Meetings

The Biological Control of Vectors

On 25 August 1970 a symposium on the biological control of vectors (*1*) took place at the 4th international colloquium on insect pathology held in College Park, Maryland. The 40 participants (*2*) included many of the specialists actively concerned with the furtherance of microbial control in public health entomology. The meeting's objective was to review achievements in this field and to consider both what has been done and what remains to be done to develop practical techniques, based upon arthropod pathogens, for use in future integrated control methodologies.

Such methodologies will reinforce naturally occurring enemies and diseases of target arthropods, through the deliberate exploitation of carefully chosen biological control agents, supported as necessary by other means (autocidal, biotechnical, mechanical, and cultural, together with chemical measures used on a highly selective basis). Ecologically acceptable procedures of this kind will correct much of the environmental deterioration now attributable to the general use of persistent pesticides, often to the exclusion of other types of control, and often, too, in reckless fashion.

Unhappily, though, years of painstaking work lie ahead before selective integrated control embodying microbial techniques becomes practical in public health entomology. Meanwhile, urgent demands are being made from many quarters for the withdrawal from use in particular countries and regions of persistent pesticides such as DDT, and even for the banning of the further manufacture of such compounds. These demands reflect increasingly widespread concern, to which the symposium subscribed, about the possible consequences (to man and other elements of his ecosystem) of a variety of undesirable side effects of the intensive use of synthetic organic chemicals.

Improperly used pesticides pose particularly serious threats to the environment. Indeed, even the selective and strictly regulated use of most pesticides probably involves some measure of hazard. Nevertheless, the fact must be faced that programs of disease eradication vital to health in many countries still depend on the continuing availability of effective pesticides combining persistency, cheapness, and safety when properly used. A notable example is the World Health Organization's global malaria eradication program. This is based upon the interruption of transmission of *Plasmodium*, largely through the highly selective application of DDT to the inner walls of dwellings to remove anopheline adults.

Over the past decade, much has been learned about the pathology of vectors. We now know of numerous potential biological control agents in this field, notably certain fungi (for example, *Coelomomyces, Metarrhizium*), spore-forming neogregarine and microsporidan protozoa, and mermithid nematodes. Much pertinent laboratory work has taken place, and field trials have been conducted with *Coelomomyces*, microsporidans, and mermithids.

Even so, and although some mosquitoes are now quite readily infectible with a few species of *Coelomomyces* in the laboratory, we still lack any culture procedures that would open the way to mass production. With regard to microsporidans, artificial infection continues to bristle with difficulties (however, these problems may eventually be solved through tissue culture). Encouraging results concerning the potential of mermithid nemathodes against blackflies are being reported, particularly from the U.S.S.R. Practical field procedures are currently under study.

Among other taxa of pathogens, the genetic manipulation of selected crystalliferous bacteria shows promise. Also, *Bacillus thuringiensis* has (with some success) been fed to chickens and cattle to inhibit breeding of muscoid flies in their feces. Otherwise, though, none of the commercially produced bacterial strains yet marketed show promise of suitability in vector control. Whereas commercially available fungal pathogens (such as *Beauveria bassiana*) are disappointingly inactive against mosquitoes, fungal toxins, when better known, may have an important role. With respect to viruses, until the last 5 or 6 years little was known about those affecting vectors in general, and practically nothing about strains pathogenic to mosquitoes. This situation has now been transformed, and reductions of mosquito populations have been achieved in local field trials.

It was pointed out that a major impediment to progress in the latter connection is the very long time it may take to collect adequate amounts of virus for experimentation where small and scantily infected natural hosts are concerned. Perhaps the use of alternative arthropod hosts much larger than mosquitoes may eventually provide a solution to the problem of obtaining reasonably large amounts of pathogenic material—for example, mosquito iridescent viruses and, for that matter, microsporidan protozoa too.

In sum, most of our progress in this field over the past decade has been in such areas as taxonomy, geographical distribution, and host occurrence. This has been in no small part due to the World Health Organization's sponsorship of worldwide surveys for potential biological control material, besides many related activities.

Ultimately, commercially available arthropod pathogens will certainly contribute to control methods (*3*). To hasten the advent of these preparations, the symposium agreed that the global survey already mentioned must be vigorously prosecuted and expanded. It was also felt that there is pressing need for intensive studies of possible hazards to the health of man and other animals (including birds susceptible to fungal infections of the lung) associated with the future use of microbial pathogens for vector control.

It was stressed that because a diversity of microbial pathogens from vectors are now known, there is no need to wait any longer before launching imaginative laboratory and field projects based upon the deliberate selection of a small group of outstandingly important vectors as target hosts. These should be exposed to a broad spectrum of candidate pathogens under laboratory and field conditions, to be carried out, wherever feasible, through collaboration between the university, government, and industrial sectors in individual countries, with international sup-

port and coordination. It was also emphasized that as acceptable microbial control may prove more difficult to achieve with respect to vectors than to many agricultural pests, it would be unwise to extrapolate experience from economic entomology directly to public health entomology. Insect pathologists thus require guidance from public health entomologists with respect to conditions of vector suppression necessary to interrupt the transmission of various diseases.

It was unanimously agreed that pending the development of practical microbial and integrated techniques of vector control we must continue to depend heavily upon carefully used pesticides. Notwithstanding this, it was pointed out that at least some alternatives to chemical control are already on hand—in particular the use of larvivorous fish in ecologically acceptable ways and "old-fashioned" sanitational methods. Until we have effective microbial procedures and other essentially novel control techniques, every effort should be made to ensure that full advantage is taken of these immediately available supplements and alternatives to chemical pesticides, in the interest of moving positively toward methodologies combining maximum vector suppression and interruption of vector-borne disease transmission with the least possible harm to the environment.

MARSHALL LAIRD
Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland, Canada

Notes

1. The term vectors is broadly interpreted herein as meaning "arthropods of public health importance."
2. Among participants the following made brief presentations as indicated: J. D. Briggs (international coordination), E. U. Canning (protozoa), H. C. Chapman (field trials of entomopathogens), C. M. Ignoffo (industrial production), M. Laird, chairman (fungi), E. L. Reeves (bacteria), D. W. Roberts (fungal toxins), T. W. Tinsley (viruses), C. Vago (viruses), and H. E. Welch (nematodes).
3. They may even perhaps contribute to autocidal control, through disease-induced sterility or lowering of fecundity.

Forthcoming Events

March

8–12. **Pollution Control** Exposition and Conf., Los Angeles, Calif. (G. D. Clayton, Soc. of Manufacturing Engineers, 20501 Ford Rd., Dearborn, Mich. 48128)

13–17. California **Medical** Assoc., Anaheim. (R. L. Thomas, CMA, 693 Sutter St., San Francisco, Calif. 94102)

14–17. International **Anesthesia Re-**