ORGANISATION INTERNATIONALE DE LUTTE BIOLOGIQUE CONTRE LES ANIMAUX ET LES PLANTES NUISIBLES (OILB)

INTERNATIONAL ORGANIZATION FOR BIOLOGICAL CONTROL OF NOXIOUS ANIMALS AND PLANTS (IOBC)

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Contents

1. NEWS FROM THE IOBC SECRETARIAT (by G. Mathys)

IVth General Assembly of the West Palaearctic Regional Section of IOBC, Antibes, France, 12-14 October, 1981

The General Assembly reviewed the activities of its Commissions and Working Parties. It defined the main policies for the four years to come. In addition to the existing 16 Working Parties, it decided to establish study groups on the following topics :

1) Integrated protection in cotton ;
2) Integrated protection in oil-seed rape ;
3) Biological control of the tingid *Corythucha ciliata* of plane tree ;
4) Biological and integrated control of plant diseases ;
5) Biological and integrated control of weeds ;
6) Management of whole arable farming systems for integrated control of pests, diseases and weeds.

Close working links have been established with the Commission of the European Communities.

Symposium on Integrated Control of the Western Hemisphere Regional Section, Santiago (Chile), 17-20 November, 1981

This Symposium generated considerable interest in the southern countries of Latin America.

A new Institute for biological research, headed by Dr A. Rada, has been set up at Aguila Sur, about 50 km from Santiago. Projects for the development of research leading to IPM systems are under study and it is anticipated that the remarkable facilities offered should also attract biologists from abroad.

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First Meeting of the IOBC South-East Asian Regional Section, Kuala Lumpur, Malaysia, 2 March, 1982

The meeting was held under the chairmanship of Dr Sankaran during the International Conference on Plant Protection in the Tropics, organized by the Malaysian Plant Protection Society from 1st to 4th March. Plans have been established for a closer coordination of work within the region and the Agricultural Academy of Sciences in China has been invited to join the Organization.

IOBC-GERDAT[1] Colloquium on Crop Loss Assessment and Economic Threshold Evaluations in Cotton, Rice and Maize, Paris, 14-16 April, 1982

The purpose of the meeting was to compare approaches in assessing economic thresholds for individual pests, diseases and weeds under various conditions (cropping systems, climates). The meeting aimed also at improving forecasting systems based on population surveillance. The proceedings of the Colloquium will be published shortly.

IOBC-INRA[2] International Symposium on Trichogramma, Antibes (FR), 20-23 April, 1982

Experts from 27 countries participated in this meeting which dealt with the following topics : 1) systematics, 2) physiology, biochemistry, 3) ecology, 4) mass-rearing and its surveillance, 5) *Trichogramma* releases and results obtained, 6) population dynamics, 7) projects for international cooperation. The Symposium decided to set up an IOBC Working Party on the global level.

2. IOBC/WPRS ACTIVITIES

IOBC/WPRS Working Group on Pesticides and Beneficial Arthropods ; summary of the report by S.A. Hassan, A.P. Hoogcarspel & J.A. Jobsen on the Fifth Meeting held in Harpenden (UK), October 27-30, 1981.

This meeting was attended by 33 research workers representing nine western European countries. In his opening remarks, Dr S.A. Hassan summarised activities of the Working Group since the previous meeting in Vienna in October 1979. The aims of this Group are :

a) development of standardized methods to test the side-effects of pesticides on beneficial arthropods,
b) arranging joint test-programmes on series of pesticides,
c) providing information to growers and planners of integrated control programmes,
d) encourage the practical use of selective pesticides.

