# BIOLOGICAL CONTROL OF INSECT PESTS: SOUTHEAST ASIAN PROSPECTS

D.F. Waterhouse

(ACIAR Consultant in Plant Protection)

Australian Centre for International Agricultural Research
Canberra
1998

The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. Its primary mandate is to help identify agricultural problems in developing countries and to commission collaborative research between Australian and developing country researchers in fields where Australia has special competence.

Where trade names are used this constitutes neither endorsement of nor discrimination against any product by the Centre.

ACIAR MONOGRAPH SERIES

This peer-reviewed series contains the results of original research supported by ACIAR, or deemed relevant to ACIAR's research objectives. The series is distributed internationally, with an emphasis on the Third World



Waterhouse, D.F. 1998, Biological Control of Insect Pests: Southeast Asian Prospects. ACIAR Monograph No. 51, 548 pp + viii, 1 fig. 16 maps.

ISBN 1 86320 221 8
Design and layout by Arawang Communication Group, Canberra
Cover: *Nezara viridula* adult, egg rafts and hatching nymphs.
Printed by Brown Prior Anderson, Melbourne

# Contents

# Foreword

Since its inception in 1982, ACIAR has been a very strong supporter of classical biological control as a key element in the management of exotic arthropod and weed pests. When practiced with appropriate safeguards, it often provides a sustainable and environmentally friendly alternative to the growing use of pesticides, particularly when integrated, if necessary, with the use of resistant plant varieties and cultural controls.

Classical biological control has been very successful in regions of the world (e.g. Australia, California, New Zealand, Oceania) where a large number of the major insect pests and weeds are exotic. This situation applies to a far lesser extent to Southeast Asia but, in a recent survey commissioned by ACIAR, Waterhouse (1993b) identified 40 major arthropod pests that merited evaluation as possible targets for biological control. Not all of these (e.g. the indigenous fruit flies) are attractive targets, but some at least are.

The present volume is a companion to *Biological Control of Weeds: Southeast Asian Prospects* (Waterhouse 1994). It summarises what is known about the natural enemies (principally the parasitoids) of the major exotic insect pests and indicates prospects for their biological control. The aim has been to facilitate, for countries of the region, the selection of promising individual, or collaborative, priority insect pest targets. This should also provide donor agencies with a readily accessible overview of the region's major exotic insect pest problems and with an evaluation, where possible, of prospects for their amelioration by introduction of natural enemies. This should assist in the selection, for support, of projects that are best suited to their individual terms of reference.

*R. Clements*
Director
Australian Centre for International
Agricultural Research

# 1 Abstract

Biological control programs have been mounted in some region(s) of the world against 13 of the 16 dossier pests and substantial or partial success has been achieved in one or more countries for 8. On the basis of available information there are good to excellent prospects for reducing, in at least some parts of the region, the damage caused by the following: *Leucinodes orbonalis*, *Nezara viridula*, *Ophiomyia phaseoli* and *Planococcus citri*. There are also good reasons for believing that there will prove to be valuable natural enemies for the following: *Agrius convolvuli, Anomis flava*, *Aphis craccivora*, *Aphis gossypii*, *Diaphorina citri*, *Dysmicoccus brevipes*, *Hypothenemus hampei*, *Phyllocnistis citrella* and *Trichoplusia ni*. There seems to be little prospect for classical biological control of *Dysdercus cingulatus,* too little is known about *Deanolis sublimbalis* and the prospects for control of *Cosmopolites sordidus* are unclear, although its lack of pest status in Myanmar is puzzling.

# 2 Estimation of biological control prospects

| Insect | Rating | Family | Any biological control successes | Attractiveness as a target in SE Asia |
|---|---|---|---|---|
| *Agrius convolvuli* | 7 | Sphingidae | yes | medium |
| *Anomis flava* | 10 | Noctuidae | yes | low to medium |
| *Aphis craccivora* | 15 | Aphididae | ? | medium |
| *Aphis gossypii* | 19 | Aphididae | yes | medium |
| *Cosmopolites sordidus* | 13 | Curculionidae | ? | uncertain |
| *Deanolis sublimbalis* | 3 | Pyralidae | no | uncertain |
| *Diaphorina citri* | 8 | Psyllidae | yes | medium |
| *Dysdercus cingulatus* | 11 | Pyrrhocoridae | no | v. low |
| *Dysmicoccus brevipes* | 10 | Pseudococcidae | yes | medium |
| *Hypothenemus hampeii* | 12 | Scolytidae | yes | medium |
| *Leucinodes orbonalis* | 15 | Pyralidae | no | medium to high |
| *Nezara viridula* | 10 | Pentatomidae | yes | high |
| *Ophiomyia phaseoli* | 14 | Agromyzidae | yes | high |
| *Phyllocnistis citrella* | 16 | Phyllocnistidae | yes | medium |
| *Planococcus citri* | 7 | Pseudococcidae | yes | high |
| *Trichoplusia ni* | 7 | Noctuidae | yes | medium |

# 3 Introduction

Waterhouse (1993b) published information, collected from agricultural and weed experts in the 10 countries of Southeast Asia, on the distribution and importance of their major arthropod pests in agriculture. Ratings were supplied on the basis of a very simple system

| | |
|---|---|
| +++ | very widespread and very important |
| ++ | widespread and important |
| + | important only locally |
| P | present, but not an important pest |

The advantages and limitations of this system were discussed by Waterhouse (1993b). Of 160 insect and mite pests nominated as important in Southeast Asia, a subset of 47 was rated as particularly so.

