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The malaria mosquito: a female *Anopheles*

How has mosquito control changed since the millennium?



Better known for his work within the worldwide pest management industry, Rob Fryatt has been involved with international mosquito control projects for over 25 years. Initially involved with some of the earliest development of products for bed net treatment, Rob has subsequently contributed to strategic reports for the Boston Consulting Group (Gates Foundation Report), IVCC and WIN organisations as well as assisting many companies developing commercial mosquito management and control systems.

It is unbelievable that, less than 20 years ago, before the turn of the millennium, mosquitoes and their control weren't seen as a major market for the global pest management industry. For the British, mosquitoes were something generally only encountered on tropical holidays! Rob Fryatt of Xenex Consulting and a **Pest** Technical Advisory Board member casts an eye over what has changed.

Over the last 20 years, not only has the technology of mosquito control changed, but both public and industry awareness has risen significantly. One good example of raised public awareness in the UK is the number of mosquito nets donated by Comic Relief to Sub-Saharan Africa – over 600,000 in Uganda last year alone!

But the counter to this is how many people are actually aware each one supplied is embedded with a long-lasting insecticide, a fact seldom, if ever, picked-up by the media.

The positive impact of integrated programmes of spraying and use of bed nets, especially for young children and pregnant women, has resulted in the number of deaths since 2000 from malaria in sub-Saharan Africa dropping by 70%.

But the changes and increased awareness has not been driven by malaria alone. Over the last 15 years awareness of what are known as 'Neglected Tropical Diseases', or

NTD's, has risen equally. These NTD's include dengue fever, West Nile virus and Zika virus, amongst others.

Again public perceptions have been shaped by the media, with significant coverage of the potential harm to competitors and visitors alike visiting the Rio Olympic Games, rather than on the impact on the population of Brazil!

Commercial game-changer

Awareness alone does not create a market, nor, indeed, fund programmes for eradication or control. The threat of virus transmission by infected mosquitoes has been a commercial game changer in the USA. *Culex* sp. carrying West Nile virus (WNV) started to spread in 1999. That spread was so rapid that, by 2012, according to the US Centre for Disease Control (CDC), over 5,000 infected cases and over 200 deaths were occurring annually right across the USA. Prior to the

spread of WNV few American pest management companies were involved with mosquito control. It was left to the Government Mosquito Abatement Districts. But, with the spread of WNV, demand was so elevated that by 2012 over 30% of the members of the US National Pest Management Association (NPMA) were involved, creating a new market worth in excess of US\$ 500 million!

WNV already in Europe

Today in small pockets in Southern and Eastern Europe, WNV infected mosquitoes have already been detected and their spread continuously monitored.

With climate change driving temperatures higher towards 'warmer winters', ideal overwintering conditions for mosquitoes, the potential threat within Europe is expected to significantly increase over the next 10 years. This is already creating an increasing mosquito treatment market in Southern France, Spain and Italy, both within the domestic market and increasingly with commercial programmes for hotel and leisure complexes.

Treatment approaches are also changing. Traditionally malaria transmission was managed through extensive and labour intensive rural house spraying programmes of residual insecticides to kill adult mosquitoes. This has not only been supplemented by the significant cultural change to extensive sleeping under bed nets, but with significant use of chemical and biological control of mosquito larvae in standing water.

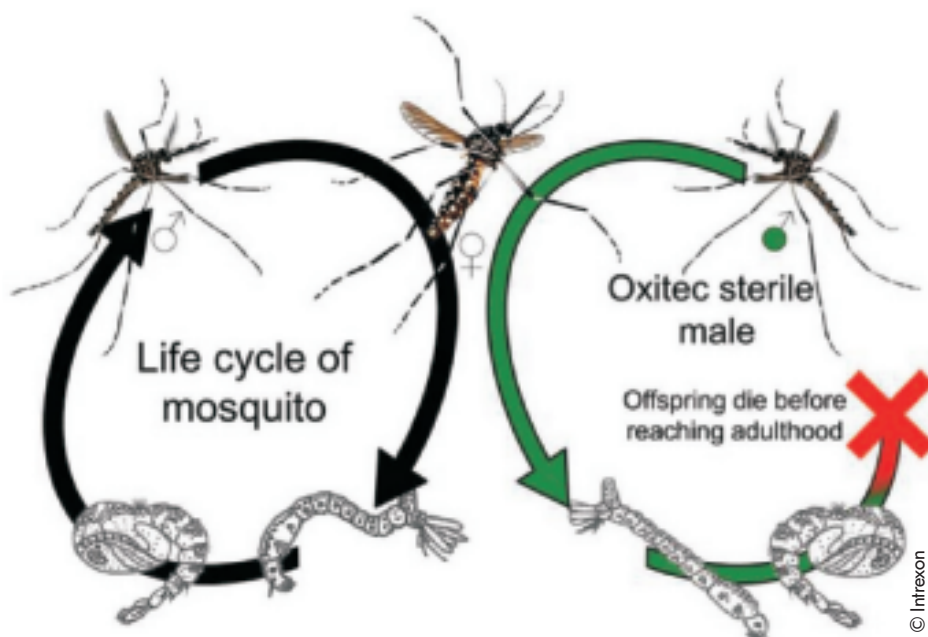
The water treatment is not only focused on larger expanses of water where larvae breed such as lakes and ponds, but also car tyres and water storage tanks – harbourages often much closer to the humans they infect.