The report is divided into the following sections :

1. Testing and the side-effects of pesticides on beneficial arthropods : views, methods and results

Stevenson reported on a large-scale field experiment in barley, and emphasized the need to be aware of the differences between field and laboratory tests. Jobsen summarised the history of the Working Group and the development of the aims and principles. The hypothesis that a pesticide which proved safe in the laboratory would most probably be safe in the field, and *vice versa*, was still valid. Reboulet reported on the field tests carried out in France to test the effect of pesticides on beneficial arthropods, using the Steiner method of spraying first with the test compound and a few days later with a pesticide that kills everything. Edwards described his approach to testing the effect of pesticides against staphylinid and carabid beetles. In laboratory experiments, Moosbeckhofer investigated the effect of pesticides on the survival of larvae of *Poecilus cupreus* (Carabidae) and adult behaviour. Brown & Copland had attempted to incorporate *Cryptolaemus montrouzieri*, a predator of the glasshouse mealybug, into an integrated control scheme. Helipap reported on field- and semi-field methods to test the side-effects of pesticides on three aphid predators, *Coccinella*, *Chrysopa* and *Syrphus*. The effects of pirimicarb on the population dynamics and predators of *Acyrthosiphon pisum* were also studied. Bigler discussed the development of a semi-field test for *Chrysopa carnea*. Huang had developed a semi-field test for *Drino inconspicua*. Schliesske described a modified mass-rearing method for two predator mites. A laboratory method to test the side-effects of pesticides on the predatory mite *Amblyseius potentillae* had been developed by van Zon & Overmeer, using pollen, rather than spider mites, to feed the predator. Samsoe-Petersen reported on the use of standard leaf instead of inert material to test *Phytoseiulus persimilis*. Ledieu reported on laboratory methods used at the Glasshouse Crops Research Institute to test the side-effects of pesticides on *Encarsia formosa* and *Phytoseiulus persimilis*. Vanwetswinkel gave some results on his semi-field test with *Amblyseius potentillae*. Sechser's contribution on *Anthocoris nemorum* was read by Stevenson.

2. Results of the second joint pesticide testing programme with 20 preparations

A table summarising the preliminary results was distributed. This work is to be published shortly.

3. Comparison of results obtained from laboratory, semi-field and field experiments

When testing 10 pesticides and comparing larval mortality of *Chrysopa carnea*, Bigler found generally that toxicity was the same or lower in semi-field tests than in laboratory experiments. Hassan reported on a semi-field test for *Trichogramma*. Albert found the data obtained from initial toxicity tests appeared generally much lower than that from semi-field tests. Dunning reported on aphid and virus control in sugarbeet, particularly with regard to the effects of demeton-s-methyl, pirimicarb and ethiofencarb.

4. The development of methods to test the duration of harmful activity of pesticides

Kapetanakis reported on an investigation to test the persistence of permethrin to *Amblyseius potentillae* on apple bark and leaves brought into the laboratory. Firth assessed the persistence of toxicity of endosulfan, methidathion, amitraz, carbosulfan, cypermethrin, deltamethrin and fenvalerate to Anthocoridae, Coccinellidae and Cecidomyiidae. Albert tested the persistence of a dozen pesticides with *Coccygominus turionellae*, while Huang detailed methods of persistence testing with *Drino inconspicua*, and Hoogcarspel described the development of a persistence test for *Encarsia formosa*. Hassan, using *Trichogramma*, compared the persistence of pesticides weathered in the field with that of pesticides subjected to simulated weather conditions.

1) GERDAT : Groupement d'Etudes et de Recherches pour le Développement de l'Agronomie Tropicale.
2) INRA : Institut National de la Recherche Agronomique

5. Improvement and rationalisation of test methods

Bigler, Huang and Hoogcarspel described modifications to the standard toxicity tests on *Chrysopa carnea*, *Drino inconspicua* and *Encarsia formosa*, respectively.

6. Research on natural enemies resistant to pesticides

Hassan described experiments done with three strains of *Phytoseiulus persimilis* and Cranham reported on resistance in *Typhlodromus pyri* to organophosphates.

7. Legislation, labelling and information on selective pesticides

Hoogcarspel proposed that a comment on relevant beneficial arthropods should be included on pesticide labels. Blaisinger summarised the role of the Information Centre of the Working Group in collating information on beneficial arthropods from other IOBC Working Groups and distributing it to the other Groups. Use of data banks will be investigated. Ledieu contributed a paper on the complex factors to be considered when designing an integrated control programme, and emphasised the role which pesticides can still play.

