE SAVE ...

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[Why I offered myself up as bait to blood-sucking mosquitoes](#)



An online article describing how Professor Philip McCall and his team at LSTM have spent the last 15 years on bed net innovation, testing new insecticides and studying mosquito behaviour. By better understanding how insects interact with nets, they hope to develop new designs – and protect a tool that’s saved many millions of lives. Also see above [Barrier bednets target malaria vectors and expand the range of usable insecticides](#)

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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.