Controlling mosquito larvae prevents and delays the build-up of mosquito populations. This is especially important in urban epidemics, such as with dengue fever, which can spread very quickly through areas of poor housing.

Sterility gene

One of the many NTDs transmitted by different species of mosquito to malaria is dengue fever. High technology systems have been developed for programmes to limit the spread and build-up of *Aedes* sp. that transmit dengue. One example is a commercial breeding programme for large numbers of male mosquitoes that carry a modified sterility gene.

These modified males are then mass



Populations of mosquitoes are being dramatically reduced through the use of British-invented technique known as RIDL (release of insect carrying dominant lethal gene)

released in target areas. Breeding occurs but does not produce viable progeny. This dramatically decreases population numbers and potential infection, but has the additional effect that the modified gene cannot be passed on into the wild population. This technique known as RIDL (release of insect carrying dominant lethal gene) is a British invention from research at Oxford University. Intrexon, now owners of the technology, has successfully commercialised its use in Brazil on a mass scale and is currently extending this experience to other markets.

But what of the future of mosquito control in the UK? There are 34 species of mosquito

native to the UK according to Dr Clare Strode of Edge Hill University in Lancashire. Responsibility for mosquito monitoring rests with Public Health England (PHE) but for England only. PHE collates data on the distribution of all British mosquitoes, working to fill the gaps in current understanding of their distribution.

The key aims of PHE in mosquito abatement are:

- To promote the surveillance of mosquitoes in the UK;
- To understand the impact of mosquitoes and their biting nuisance on people;
- To detect exotic mosquito species. ▶ ▶ ▶



The use of insecticide impregnated bed nets has been a cultural change across sub-Saharan Africa that has resulted in a massive drop in the number of deaths from malaria

Both individuals and groups are invited to help in the development of a database of mosquito distribution. This can be done by submitting photographs, or by sending in any mosquitoes collected.

In addition, PHE conducts surveillance for invasive mosquitoes, as there is considerable concern about the number of exotic mosquito species that have recently become established in Europe.

Over the last few years the Asian tiger mosquito (*Aedes albopictus*) has spread across Europe, with increasing reports of disease infected mosquitoes being trapped.

The Asian tiger mosquito is able to vector WNV and has been identified as a species that could potentially establish itself in the UK. Prior to 2016 there had been no confirmed reports of this mosquito in the UK. But, as a result of its routine surveillance, PHE has confirmed small numbers of eggs of the species in Kent in both 2016 and 2017.

Impact of climate change

The spread of mosquitoes is clearly impacted by climate change. As mosquitoes don't understand country boundaries or laws, any response cannot be successful by any one country acting alone – a co-ordinated, pan-European activity is required. This is led by the European Centre for Disease Control and Prevention (ECDC) through a system called VectorNet. But what is emerging very quickly, alongside and complementing professional networks, is the integration of 'Citizen Science'. This is where interested and committed citizens contribute sightings and pictures through mobile Apps to add to the collective knowledge.

Whereas 'Research Science' looks at small samples through expert collection and data interpretation, Citizen Science brings together much larger data blocks with the acceptance that the data will not pass scientific rigour, but it will complement, enhance and verify scientific data.

This is but one example of how technology is changing mosquito surveillance and control. Another new technology, used especially in China but also in Europe, is the use of drones for targeted application. Interesting though, since the millennium, the use of aerial application worldwide has significantly reduced due to consumer



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resistance and an increased understanding of the impact of insecticides in the wider environment.

One final factor in the changes since the millennium, and maybe the most significant of all, is what is increasingly known as 'The Gates Effect'. The US-based Bill and Melinda Gates Foundation has invested and encouraged others to invest significant billions in mosquito control, surveillance and awareness. Within a holistic approach to disease control that covers vaccines, insecticides and information technology, mosquito control has been a key platform.

Impact of the Gates Foundation

Bill and Melinda Gates have together led the assertion that Malaria can and should be eradicated. The Gates Foundation has funded direct research itself and through the Liverpool School of Tropical Hygiene (LSTH) based Innovative Vector Control Consortium (IVCC) funded product development.

This has supported many small innovators alongside encouraging the major chemical corporations such as Bayer, Sumitomo, Syngenta and BASF to increase resources directed toward novel chemical actives as

increasing resistance to pyrethroids is the single largest threat to all the progress made in disease control. This has included companies going back into their chemical libraries and retesting old inventions, developing novel actives and the 'repurposing' older chemistry in an attempt to create resistance management programmes.

The Gates Effect continues to influence global thinking, such as supporting the recent creation of a dedicated worldwide mosquito resistance consortium – WIN – to share good practice, education and to bring together influencers and researchers on a regular basis.

Much has changed in mosquito control over the last 20 years, even more will change in the next 20!

In the UK, mosquitoes may well become a regular treatment pest. This will mean changes to our education and qualifications process. It may well create specialist companies as we see today for fumigation and bird control.

For our great industry it will be a challenge to understand these new pests, to use different application equipment, techniques and to integrate modern technology even further into systems. One thing is for sure, it has the potential to add further revenue to any business ready for the challenge.



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