8. Cooperation with other Working Groups and Organisations

Good links exist between the various IOBC Working Groups.

9. Recommendations and Conclusions

The main points were :

- that the order of approach to test methods should be : 1) initial lab toxicity test ; 2) persistence (and other additional) test(s) ; 3) field test ; 4) semi-field test (for clarification of certain aspects) ;
- Hassan put forward various priorities for testing species, according to the crop :
  a) crops with aphids as pests ; at least 1 aphid predator (i.e. Chrysopidae, Coccinellidae, Syrphidae) as well as at least 1 aphid parasite (i.e. Aphidiinae) ;
  b) crops with Lepidoptera as pests ; at least 1 egg parasite (i.e. Trichogrammatidae) and/or 1 larval (pupal) parasite (i.e. Tachinidae, Braconidae, Ichneumonidae) ;
  c) crops with mites as pests ; at least 1 predator (i.e. *Typhlodromus* sp., *Amblyseius* sp.) and/or Anthocoridae, for glasshouse crops *Phytoseiulus* sp.
  d) crops with psylla as pests ; Anthocoridae ;
  e) crops with flies as pests ; at least 1 parasite (i.e. Cynipidae, Ichneumonidae) ;
  f) when soil is treated ; at least 1 predator (i.e. Carabidae, Staphylinidae) as well as 1 soil-living parasite (i.e. Cynipidae, Ichneumonidae) ;
  g) glasshouse crops with whiteflies as pests ; the parasite *Encarsia formosa*.
- the joint testing programme had been successful and would be extended. Efforts will be made to publish results ;
- research on resistance to pesticides in beneficial arthropods was to be encouraged ;
- closer links would be forged with industry ;
- the next meeting is planned for 1983 in France (Colmar). A technical meeting is scheduled for September 14-17, 1982, in Copenhagen.

Laboratory tests

Discussion points included capacity of intake of prey, application of pesticides to a standard soil sample (as well as an inert surface and leaf), and untreated food. Attempts will be made to develop test methods for *Cryptolaemus montrouzieri*, an aphid parasite, *Anthocoris nemorum*, carabids and a parasite of the miner fly. Methods for two predatory mites, *Amblyseius potentillae* and *Phytoseiulus persimilis* were reviewed and amended. The importance of persistence tests, particularly with regard to detecting possible toxic pesticide metabolites was emphasised. Methods are already available for *Trichogramma*, *Coccygominus turionellae*, *Drino inconspicua* and *Chrysopa carnea*, and are being developed for *Encarsia formosa*.

Field tests

The importance of field tests is stressed. Other Working Groups will play a major role in doing such tests, and comparison of field and laboratory results should always be made.

Semi-field tests

The problems associated with semi-field tests are listed, including reduced exposure of flying insects, fluctuating temperature, unreliable predation, herbicides killing test plants, predators possibly dying of starvation. More experience is needed before final conclusions on these methods can be drawn. Meanwhile, tests on the following species will be continued : *P. persimilis*, *A. potentillae*, *D. inconspicua*, *C. turionellae* and *C. carnea*.

3. IOBC (GLOBAL) ACTIVITIES

Formation of International *Heliothis* Biological Control Work Group

An International Workshop on *Heliothis* Management, sponsored by the International Crops Research Institute for Semi-Arid Tropics, was held in Hyderabad, India, on November 15-20, 1981. Informal discussion between some participants (Dr Sudha Nagarakatti, Institute of Horticultural Research, Bangalore, IN ; Dr S. Sithanantham, ICRISAT, Hyderabad ; Dr Peter Twine, CSIRO, Australia ; Dr David Greathead, CIBC, United Kingdom ; and Dr Edgar G. King, Southern Field Crop Insect Management Laboratory, ARS/USDA, P.O. Box 225, Stoneville, Mississippi, USA) resulted in the formation of an International *Heliothis* Biological Control Work Group. This Work Group has been endorsed by and affiliated with IOBC. Specific objectives of this Group are to facilitate exchange of *Heliothis* natural enemies and information on biological control of *Heliothis*. Initially, these objectives will be accomplished through distribution of a newsletter. The first newsletter will briefly review the recent workshop on *Heliothis* and request information for a subsequent newsletter – such as list of natural enemies available for exchange, scientists involved in biological control of *Heliothis*, *Heliothis* spp. present by geographical area and their host range, and other highlight information. Dr Edgar G. King will coordinate distribution of the first 2 to 3 newsletters at about six-month intervals. Those interested in receiving this newsletter and participating in the Work Group should contact Dr King.

