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A genetic model for the spread of insecticide resistance in a heterogeneous environment

Protection measures against insect borne diseases predominantly depend upon the usage of insecticides. Different strategies of delivery can use single insecticides or use them in combination. The effects of combined control interventions on the evolution of insecticide resistance in a mosquito population has not been assessed and the model presented here is designed to be a starting point.

We incorporate the use of insecticides outside the household and the advent of new generation long-lasting insecticidal nets that allegedly have increased efficacy against pyrethroid-resistant malaria vectors. Here we describe a model that allows mosquitoes to encounter insecticides in several environments and explicitly investigate the use of synergists on bednets.

The model includes two parameters that quantify the effects of using a synergist in combination with a insecticide: the reduce survival due the synergist and the proportions of mosquitoes (males and females) that encounter both chemicals. These parameters had a small correlation with male and female mean fitness suggesting that their impact in the spreading of resistance is small. A sensitivity analysis pinpointed the baseline fitness of susceptible homozygotes and the proportion of mosquitoes that enter the household as the most influential parameters and the ones that play the major role in the spread of insecticide resistance.