WHAT MOSQUITO CONTROL DISTRICTS MIGHT WANT TO KNOW ABOUT BIOLOGICAL CONTROL[1]

H. C. CHAPMAN

Gulf Coast Mosquito Research, Agricultural Research,
Science and Education Administration,
U. S. Department of Agriculture, Lake Charles, Louisiana 70601

My presidential address at the American Mosquito Control Association meeting in 1976 was on biological control of mosquitoes, specifically the present status and future potential of biocontrol agents and other inherent problems. The main theme of the keynote address by Dr. Marshall Laird at the AMCA meeting in 1977 involved enemies and diseases of mosquitoes. Again this year, you the audience, will be bombarded by many of the same thoughts and ideas that were mentioned in those 2 previous presentations. Hopefully, repetition will serve to underscore the increasing importance of biocontrol to workers in mosquito control.

I recently attended a workshop entitled Microbial Control of Insect Pests: Future Strategies in Pest Management Systems. Integrated pest management (IPM) systems were discussed for agriculture (row crops, fruits, ornamentals), forests, rangeland, stored products, and the aquatic ecosystem. In fact, successful IPM systems, many regional or national, are now in operation for certain row crops, fruits, ornamentals, and in forests; but it was apparent that we have no IPM systems for pests or vectors in our aquatic ecosystem. The closest that we in mosquito control have come is manipulation of the environment (by source reduction); then we use chemical pesticides or fish, particularly in those areas that do not readily lend themselves to such strategies. But there is no doubt that in the future we are going to be forced to develop IPM systems in aquatic ecosystems that will provide adequate control of mosquitoes, tabanids, biting and non-biting midges and black flies. Moreover, we are going to have to integrate chemical pesticides, microbial agents, predators, and the environment so we can achieve sufficient control while we are thereby reducing the amounts of chemical pesticides and minimizing our reliance on chemical pesticides. If there were no other reasons, the continuing development of resistance would dictate it. A step in this direction was taken more than a year ago when the Southern Regional Project S-122, Biology, Ecology and Management of Rice Land Mosquito Populations in the Southern Region was approved. Presently, this project involves the Agricultural Experi-

[1] Invitational paper, Chicago meeting, April, 1978.

ment Stations in Arkansas, Louisiana, and Texas and also utilizes the cooperation and technical assistance of some mosquito control agencies and of the U.S. Department of Agriculture in making biological studies, as well as economic and health impact studies (chemical control, biocontrol, cultural control) and the environmental impact of all of the control methodologies.

But let us return to the present and what MCD's might want to know about biocontrol of mosquitoes. There are no more new biocontrol agents that can now be employed by MCD's than there were in 1976 when I spoke before this group in Boston. Our arsenal of available biocontrol weapons still includes only fishes and a mermithid nematode (*Romanomermis culicivorax*). Actually several commercial companies are interested in producing the nematode, but in its present form, this nematode must be produced in a mosquito host, and its use is somewhat restricted to freshwater habitats. The probable cost may well eliminate its use by MCD's in treating large breeding areas. An alternative might be production of nematode cultures by a MCD for the treatment of small or sensitive areas. However, the extent of control obtained with this nematode varies with the host and the site. One site was treated almost 6 years ago and today still provides almost perfect control due to the recycling of the nematode. Our pilot test in El Salvador had quite a different result. There we treated the breeding area of an entire lake 11 times in 7 weeks and were quite successful in reducing mosquito populations (a malaria vector) during the releases. However, the releases provided no further control since the nematode failed to colonize or recycle.

MCD's are undoubtedly more cost conscious than many scientists. I include especially myself. I do not worry about costs of a biocontrol agent compared with chemical pesticides until the safety and efficacy of the agent has been proven and it is ready for mass production. At that point, it is time for engineers to improve the mass production techniques and the formulation and delivery systems. In other words, the time has arrived, if MCD's are to use the biocontrol agents, to determine whether they are competitive, costwise, with chemical pesticides.