4. WHO ACTIVITIES

UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases. Summary of the Report of the 5th Meeting of the Scientific Working Group on Biological Control of Vectors, held in Geneva, 12-16 October, 1981. Doc. No. TDR/VEC-SWG (5)/81.3 (in English only), 24 pp.

This meeting, which was attended by 16 participants from France, United Kingdom, USA, Ivory Coast, Ghana, New Zealand, India, China and Czechoslovakia, in addition to the Secretariat of 4, focussed attention on bacterial agents.

1. Review of research on bacterial control agents

1.1 Field evaluation of bacterial pathogens

The Group analysed and evaluated available data on the effectiveness of both *Bacillus thuringiensis* H-14 and *B. sphaericus* against mosquito and *Simulium* vectors. Research on the isolation, identification, development and preliminary field assessment of more potent strains of these bacteria, and improved formulations of currently available strains, should be continued. It was crucial that the influence of environmental and biotic factors, the role of formulations and methods of application be scrutinised in small-scale field trials before large field trials were planned. The Group recommends initiation of large-scale field trials, principally on *An. culicifacies, An. sacharovi, An. arabiensis, An. albimanus* and other culicine vector species. Detailed protocols for small- and large-scale field trials are appended, as well as a field evaluation procedure for bacterial larvicides used in onchocerciasis control. Possible locations for large-scale trials with *B.t.* H-14 for mosquito control were the island of Rameshwaram off the southern coast of India, where *An. culicifacies* is the main vector of malaria, Turkey where *An. sacharovi* in a man-made biotope is involved in the transmission of endemic malaria, and on *An. arabiensis* in Ethiopia or *An. albimanus* in the Americas. Safety and environmental impact should also be monitored.

1.2 Assessment of biocontrol potential of new bacterial isolates

It was hoped that the success of large-scale screening of *B.t.* isolates for improved activity against lepidopterous pests could be extended to mosquitoes and blackflies. A proposed method for screening of candidate bacilli as potential pathogens of these species is outlined in the appendix, as are guidelines for the isolation of sporeforming bacteria possessing vector control potential. When isolates are identified, there must be an effective means of cataloguing them in a culture collection and of producing powders from them by carefully controlled and standard procedures. Powders of candidate isolates should be prepared under identical conditions by a single laboratory source for distribution to experts for valid comparative studies.

1.3 Standardisation of Bacillus thuringiensis

A recommended protocol for the bioassay of *B.t.* H-14 preparations is appended. The potency of unformulated and formulated *B.t.* H-14 is evaluated in comparison with a standard, IPS-78, details of the production of which are also given in the appendix. In addition to data on the potency of the active ingredient, it was felt that other information on the product should be included on the label. For example, the strain, its potency in *Aedes aegypti* International Units, and certain physical characteristics such as moisture content, heat stability, sieving after accelerated storage, pH, etc.