The aim of the present work has been to summarise information relevant to the prospects for classical biological control of the most important of those of this subset of 47 that are thought to have evolved outside Southeast Asia. The assumption is that many of these have been introduced without some (sometimes without any) of the natural enemies that help to control them where they evolved. The chances are very much lower for arthropod pests that evolved in Southeast Asia of introducing effective, sufficiently host-specific, organisms from outside the region. On the other hand, there is reason to believe that some parasitoids of pests that are thought to have arisen in, or adjacent to, the Indian subcontinent may not yet occur throughout the eastern region of Southeast Asia and several such pests are dealt with.

In regional considerations of this sort, it is to be expected that not all of the top 20, or even the top 10, of any one country's arthropod pests will necessarily be included. Indeed, at least some of those omitted might well merit the production of additional dossiers if they are of such importance locally that a biological control program might be justified. ACIAR would be interested to learn of pests that might be considered in this category.

The summary accounts presented are designed to enable a rapid review to be made of (i) the main characteristics of the principal insect pests of agriculture that are believed to be exotic to part or all of Southeast Asia, (ii) what is known of their enemies, particularly those that have high or moderate levels of host specificity and (iii) what the prospects appear to be for reducing their pest status by classical biological control.

In most instances four databases (and particularly CABI) were searched for relevant information:

AGRICOLA (Bibliography of Agriculture) 1970+
BIOSIS (Biological Abstracts) 1989+
CABI (CAB International) 1972+
DIALOG (Biological Abstracts) 1969+

In addition, in many instances abstracting journals and other published sources prior to the above commencement dates were also searched. Furthermore, useful information was also obtained from other references and from unpublished records. Nevertheless, in many cases the search cannot be described as exhaustive. Even more relevant than attempting an exhaustive search would be a fresh, detailed, field survey targeted on the pest in the region where it is causing problems. This is in order to determine what natural enemies are already present and, in particular, whether any of the organisms that might be considered for introduction are already present.

The species dealt with are drawn from tables 4 and 5 of 'The Major Arthropod Pests and Weeds of Agriculture in Southeast Asia: Distribution, Importance and Origin' (Waterhouse 1993b). It is quite possible that additional arthropod pests rating highly in these tables will prove to be exotic to Southeast Asia (or significant parts of it) and, alternatively, that some considered to be exotic will, on further evidence, be shown to have evolved in the region. The ratings of the pests in the Pacific and Southern China included at the beginning of each dossier are based on information in Waterhouse (1997) and Li et al. (1997).

The natural enemies most commonly selected against insect pests in modern classical biological practice are specific or relatively specific parasitoids. Although predators also clearly play an important role in reducing pest numbers (and have achieved considerable successes against scale insects and mealybugs) the majority of predators attack a wide spectrum of hosts. National authorities responsible for approving the introduction of biological control agents are becoming increasingly reluctant to do so for natural enemies that may possibly have adverse effects on non-target species of environmental significance. For this reason far more emphasis has been placed in the dossiers on parasitoids than on predators.

There appears to be a widespread view that, when biological control alone results in a spectacular reduction in pest populations (as it often does) it is very worthwhile, but a lesser reduction is of little or no value. Nothing can be further from the truth, since far lower levels can have a major impact when integrated with other means of pest control. This applies particularly to integration with the use of plant varieties that are partially resistant to the pest (Waterhouse 1993a).

Plant resistance serves to decrease numbers, in particular by lowering reproductive rate and slowing growth rate. Resistance can be brought about inter alia by alteration of the physical characteristics (e.g. hairiness, cuticle thickness) of the plant and/or its chemical composition. If, as usually occurs, parasitoids and predators are not affected to an equal extent, an improved ratio of natural enemy to the pest will result and the impact of biological control will be increased. This was pointed out many years ago (van Emden 1966; van Emden and Wearing 1965) and is well illustrated by glasshouse tests with the aphis *Schizaphis graminum* on susceptible and resistant barley and sorghum varieties and the parasitoid *Lysiphlebus testaceipes* (Starks et al. 1972). If it is assumed, as in the illustrative example in Figure 1, that the economic injury level is 100 aphids per plant, then neither the resistant variety alone, nor the parasitoid alone will prevent the injury level being exceeded, whereas the combination of resistance and parasitoids achieves this by a wide margin. As another example, biological control of *Myzus persicae* with *Aphidius matricariae* was only effective on chrysanthemums if the variety involved was partly aphid resistant (Wyatt 1970).

