Preface

Classically, biological control (or biocontrol) has been largely associated with the deliberate use of predators, parasites, and pathogens as agents in the control of insect pests and disease vectors. To date, this branch of applied entomology has had far greater impact in the economic than in the medical aspects of the subject. Public health entomology boasts some successes, though mostly on a rather limited scale, and mostly relating to mosquitoes. Certainly, it has no achievements to compare with, for example, the spectacular saving of California's citrus industry from scale-insects through the importation of Australasian coccinellid beetles almost a century ago; or the reclamation of huge areas of Australian and South African pasture-land from prickly-pear cactus by the importation of *Cactoblastis* moths from South America in the 1920s.

This is partly because mankind's dispersal of economically important plants about the world has often resulted in the accidental dispersal of pests and weeds, which in varying degree have proved susceptible to control by means of the introduction and establishment of their natural enemies (and latterly, diseases), from the original homeland. Many of our prime vector-borne disease problems pose the need to impose drastic control — occasionally pressed to the point of local eradication — upon insects (such as many mosquito transmitters of malaria, filariasis, and arboviruses, and all of continental Africa's tsetse transmitters of human sleeping sickness and domestic-animal nagana) securely established in areas to which they are indigenous. Moreover, some of the most important insect vectors of disease, all the mosquitoes and blackflies for example, are virtually free from attack by the tiny parasitic wasps and flies collectively known as parasitoids, which have proved so important as biocontrol agents in agricultural and forestry entomology.

Therefore, the biocontrol successes against these insects of health importance have tended to be associated with the manipulation of predator populations, notably larvivorous fish of the genera *Gambusia* and *Lebistes*. In fact, beyond the realm of chemical control, environmental manipulation by, for example, source reduction, has made a larger contribution insofar as medical entomology is concerned. However, the muscoid flies and their near relatives, tsetse flies included, *do* suffer a measure of natural population limitation by parasitoids. There have been many experimental studies of these relationships, and some modest practical successes; though very modest and short-lived at least for *Glossina*.

The post-World War II period saw the widespread introduction of synthetic chemical pesticides. These brought about a revolution in insect control. They opened prospects of our at last being able not only to maximize crop production in the face of an inexorably growing human population combined with a fairly static arable land resource, but also to break the chain of transmission of such vector-borne scourges as malaria, filariasis, onchocerciasis, and sleeping sickness. Two main obstacles to the attainment of these goals duly presented themselves: (1) the highly complex problems of the resistance of insects to pesticides; and (2) the nonselectivity and environmental persistence of some of these compounds. (Lately, due to the oil crisis, another such obstacle has been raised: (3) escalating costs of pesticides.)

Meanwhile, the essentially new discipline of invertebrate pathology was emerging. Microbial control agents started to play an increasingly important role in biocontrol, alongside the "classical" agents already mentioned. Once again, though, the early achievements tended to be in economic rather than public health entomology. Stimulating epizootics among pests of monoculture crops continued to prove easier of attainment than among more diffusely scattered vector populations. Nevertheless, from the start, the potential of microbial control of medically important insects was recognized. Following promising small-scale field trials with disease-causing organisms against mosquitoes, the World Health Organization (WHO) issued an annotated list and bibliography of pathogens, parasites, and predators of medically important arthropods (Jenkins 1964) that provided an indication of the great diversity of candidate biocontrol agents awaiting intensive study.

Such study has been vigorously pursued since then. Public health entomologists, like their economic counterparts, are now generally agreed that the future lies with integrated control, within the broader parameters of pest management. This approach provides for the conjoint or sequential use of selectively applied chemical pesticides, biocontrol agents, and other new noninsecticidal procedures (e.g. based on synthetic insect growth regulators and genetic control), along with mechanical and other measures, in methodologies carefully designed not only for long-term effectiveness but also for health and environmental acceptability. Since 1972, there have been reports and compilations on the feasibility of incorporating biocontrol techniques in future integrated control programs against blackflies (IDRC 1972), mosquitoes (NAS 1973), and tsetse flies (IDRC 1974). There has also been some preliminary planning in this direction with respect to the control of the snail hosts of schistosomiasis.

The last-cited publication was the first outcome of a Scientific Advisory Group on "Tsetse Control: The Role of Pathogens, Parasites, and Predators," convened at The Memorial University of Newfoundland, St. John's, Canada, 25–29 March 1974, under the sponsorship of the International Development Research Centre (IDRC), Ottawa. This book is the second outcome of that meeting. It represents the first attempt to place between two covers the essential information on the status of existing knowledge of the natural enemies and diseases of one particular group of insect disease vectors, together with background information of ultimate relevance to the topic (i.e. pertinent facts about the taxonomy, distribution, bionomics, physiology, and control-history of that group), besides projections of the types of research and development likely to prove rewarding toward the early attainment of practical biocontrol procedures.

It is both encouraging to notice, and illustrative of the rapid maturing of the discipline of invertebrate pathology, that some notable events directly bearing upon this book's subject have taken place in the brief period since its contributors began their task less than 2 years ago. Data concerning virus-like particles from tsetse are rapidly accumulating, now that renewed interest is being taken in a fresh approach to integrated control, just as was the case with mosquitoes a decade ago. We can only hope that heightened awareness among those now handling large numbers of laboratory-reared *Glossina*, using sophisticated research technology, will be extended to large-scale surveys among "wild" tsetse and lead to the discovery of baculoviruses — nuclear polyhedrosis (NPV) and granulosis (GV) viruses—of interest as future microbial control agents. It would be an especially happy discovery at a time when these entomopathogenic entities have just been the subject of searching safety assessments. Out of this analysis has come the first-ever registration for a "viral insecticide" (U.S. Environmental Protection Agency Reg. No. 11273-17, with respect to ELCAR Sandoz Inc., Homestead, Florida), an isolate of the *Heliothis* nucleopolyhedrosis virus. The product was granted registration and label approval on 1 December 1975, for use against two crop pests, the cotton bollworm and tobacco budworm.

As the present work goes to press, an American product based on the mosquito worm *Romanomermis culicivorax* (Fairfax Biological Lab. Inc., Clinton Corners, New York) has been placed on the market in the USA as a contributor to the suppression of the larvae of many species of mosquitoes. Even more significantly, efforts are in progress to replace the present *in vivo* production of this mermithid (and others from blackflies) by *in vitro* technology. In this context, tsetse flies, while not yet known to be subject to baculovirus mortality, *are* parasitized by mermithids. Also, as recommended by the 1974 Scientific Advisory Group, an International Development Research Centre grant has been made (8 July 1975) to the Commonwealth Institute of Biological Control (CIBC) to explore the feasibility of using mutillid and bombyliid parasitoids of southern and southeastern African tsetse for *Glossina* abatement, notably in West Africa where *Mutilla* spp. are not yet known from these hosts.

Meanwhile, WHO has reaffirmed its intention to conduct field trials of bacterial and fungal microbial control agents, and selected larvivorous fish, against West African mosquito disease vectors. The Organization has also declared its interest in investigating the possibility of using biocontrol agents against tsetse flies. To this need only be added the fact that the 14th Meeting of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC), of the Organization for African Unity, convened at Dakar, Senegal, 15–17 April 1975, included among its recommendations not only "the creation of breeding units in Africa, capable of producing the principal species of *Glossina* on a large scale" (i.e. to facilitate basic research as well as genetic control) but also "that every effort should be made to intensify research on the possibility of using predators, parasites or pathogenic germs in biological control." It is hoped that our book may help toward this end.

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