1.4 Pathogenesis of bacterial control agents

The mechanism of action of the *B.t.* H-14 endotoxin at the molecular level is unknown. In the larval mosquito gut, the caeca and posterior stomach are the most sensitive regions; similarly in blackfly larvae. Death follows shortly after gut disruption or exfoliation, and may be due to alterations in haemolymph pH. The Group doubts whether efficacy of *B.t.* H-14 could be improved against the blackfly, but feels this should be possible against mosquito larvae. Advances in the field of molecular genetics may help the problem of lack of field persistence of *B.t.* toxin; the gene coding for toxin production might be transferred to endemic bacteria in the aquatic mosquito habitat. Of three types of inclusion produced by *B. sphaericus* 1593 in *Cx. quinquefasciatus* larvae, only one dissolves rapidly in the larval gut. Cell fractionation and toxin characterisation studies are underway to determine whether these inclusions are sites of toxicity. Gross pathology is similar to that in larvae which have consumed *B.t.* H-14 toxin. Further research is recommended on *B. sp.* 1593 and *B. sp.* 2297 (= MR4); a few kilos of a primary powder of 1593 should be produced for field trials.

2. Related activities

Greater coordination between the Scientific Working Groups (SWG) within the Special Programme was desirable. The Group recommended a meeting in 1982 between a limited number of Biological Control of Vectors specialists and members of the SWG on Biomedical Sciences, to discuss the possibility of joint projects, particularly genetic manipulation of *B.t.* H-14 and its endotoxin. Also, meetings with the SWG on Applied Field Research on Malaria and Filariasis to discuss field evaluation of *B.t.* H-14 in selected areas where these diseases are endemic.

3. Development of guidelines for local production of bacterial agents

Local production of bacterial insect pathogens in reasonably large batches for local distribution is probably feasible, both in terms of cost and safety. Assistance from or integration with an existing local fermentation industry would be desirable. A UN Industrial Development Organisation representative confirmed this principle. Draft guidelines would be worked out in cooperation with WHO and UNIDO, and a descriptive booklet should be produced.

4. Dissemination of information

Publications (1979-81) on bacterial pathogens of vectors generated under the SWG-BCV programme are appended (48 refs.).

5. CONFERENCE REPORTS

The British Society for Parasitology Autumn Symposium – Parasites as Biological Control Agents – held in the Meeting Rooms of the Zoological Society of London, Regents Park, London (UK) on Friday 30 October, 1981.

The meeting, chaired by Dr C.A. Wright (British Museum, Natural History), was opened by Professor Michael Way (Imperial College, London), who emphasised that biological control was a vital component of integrated pest management schemes. Dr R.M. Anderson (Imperial College) then spoke on the theoretical basis of host population control by pathogens. There followed some seven papers dealing with the main groups of biological control agents, viz. viruses, bacteria, protozoa, trematodes, nematodes, fungi and parasitoids. Dr K. Harrap (NERC Institute Virology, Oxford) gave the closing paper on the ecological hazards of microbial insecticides. The chairman's summing up and general discussion followed. Abstracts of some of the papers presented are given below:

Dr R.M. Anderson (Imperial College, London University): Theoretical basis of the use of pathogens as biological control agents of pest species

The population dynamics of insect-pathogen interactions are examined with the aid of simple mathematical models. Three concepts of central importance to the interpretation of

population behaviour are discussed, namely : the ability of the pathogen to persist within its host population, the ability to regulate and depress host population abundance and the ability to induce non-seasonal cyclic changes in host density. The selection of pathogen species or strains to depress pest population growth is discussed and the optimal characterisation is shown to be intermediate pathogenicity combined with an ability to reduce infected host reproduction, high transmission efficiency, including elements of vertical as well as horizontal transmission, and the ability to produce large numbers of long-lived infective transmission stages. When the pathogen plays a significant role in the regulation of host population growth, it is argued that many insect-pathogen interactions will exhibit non-seasonal oscillations in host and pathogen abundance. Mathematical models are used to explore the patterns of population behaviour that result from the continual introduction of a pathogen into a target pest population. It is shown that there exists a critical introduction rate, above which the eradication of the pest is theoretically possible. Significant reductions in pest population abundance will not occur until the introduction rate approaches this critical value, whereupon the oscillatory behaviour of the interaction between host and pathogen populations will be suppressed. A general discussion is given of the problems arising from the combined use of chemical agents and pathogens for the control of pest species, and the evolutionary pressures acting on host and pathogen populations.