Until recently, most scientists considered a biocontrol agent a failure if it did not infect and kill at least 90–95% of the target hosts. Research now shows that a substantial reduction in fecundity or longevity in a mosquito can be very important. Also, if several biocontrol agents can be colonized and each removes 20–30% or more of the pest problem, we may have an approach that should not be overlooked.

Also, thinking scientists do not expect a biocontrol agent to operate alone; they expect it to be used in conjunction with chemical pesticides. Of course, much research remains to be done on the compatibility of chemicals and biocontrol agents. Preliminary studies indicate that the target mosquito sometimes is more susceptible than the pathogen or parasite, but some chemical pesticides are more toxic to the biocontrol agent than others. This is why we need information about the best chemical pesticide to use in a given situation. In the meantime it is not too soon for MCD's to observe the effect of chemical pesticide treatments on predators. If the cost and control achieved are similar but one chemical pesticide is more lethal to predators, it would only be sensible not to use that compound. This is particularly important since mosquito populations almost always rebound much faster from chemical control operations than their predators.

It is more difficult for MCD's to contribute in other ways, for example, to survey their area for the presence, extent, and effect of biocontrol agents such as nematodes, viruses, bacteria, protozoa, and fungi. Districts seldom have personnel blessed with the required expertise, and limited budgets and manpower, particularly in newly established MCD's, make it difficult to become involved in such research. Also, it may be difficult to

convince trustees, commissioners, or board members of the merit of such long term observations.

Nevertheless, I would like to mention two MCD's among several that have a considerable involvement in biological control of mosquitoes. Lee County MCD, Fort Myers, Florida, directed by T. Wayne Miller, Jr., has made some interesting contributions to biological control, principally in the matter of a mermithid nematode, but also with *Bacillus sphaericus,* mucilaginous seeds, hydra and a planarian. Such studies were possible because of in-house expertise and a cooperative agreement with extramural expertise. The second is the Metropolitan MCD, St. Paul, Minn., under the direction of Dr. Robert Sjogren. This MCD is not only doing some excellent studies on planaria and the hemipteran *Plea striola,* but is also looking at the benefits gained from general predators in various types of habitats.

Our knowledge of the actual numbers and kinds of microbial agents and parasites that exist in this country is quite limited; even the total distribution of presently described biocontrol agents is not known and thus speculative. However, there is an interesting positive correlation between proximity of research laboratories and records of mosquitoes infected with biocontrol agents. We probably have a wealth of unknown and untapped biocontrol agents in unsurveyed areas. Furthermore, a great deal more exploration is needed abroad to discover exotic organisms that might be more lethal to our native mosquito pests and vectors.

General interest in biocontrol of mosquitoes has increased greatly the past few years though we all know that interest alone will not provide new and effective biocontrol agents. I mentioned in my 1976 presidential address the role of the World Health Organization, Geneva, Switzerland, in attempting to coordinate the development of biocontrol agents. This past year, a Scientific Working Group on Biological Control of Insect Vectors of Disease under WHO's Special Programme on Research and Training in Tropical Diseases was formed and funded. This SWG is responsible for funding the search for and development of new biocontrol agents (only pathogens and parasites) and especially for bringing the presently known most promising biocontrol agents to large-scale field testing against important insect vectors in developing countries. Thus far, high priority has been given to spore forming bacteria (*Bacillus sphaericus* and *B. thuringiensis*), fungi (*Metarhizium anisopliae* and *Lagenidium giganteum*), a protozoan (*Nosema algerae*), and a mermithid nematode (*Romanomermis culicivorax*). Although the thrust of the SWG under WHO's Special Programme is directed against vectors of 5 tropical diseases, it is readily apparent that any of their successes will be available for mosquito control in this country.

The day of treating insect populations in the field with chemicals or biocontrol agents without regard to their effect on man and the environment is gone. Even though we are releasing microbial agents back into an environment where we found them, regulatory agencies in this country and abroad are properly demanding safety data for mammals and non-target organisms as well as efficacy data. Barring unforeseen problems in this area and assuming our ability to interest industry in commercial production, a number of biocontrol agents should be available to MCD's within a 5-year period.