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2024_73_SPH_PH: Modelling strategies for the release of genetically-modified mosquitoes for arboviral control across different ecological settings

Supervisors: Dr Penny Hancock (mailto:p.hancock@imperial.ac.uk); Illaria Dorigatti, Department of Infectious Disease Epidemiology, Imperial College London; Andrew Hammond, Biocentis

Department: School of Public Health

In present conditions of accelerating environmental and socioeconomic change, it is critical to have a diverse arsenal of effective tools that can be rapidly deployed in response to new threats. Here, we will develop mathematical models to investigate the potential of novel strategies for controlling natural populations of insect pests and disease vectors that utilise cutting edge approaches in genome engineering. These strategies involve releasing insects carrying genes that spread through wild populations despite incurring fitness costs. These genes spread because they use CRISPR-based molecular mechanisms to bias their own inheritance above the normal Mendelian rate of 50%, a process known as “gene drive”. As the genes increase in frequency, the population undergoes phenotypic transformation that can manifest as population suppression or reduced rates of insect-to-human disease transmission. For instance, a gene-drive that confers female sterility has been shown to induce complete suppression of caged populations of *Anopheles gambiae* mosquitoes, a major vector of malaria. These technologies offer an environmentally beneficial alternative to existing technologies, such as chemical insecticides, because their impacts are restricted to the target organism.

We will develop an ecological modelling approach to inform the design of novel gene drive strategies to control *Aedes aegypti* mosquitoes, the major vector of several human arboviruses including the dengue, chikungunya and Zika viruses. Arbovirus transmission and prevalence is highly sensitive to climatic conditions, so it is critical to understand how our changing climate will influence their distribution and spread. Our modelling approach will represent key aspects of mosquito ecology, considering different environmental settings and projected climate change scenarios. We will use empirical data to capture ecologically realistic aspects of mosquito life history, representing effects of temperature, humidity, density-dependent population regulation, spatial landscape structure and connectivity. Model sensitivity analyses will identify key aspects of mosquito ecology that influence the fate of introduced gene drive constructs. We will link these ecological models to epidemiological analyses to investigate the potential of gene drives to reduce the burden of arboviruses across the global environmental range of Ae. aegypti under climate change.

Our candidate will be part of an industrial collaboration with Biocentis (https://biocentis.com/), a biotechnology company building sustainable solutions for genetic control of insect pest and vector species. Biocentis uses genome engineering to develop novel insect strains that can be released to reduce populations of harmful insect species that threaten agriculture, human health, and the environment. The candidate will benefit from a placement period with Biocentis, providing interdisciplinary training across academic and industrial settings. This exposure will provide unique insight into the translation from genome engineering and product development through to field trials.