PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

General Discussion

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General discussion

A. K. Minks (*Research Institute for Plant Protection, Wageningen, The Netherlands*). The organizers should be given much credit for arranging this meeting on biological control where attention has been given not only to entomological but also to the other disciplines of plant protection. It is my belief that a multidisciplinary approach is the only way to develop biological control methods and to implement them successfully. In our Institute we became aware of this and recently we decided to leave the classical organizational division in entomology, mycology, plant virology, etc. sections and to change to sections named: detection, ecology, genetics and resistance breeding, and control, in which entomologists, mycologists, etc. have a much better possibility to work together. Another example of this in the Netherlands is the operation (since 1980) of the experimental farm 'Development of Farming Systems', recently followed by a second farm with a similar set-up where systems can be studied at the farm level.

R. M. May, F.R.S. (*Department of Biology, Princeton University, New Jersey, U.S.A.*). Many speakers have emphasized the need to think about the population- or even community-level consequences of releasing viral, bacterial or other pathogenic microorganisms into the environment. In particular, such questions arise for the release of genetically engineered microorganisms. Although it is obviously difficult to plan systematic studies of the unanticipated, I think that two approaches may deserve more attention than they have received here.

First, as seen in several of the papers dealing with insect pests, mathematical models can serve as strategic tools for exploring possibilities, for formulating testable ideas and for guiding the design of focused experiments and data gathering. I do not believe that mathematical models are intrisically either more or less useful in illuminating the population dynamics of host–pathogen associations than they provenly are for insect pests and enemies; as shown in my paper with Hassell, there are many useful parallels between the dynamical behaviour of insect and of pathogen systems.

Second, I think there is need for studies of the ecology of microorganisms in controlled laboratory settings (as well as in the field), as part of the safety programmes that must accompany the release of the pathogens, particularly genetically modified ones, as control agents. Such studies of 'microcosms' may require expenditures on a scale more customary for chemists and physicists than ecologists!

C. C. Payne (*Institute of Horticultural Research, Littlehampton, U.K.*). I would like to endorse these comments. Biological control has had its few successes with trial and error on 'enlightened empiricism' approaches. There is urgent need to consider now a more analytical and quantitative approach.

K. Jones (*Tropical Development and Research Institute, Porton Down, U.K.*). Emphasizing the need to consider all aspects when using biological control in the field, we need to be aware of relationships of pest with crop, pathogen and crop, and so on.

Taking *Spodoptera littorolis ruru* as an example, the slow speed of action of the virus on this crop is not a disadvantage. The cotton leaf can stand a large amount of damage before there is a loss in yield. Looking further, the target is found on the lower leaf surface; here we find protection against the effects of ultraviolet light due to shading and hence ultraviolet light is not such a problem as it would seem. Here also we need to bring in spray application specialists to get the virus to the area we need.

D. Badulsescu (*Faculty of Agriculture, University of Reading, U.K.*). I think that one of the reasons for the lack of widespread practical application and success of biological control measures is the fact that the projects are directed and run in most cases very far away from the farmer. How can a scientist sitting in central London understand and visualize the real needs of a farmer in Peru or China? I believe that it is important to understand that needs may vary between farmers even if they grow the same crop and have to fight against the same pest. A multidisciplinary approach and a better understanding of farmers' needs are essential.

A. R. Jutsum (*I.C.I. Plant Protection Division, Jealott's Hill, U.K.*). In response to the request [not printed] for comments on approaches to developing control agents aimed at outlets which are small on a global basis, I would like to describe the process pursued in developing controlled-release pheromone formulations which can be applied by using conventional application equipment. Development of the microcapsule formulation involved collaboration between industry (I.C.I.) and the Tropical Products Institute (T.P.I., now T.D.R.I.) which culminated in the filing of a joint patent. Field trials using the sex pheromone of the adult pink ballworm, *Pectinophora gossypiella* in this formulation were performed by I.C.I. with T.P.I. and the Centre for Overseas Pest Research (now also T.D.R.I.) in conjunction with the Egyptian Government. Highly successful trials were done over a number of seasons which finally led to commercialization of the product 'Pectone'. Thus a market of significant local value, but of limited value globally, was entered through effective collaboration. The formulation is now also being progressed in countries such as Pakistan and Peru.

C. C. Payne (*Institute of Horticultural Research, Littlehampton, U.K.*). Factors important in the implementation of practical biological control include:

(*a*) economic necessity: this way is the driving force for the uptake of biological control under glass. Growers have few if any chemical alternatives;

(*b*) political will: creation of a national or international atmosphere for the preferential deployment of biological control, e.g. *Oryctes* virus, and biological control of cassava pests.

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