Pest Resistance to Pesticides

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PREFACE

The development of resistance to pesticides is generally acknowledged as one of the most serious obstacles to effective pest control today. Since house flies first developed resistance to DDT in 1946, more than 428 species of arthropods, at least 91 species of plant pathogens, five species of noxious weeds and two species of nematodes were reported to have developed strains resistant to one or more pesticides. A seminar of U.S. and Japanese scientists was held in Palm Springs, California, during December 3-7, 1979, under the U.S.-Japan Cooperative Science Program, in order to evaluate the status of research on resistance and to discuss directions for future emphasis. A total of 32 papers were presented under three principal topics: Origins and Dynamics of Resistance (6), Mechanisms of Resistance (18), and Suppression and Management of Resistance (8). The seminar was unique in that it brought together for the first time researchers from the disciplines of entomology, plant pathology and weed science for a comprehensive discussion of this common problem.

Significant advances have been identified in (a) the development of methods for detection and monitoring of resistance in arthropods (electrophoresis, diagnostic dosage tests) and plant pathogens, (b) research on biochemical and physiological mechanisms of resistance (cytochrome P⁴⁵⁰, sensitivity of target site, gene regulation), (c) the identification and quantification of biotic, genetic and operational factors influencing the evolution of resistance, and (d) the exploration of pest management approaches incorporating resistance-delaying measures. The participants also discussed recent progress in the synthesis of new pesticides that possess novel modes of action and are affected only minimally by cross resistance. The seminar delegates concluded that the increasing impact of pesticide resistance in the agricultural and public health fields requires substantial expansion of research with emphasis on the discovery of compounds with negatively correlated toxicity or multi-site mode of action and the formulation of pest control practices that minimize unidirectional selection pressure.

It was not the intention of the seminar to compile a formal list of research topics for future emphasis. However, many recommendations on promising areas for investigation were made by the participants, and there is no doubt that many of these will be pursued in the future. These areas include:

- The significance of enzyme induction in the development of resistance.
- Gene amplification as a mechanism contributing higher levels of resistance.
- Gene duplication as a source of resistance toward related compounds.
- Genetic studies of resistance in principal lepidopterous pests.
- Practical methods for detecting the presence of resistant mutants at low frequencies.
- Biotic fitness of resistant mutants as affecting the stability of resistance.
- The multiplicity and specificity of detoxifying oxidases, esterases and glutathione transferases.
- Purification of cytochrome P⁴⁵⁰ from resistant and susceptible strains and comparative studies on these.
- Basis for reduced sensitivity of acetylcholinesterase toward organophosphates and carbamates in resistant strains.
- Synthesis of chemicals with higher inhibitory activity on acetylcholinesterase of resistant than of susceptible strains.
- A better understanding of the mechanism of "reduced nerve sensitivity" in pyrethroid-resistant strains.
- Sequence of development of resistance in non-target organisms according to their status in the trophic chain.
- Discovery and utilization of pairs of chemicals which demonstrate negatively correlated cross resistance in pests.
- Search for chemicals with distinctly novel modes of action.
- Assessment of methods for inhibiting the evolution of resistance utilizing joint or rotational uses of chemicals.

- Search for synergists that may inhibit the evolution of resistance through suppression of detoxification mechanisms.
- Competitiveness of insecticide-resistant parasites and predators and stability of their resistance in the absence of insecticidal selection.

Each author was given the opportunity to revise his paper following the symposium. Research data are included for illustration, but the emphasis is on the comprehensive coverage of the principles and concepts of resistance, the critical appraisal of current knowledge, and prospects for future breakthroughs.

Thanks are due to the National Science Foundation of the U.S. and the Japan Society for the Promotion of Science for their sponsorship of this seminar. We are grateful to Miss Roni Mellon for patient and valuable editorial assistance. Of course, this volume could not have been prepared without the collaboration of the contributing authors to whom we wish to express our sincere appreciation.

George P. Georgioui
Tetsuo Saito

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