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CONTROLLING URBAN ARBOVIRUSES WITH WOLBACHIA: FROM THEORY TO DATA

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Wolbachia is a maternally transmitted bacteria, that has been shown to being capable of blocking the disease transmission of dengue, and recent results suggest that is also able to block chikungunya and zika. We present a model of infection by Wolbachia of an Aedes aegypti population. This model was designed to take into account both the biology of this infection and athe ecology of the vector. The objective is to use this model for predicting the sustainable introduction of this bacteria into field population.

In this vein, we provide a complete mathematical analysis of the model proposed and give the basic reproduction ratio R_0 for Wolbachia. We observe a bistability phenomenon. Two equilibria are asymptotically stable: the mosquito population completely uninfected or completely infected; also a third unstable equilibrium exists. We are then in a backward bifurcation situation, with bistable situations occurring with natural biological values for the parameters. This is an example of an epidemiological model with only vertical transmission.

We then use the data of a real trial of releases of infected mosquitoes in Cairns (Australia) to calibrate our model. The calibrated model behaves remarkably well vis vis the observed field. Then we use the calibrated model to simulate different scenarios of appearance of dengue. We assume a worst case scenario of dengue epidemics development and take the large R_0 estimation available in the literature. The simulations confirm our findings that a dengue epidemics will not occur if Wolbachia infection is sufficiently prevalent in the Aedes populations. This suggests that the introduction of Wolbachia can become an effective control tool for dengue.

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