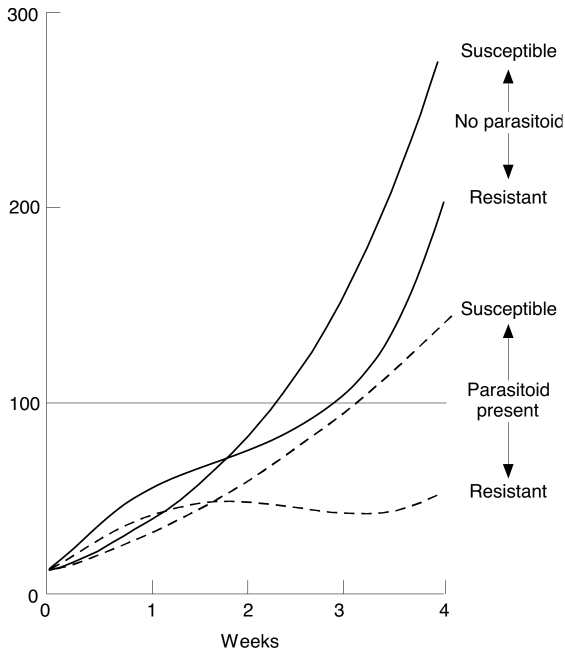


**Figure 1.** Population growth of *Schizaphis graminum* on susceptible and partly resistant barley in the presence and absence of the parasitoid *Lysiphlebus testiceipes*.

Efforts to achieve pest control by high levels of plant resistance alone may prove counterproductive if significant energy or other resources are diverted by the plant, since they cannot then be used for growth or reproduction. Thus, van Emden (1991) quotes data on 31 pigeon pea varieties screened at the International Crops Research Institute for the Semi Arid Tropics for insect pod damage. These data predicted a 31% yield loss for 90% resistance to insects. To accept a loss of this order is surely an unacceptable 'solution' to the problem, particularly when even a low level of natural enemy attack combined with moderate plant resistance is likely to achieve a far better yield. However, the interaction of resistance and natural enemies may not be a simple one, as pointed out by Wellings and Ward (1994) and such interactions urgently deserve further study. Nevertheless, the fact remains that, when integrated appropriately with plant resistance and other measures, even comparatively low levels of attack by natural enemies can lead to disproportionately large improvements in pest control.

Although the major focus of the dossiers has been on the applicability of the information to biological control in Southeast Asia, much has far wider applicability. In particular, a great deal is relevant to classical biological control in the oceanic Pacific which, until the past few decades, has received almost all its important insect pests from Southeast Asia. A brief tabulation of the distribution and importance of each pest in the Pacific is, therefore, given at the beginning of each dossier. The key to Pacific Country abbreviations is: Fr P, French Polynesia; FSM, Federated States of Micronesia; Kiri, Kiribati; Mar Is, Marshall Islands; N Cal, New Caledonia; PNG, Papua New Guinea; A Sam, American Samoa; Sam, Western Samoa; Sol Is, Solomon Islands; Tok, Tokelau; Tong, Tonga; Tuv, Tuvalu; Van, Vanuatu; W&F, Wallis and Futuna. The key to Southeast Asian countries is: Myan, Myanmar (Burma); Thai, Thailand; Laos; Camb, Cambodia; Viet, Vietnam; Msia, Malaysia; Sing, Singapore; Brun, Brunei; Indo, Indonesia; Phil, Philippines.

In any biological control program it is essential that appropriate procedures are adopted in relation to the selection of suitably host-specific natural enemies, the gaining of approval for introduction and release from the national authorities and safe procedures for eliminating unwanted fellow travellers. Simple *Guidelines for biological control projects in the Pacific* (Waterhouse 1991) are available from the South Pacific Commission, Noumea and FAO has a *Draft Code of Conduct for the Import and Release of Biological Control Agents (1993).*

Because there is a considerable lack of uniformity in the names applied to many of the insects involved, a separate index is included listing the preferred scientific names. These have been used in the text, replacing where necessary those used by the authors quoted. Where the name of an insect used in a publication is no longer preferred by taxonomists, the superseded name, x, is shown thus (= x), but this usage is not intended to convey any other taxonomic message. Indeed, the superseded name may still be valid, but simply not applicable to the particular species referred to by the author.

I am most grateful for assistance from many colleagues during the preparation of this book. It is not possible to name them all, but special thanks are due to a number of CSIRO colleagues, in particular to Dr K.R. Norris for editorial assistance, Dr M. Carver for valuable advice on the *Aphis* dossiers, J. Prance for bibliographic assistance and to several taxonomists, including Dr M. Carver (Hemiptera), Dr P. Cranston (Diptera), E.D. Edwards (Lepidoptera), Dr I.D. Naumann (Hymenoptera) and T. Weir (Coleoptera). Others who have provided valuable information include D. Smith (Queensland Department of Primary Industries), Dr P. Cochereau (ORSTOM, Noumea) and Dr C. Klein Koch (Chile).

Continuing warm support has been provided by Dr P. Ferrar, Research Program Coordinator, Crop Sciences, ACIAR, Canberra.

It is again a pleasure to acknowledge, warmly, the expert assistance of Mrs Audra Johnstone in converting my manuscripts into presentable form.

It would certainly not have been possible to continue with these biological control activities long into retirement without the unfailing support, encouragement and forbearance of my wife, to whom my very special thanks are due.