Dr C.C. Payne (Glasshouse Crops Research Institute, Littlehampton) : Viruses

Virus diseases of insects and mites provide a large reservoir of potential biological control agents. More than 1200 viruses have been recorded producing infections in more than 800 host species. Properties of viruses within the baculovirus and cytoplasmic polyhedrosis virus groups are considered in relation to their potential as pest control agents. The successful use of a virus depends on the acquisition of an effective dose, virus virulence, the host response to infection and the persistence of virus within the pest population and the environment. The relative importance of such factors is demonstrated by considering examples of the use of viruses both as short-term insecticides on annual crops and in more stable ecosystems, including pastures and plantations where a long-term virus-host interaction can be established. The chapter is concluded by sections on commercial exploitation and future work.

Dr H.D. Burges (Glasshouse Crops Research Institute, Littlehampton) : Control of pests by bacteria

Some bacteria can be introduced and will give biocontrol lasting many years. Others are transient and must be applied to each new pest infestation. For three decades, *Bacillus popilliae* has been marketed on a small scale for the long-term control of the introduced scarabaeid beetle, the Japanese beetle, *Popillia japonica*, in the USA. Strains of *Bacillus thuringiensis* have been marketed on an increasing scale over the past two decades for the control of a wide range of lepidopterous pests of field and forest, totalling something in the order of two or three thousand tons in 1980. This year, a new strain has been marketed against vectors of human disease. A few other species are being developed. Although replacement of chemical pesticides by biologicals is not anticipated on a grand scale, the advance of genetical engineering may herald exciting developments.

Professor Elizabeth U. Canning (Imperial College, London University) : Protozoa

Protozoa generally kill their invertebrate hosts by overwhelming numbers. They tend to kill in late instars, and surviving adults have reduced longevity and fecundity. Because they are slow-acting pathogens, they cannot be used on their own, either when pests have reached a critical level or when the damage threshold of pests is low. Their principal use will be as the slow-acting component of a 2-pathogen or pathogen plus chemical formulation. Two microsporidia, *Vairimorpha necatrix* and *Nosema pyrausta*, were compared : the former has potential as a short-term control agent because it induces an early high mortality in lepidopteran larvae ; the latter demonstrates how cycles of host abundance may be driven by host/parasite associations. The 2 parasites illustrate, respectively, the relationship between high pathogenicity and low prevalence and between low pathogenicity and high prevalence. Other topics covered are a) transovarial transmission as an important mechanism in parasite persistence, b) compatibility of *Nosema locustae* with chemical insecticides and its role in grasshopper control, c) interaction of microsporidia and a virus in controlling fall webworm, *Hyphantria cunea*, and d) the use of pheromone lures to introduce pathogens into infestations of pests in stored products.

Professor Cl. Combes (University of Perpignan, France) : Trematodes

During the past ten years, much research has bee devoted to the use of trematodes in biological control of human diseases, such as schistosomiasis. Biological control using trematodes can be directed either at the molluscan hosts, by sterilisation, or at other trematode species, by intra-molluscan antagonism. In either case, the echinostomes are suitable agents and, in laboratory studies, have proved effective in sterilising snails and in eliminating larval schistosomes within the snails. Choice of a suitable trematode as a control agent must start with selection of a species which is able to develop in the target snail. The life cycle must be established in the laboratory and techniques developed for mass-production of eggs which can be introduced into the molluses' habitat. Recent results have been obtained with *Echinostoma togoensis* which can be established in laboratory mice and yield 60,000-70,000 eggs per mouse each day. Field trials have not yet been carried out and some of the problems involved are discussed.

Drs R.A. Hall & B. Papierok (Glasshouse Crops Research Institute, Littlehampton & Institut Pasteur, France, respectively) : Fungi.

