New model predicts substantial reduction of malaria transmitting mosquitoes

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Anopheles gambiae mosquito, feeding on blood. Credit: James Gathany, Centers for Disease Control and Prevention

The role of mosquitoes in spreading malaria is the biggest factor behind a recent study that found them to be the 'World's Deadliest Animal'. It is

particularly concerning that current measures to control them (the most important of which is the use of insecticide treated bed-nets) are losing potency as mosquitoes are evolving resistance.

The persistence of malaria in large parts of sub-Saharan Africa has motivated the development of novel tools to complement existing control programmes. These include gene-drive technologies to modify mosquito populations, either to reduce them in number or to make the mosquitoes unable to transmit disease.

In new research published today in *BMC Biology*, from Oxford's Department of Zoology and Oxford Martin School, a team of scientists model the potential of modifying mosquitoes with a gene-drive technology called "driving-Y chromosome" to reduce mosquito populations in a one million square km area of West Africa, including all of Burkina Faso. A driving-Y chromosome has been genetically modified so that the male mosquitoes that carry it produce predominantly male offspring (which also carry the modification). Since only female mosquitoes bite, the spread of this modification will result in less females to transmit the disease, and less mosquitoes overall.

The researchers predict that introductions of driving-Y mosquitoes will cause significant reduction of the target mosquito species in some regions and complete elimination in others.

Lead researcher, Dr. Ace North, from the Department of Zoology, said: 'Gene drive holds a lot of promise for malaria control, yet the potential impact at the scale of a country has not been considered much before. We built models to help understand how a gene-drive technology could affect mosquito populations in Burkina Faso, a country with a huge malaria burden. Our results suggest it would have a major impact in reducing malaria.'

The researchers found seasonality to be the most important predictor of the local impact of the gene-drive. Population elimination is more likely in regions with mild dry seasons, while reduction is more likely in regions with strong seasonality. However, even in the most challenging environments, populations were reduced. The model suggests that this approach would have a major impact in reducing malaria.

To reach this conclusion, the scientists fed large and varied data into their models, including:

- information of more than 40,000 settlements
- locations of all rivers and lakes—seasonal and permanent
- historical rainfall data
- field data estimating mosquito population sizes and mosquito movement rates

They ran a large number of simulations on Oxford University "super-computer" facilities to explore how different factors and assumptions influence the outcome of introductions of genetically modified mosquitoes with a driving-Y chromosome.

This technology, still under development, proposes creating a driving-Y chromosome modification into the most important species of malaria mosquitoes of sub-Saharan Africa.

Professor Charles Godfray, Director of the Oxford Martin School and co-author, said: 'This study suggests that repeated introductions of modified mosquitoes over a few years into a small fraction of human settlements may be sufficient to substantially reduce the overall number of mosquitoes across the entire geographic area.'

Dr. Abdoulaye Diabate, a medical entomologist at the Institut de Recherche en Science de la Santé (IRSS), Burkina Faso, said: 'There is

evidence that this approach, with the right national and international approvals, could be rolled out within the next 10 years.'

The region to model was selected as it is one of the worst malaria affected areas in Africa and exhibits much of the wide variation in environmental conditions found in West Africa.

The researchers are part of Target Malaria, an international not-for-profit research consortium aiming at developing and sharing new, cost-effective and sustainable genetic technologies to modify mosquitoes and reduce malaria transmission.

Provided by University of Oxford

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