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BIOCONTROL FROM A MOSQUITO CONTROL DIRECTOR'S POINT OF VIEW

E. J. BEIDLER

Indian River Mosquito Control District, P. O. Box 670, Vero Beach, FL 32961

ABSTRACT. Two principal mosquito breeding problems that occur in Florida are discussed from the standpoint of a manager of a mosquito abatement district: 1) mosquitoes that breed in standing or permanent water, and 2) mosquitoes that breed in temporary habitats such as floodwater pools. The efficacies of several different types of biological control agents are discussed for each type of problem. Fish are used in permanent water sites, and several other organisms are being evaluated. No programs are based exclusively on biological control agents. Biological control is generally not used in temporary sites. Relative costs of chemical and biological control are discussed.

INTRODUCTION

In the USA there are 2 main mosquito problems faced by most mosquito control districts. These are: 1) mosquitoes that breed in permanent or standing water, and 2) those that breed in floodwater or temporary sites.

BIOCONTROL IN STANDING WATER HABITATS

Examples of standing water breeders include mosquito species that colonize phytotelmata, tires, tin cans, and sewage lagoons—an endless list (Morris et al. 1992, Lounibos and Frank 1994). Biocontrol in standing waters can be done with a variety of agents so long as the habitat is suitable for the control agent, as well as the prey. The control agent's basic job is to stay viable long enough to do its job—in whatever manner. The biocontrol agent need not reproduce—BUT this might be the ultimate goal. We treat standing water breeding areas with chemical larvicides as needed—so why not treat them similarly with biologicals? And by using biologicals we gain control and good public relations.

Fish are often the biological control agents of choice in permanent water bodies. *Gambusia* species (appropriate for the area) are the most widely used and are virtually ideal. They can feed on a variety of items—protein sources (larvae), vegetable matter, etc. (Harrington and Harrington 1961). They can be caught and transferred easily from one site to another. They can be raised easily or purchased if necessary. As with all controls, some restrictions apply, so check with local Game and Fish authorities before introducing fish into new areas.

Our only use of biocontrol is the control of mosquitoes that breed in permanent water, such as *Anopheles* spp. and *Culex nigripalpus* Theobald in impoundments designed for control of floodwater salt-marsh *Aedes.* This is an inadvertent event because fish are always present in a diked (sealed off) marsh. However, if fish were not present, they could easily be introduced from other natural sources.

Of course, fish are not the answer for mosquitoes breeding in car tires, tin cans, or phytotelmata. Some districts are experimenting with several control agents in these habitats, such as copepods (*Mesocyclops* spp., *Macrocyclops* spp.), *Toxorhynchites,* and a number of other organisms (Service 1983, Morris et al. 1992). I know of no active control programs based solely on any of these organisms. The New Orleans Mosquito Control District (MCD) has been in the forefront of biocontrol efforts for many years with container breeders in mind. The monthly reports of the New Orleans MCD can provide a good source of practical information on biological control methods.

BIOCONTROL IN FLOODWATER HABITATS

Floodwater mosquitoes are the reason for the existence of many MCDs. Certainly in our case, if we did not have the 5,000 acres of salt-marsh *Aedes taeniorhynchus* Wiedemann breeding sites; 70,000 acres of citrus groves producing *Aedes* and *Psorophora* species (Curtis 1985); and untold acres of flatwoods, pastures, and shallow ditches breeding enormous numbers of *Psorophora* and *Culex* species, we would not have been in business since 1925.

Control of salt-march *Aedes* is accomplished with marsh management techniques in most areas and with larvicides in others. Our larvicide of choice is methoprene—a juvenile hormone compound. If these materials are included in the definition of biocontrol (as described in this program), then we are certainly into it in a big way. Fish, as mentioned above, of course play a role in control of salt-marsh *Aedes* (Harrington and Harrington 1961), but a normal brood of *Ae. taeniorhynchus* will fill up all the hungry fish that

I have ever seen on the marsh; who can tell the difference that they make on the numbers of such pest mosquitoes.

Aedes and *Psorophora* breeding in citrus groves, pastures, flatwoods, etc. are even less amenable to biocontrol. Huge broods mature from egg to adult in 5—10 days. By huge I refer to a personal communication with Alan Curtis in which he very scientifically estimates that a 580-acre grove produced 21 tons of adult mosquitoes from one flooding. A biocontrol agent with the potential to control such numbers of mosquitoes would be awesome and probably require formation of a new type of control district.

In these grove ditches there are several naturally occurring biocontrol agents at work. The most obvious are the predaceous larvae of *Psorophora ciliata* Fabricius and *Ps. howardii* Coquillett. Larvae of both species are killing machines and account for approximately 1,000 prey larvae. However, if you have seen *Ps. ciliata* and *Ps. howardii,* commonly called "Gallinippers" (take a gallon per nip), you would know why we do not encourage them too much.

OTHER BIOCONTROL POSSIBILITIES

Examining the other talks to be given in this symposium, perhaps we are using biocontrol techniques more than already mentioned. For example insect growth regulators (IGRs) are a mainstay with us and many districts, and *Bacillus thuringiensis israelensis* (*B.t.i.*) thought by some to be a biocontrol agent, is another staple larvicide (Service 1983). Deet is mentioned and although we do not use much, we do recommend it to our constituents. It could be argued that if an artificial IGR is regarded as biocontrol agent, then why not pyrethrum (a botanical) and the man-made pyrethrum substitutes (e.g., resmethrin and permethrin) (Morris et al. 1992)? Even if some of these methods are not strictly biocontrol, can it hurt to say that they are? We do not get sufficient credit for our integrated pest management programs (Popiel and Olkowski 1990). We could make up for it by bragging about biocontrol, real or imagined.

Finally, should we give up on trying to use biocontrol methods (using the strict interpretation)? Certainly not for permanent waters and container breeders. Perhaps no universally useful method will develop, but surely new and better methods will appear. Floodwater problems may be more difficult. Must they be self-perpetuating? No, nothing we use now is, so why restrict ourselves? Must biocontrol agents be cheap? Larvicides now range from $1.10/acre for Abate (temephos), $1.60/acre for ULV *B.t.i.*, $10–$15/acre for *B.t.i.* granules, $8–$12/acre for Golden Bear oil, to $82/acre for Altosid 30 day pellets ($27/brood for 3 broods). The main problems will be commercial development and registration. Mosquito control is a tiny market so any product must appeal to a lot of us or have other uses (Service 1983). Let us hope for the best.

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