The IR-4 Project
Pest Management Solutions for Specialty Crops and Minor Uses

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"All Natural" Mosquito Control?

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Citronella & its Oil

Mosquito control has long made use of biocontrol and biopesticides, although the effectiveness of these "natural" control measures has been debated and their popularity has waxed and waned relative to "conventional" pesticides. Recently there has been significant interest in reducing the use of synthetic chemicals in vector control and elsewhere, and a range of traditional and novel practices have been suggested as alternatives. This article reviews some biological and biochemical approaches to mosquito management and discusses whether "all-natural" mosquito control is feasible.

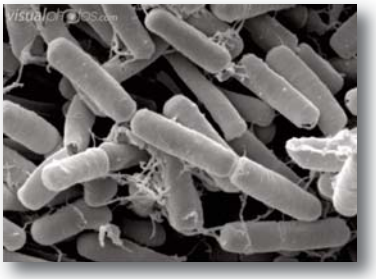
A wide range of predators and pathogens help limit mosquito populations in nature and several have been adopted as mosquito control interventions. Rearing and stocking fish so that they can eat mosquito larvae is a time-honored form of biological control, to the extent that the top-minnow *Gambusia affinis* is widely known as the "mosquitofish." Applying natural products, such as oils of citronella or lemon eucalyptus, to the skin to repel adult mosquitoes is intended to reduce biting and the risk of disease transmission without reducing vector populations. Ditching is a form of habitat management used primarily to encourage dispersal of predaceous fish. The bacteria *Bacillus thuringiensis israelensis* (Bti) and *Bacillus sphaericus* (Bs) are both sold as EPA-registered biopesticides, but Bti is dead when applied to mosquito habitats while Bs is applied as a live culture with hopes that it will persist and grow. Methoprene is a synthetic insect juvenile hormone mimic which prevents emergence of adult mosquitoes without actually killing them. Oil from the chrysanthemum species known as pyrethrum includes natural biochemicals that are toxic to mosquitoes. Thus, it is possible to distinguish naturally-derived from synthetic chemicals, but it is difficult to make meaningful general statements about "natural" approaches to mosquito control.

Pyrethrum flowers, the source for pyrethrins

As with synthetics, biocontrol organisms and natural products can target different mosquito life stages, and can be used either to kill or to repel pests. Mosquito biocontrol usually aims at killing larval mosquitoes, as this is the life stage that is most concentrated and least able to avoid predators. In addition to fish, predaceous aquatic beetles and other invertebrates can be encouraged with habitat manipulation. Bats and birds will sometimes eat adult mosquitoes, but do not effectively reduce mosquito populations; dragonflies are good predators of adult mosquito but hard to rear. Plant oils can be

used to kill larval mosquitoes but require large quantities for effective control. On the other hand, many plant oils repel mosquitoes if one is willing to reapply frequently, and pyrethrum is very toxic to adult mosquitoes in small quantities. This means that botanical extracts are effectively used by individuals to repel adult mosquitoes and by organized programs to kill them; the markets for both of these product types is large and growing.

Some new biological materials and new application methods appear promising. Many strains of entomopathogenic viruses and fungi have been screened for vector control use, and the fungus *Lagenidium giganteum* has been registered for mosquito control. In addition, botanical or bacterial extracts have been tested in volatile "spatial repellents" and in Attractive Toxic Sugar Baits, and short strands of RNA may form highly selective biopesticides.
Public interest in natural products and their use in mosquito control is likely to increase. However, natural products vary in composition and effectiveness, are less potent than synthesized analogues, can be expensive, and are not as harmless as some may hope. They can have a significant role preventing mosquito bites, but it seems highly unlikely that they will fully replace synthetic chemical repellents, larvicides, or adulticides.



Bti bacteria forming spores