

Selfish DNA and the Genetic Control of Vector-Borne Diseases

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Mosquito borne diseases such as malaria and dengue cause suffering and death around the world. Malaria alone causes at least one million deaths annually, and is particularly devastating in children under the age of five. In addition to the human toll, these diseases consume vast economic resources in the very communities that can least afford it.

Various approaches to controlling these diseases such as insecticides, vaccine development, and preventive medicine have had limited success. The insect vectors responsible for spread of these diseases are widespread, numerous and adapt rapidly.

Another possibility for reducing the spread of disease by these insect vectors is genetically modifying the mosquitoes. Scientists have introduced genes into mosquitoes that render them unable to carry the human pathogens they often harbor and transmit to people. However, releasing these genetically modified mosquitoes into wild populations would not change the rate of disease transmission. In order to reduce pathogen transmission, it is critical that the modified mosquitoes supplant the wild population. Population genetics tells us that this is unlikely to occur under normal conditions even if huge numbers of modified mosquitoes are released into the wild.

One way to promote the spread of anti-pathogen genes in a population is by linking them with “selfish genetic elements”. Selfish genetic elements are pieces of DNA that propagate much more rapidly in populations than other DNA. By linking the desired genes with these rapidly spreading

selfish elements, researchers believe that entire populations of mosquitoes can be changed from vectors of deadly pathogens to merely annoying pests.

There are a number of naturally occurring selfish genetic elements. The most familiar of these are transposable elements, often called jumping genes, but more exotic examples include sex ratio distorters, and gamete killers. Each selfish element uses a slightly different mechanism involving clever molecular manipulations which result in the reduction of other genotypes. Recently, a synthetic form of one of these selfish elements, the Medea element, was created by researchers. This “tame” selfish element may be more tractable in the development of effectively modified mosquitoes, bringing researchers closer to the goal of reducing the transmission of pathogens by insect vectors.

To accomplish this goal, researchers working on the molecular biology of selfish DNA must combine forces with entomologists and population geneticists who study these same genes at the level of the organism or populations of organisms. This is a challenge because most individual researchers tend to interact only with others in their fields and often have only a superficial understanding and appreciation for work on other aspects of selfish genetic elements. In part this is because scientists from these different backgrounds do not often have an opportunity to interact and this hampers their ability develop fruitful collaborations.

To overcome this isolation, the organizers of this meeting are bringing together leading scientists working on this problem from different perspectives to exchange information and discuss new approaches for using selfish genetic elements to control vector-borne diseases. This kind of synthetic, cross-fertilization can lead to breakthroughs in research and advance the field by creating opportunities for new collaborations. The organizers hope to move the research forward in this field and shorten the time-line for producing a practical solution to controlling disease

vectors.

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Reference:

Sinkins, S.P. and Gould, F. 2006. Gene driven systems for insect disease vectors. *Nature Reviews Genetics* Vol 7:427-435.

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