In recent years, we have seen a steady increase in the research inputs into the potential of entomogenous fungi as biological pesticides of insect pests of agricultural and medical importance. This review provides up-to-date information on the state of the art and encompasses both fundamental and applied aspects : infection mechanisms, host-defence reactions, epizootiology, infection cycles, bioassay and experimental field efficacy are all discussed. In particular, recent examples of successful commercialization with the attendant developmental problems of mass-production, formulation and storage are highlighted. The review critically analyses present trends of research and offers suggestions as to how future investigations may proceed.

Dr K.A. Harrap (NERC Institute of Virology, Oxford) : Assessing human and ecological hazards of microbial insecticides

The article gives particular emphasis to the use of viruses for pest control and the various guidelines developed to

assess their possible hazards. The likely gains and risks associated with using viruses are considered. Several meetings have been held in the last ten years to assess the hazards of virus insecticides. Some of these have produced recommendations, some have developed guidelines for safety testing. These meetings are reviewed and detailed consideration is given to the various guidelines for safety testing and to viruses that have been safety tested and/or registered for use. Some conclusions are drawn and the likely future development of safety testing schemes is considered.

Summary of the Proceedings of the Joint American-Soviet Conference on 'Use of Beneficial Organisms in the Control of Crop Pests', held in Washington D.C., USA, August 13-14, 1979. Ed. J.R. Coulson (1981); Ent. Soc. Am., ISBN 0-938522-08-6, 62 pp (in English).

This conference was one of a series organised under the Integrated Pest Management (IPM) Project of the US/USSR Agreement on Cooperation in the Area of Environmental Protection, and was attended by some 65 persons from all over the world.

The first paper, pp 1-11, by J.R. Coulson, the conference organiser, presents background information, together with a record of beneficial organisms exchanged between the two countries from 1972 through 1979 as a result of the Agreement. The purpose of the US/USSR IPM Project was to improve pest management programmes in certain crop areas through an exchange of technical information, beneficial organisms for pest control, and scientific personnel, and through joint or other cooperative research trials. There are three tables: 1) Biological control material exchanged between the USA and USSR 1972-1977 (to USSR 15 species, to USA 23 species); 2) Biological control material shipped to the USSR 1978-1979, 16 species; 3) Biological control material shipped to the USA 1978-1979, 16 species. For 1978-79, the following information is tabulated: material shipped (species, order, type), host or prey (Latin and common names where appropriate), origin, shipment date and number and number shipped, destination, disposition of material (condition on arrival, fate).

There were five specialised sessions preceded by a general overview.

Overview Session

Y.N. Fadeev: Prospects for development of biological methods of plant protection in the USSR, pp 12-13

Statistics are given on the application of biological methods of plant protection in the USSR. Research on *Trichogramma*, which was applied on 9.3 m ha in 1978, is directed towards the mechanisation of production and application. The development of a simple procedure for mass production of *Phytoseiulus persimilis* has led to its use indoors on 19.3 m m^2. Studies are being conducted with a number of other species, and it is hoped that, in the near future, a complex of agents can be selected for biological protection of certain vegetables and ornamentals in indoor cultivation. Field releases of *Aleochara* and chrysopids are promising. In addition to the use of biological agents, importance is attached to the preservation and utilisation of natural complexes of beneficial organisms. Two bacterial preparations, entobacterin and dendrobacillin, are under industrial production. Others, and those based on entomopathogenic viruses, are undergoing tests. The fungal preparations, boverin and *Aschersonia*, are used on a small scale. A bactorodenticide is used extensively for rodent control. The weed control programme is in its infancy, but *Phytomyza* was released in 1977 on 132,000 ha for control of *Orobanche*. Protection of plants from disease, such as tomatoes from virus infection by vaccination, is promising. Membership of IOBC/EPRS has proved very valuable.

C.B. Huffaker: Prospects for development of biological control methods for crop protection in the USA, pp 14-20

The author considers the recent biological control developments in truck and field crops, tree fruits, range and pasture, forests and woodlands, aquatic weeds and plant pathogens. Those of particular interest include release of *Pediobius foveolatus* to control *Epilachna varivestis*, *Anaphes flavipes*, *Tetrastichus julis* and *Diaparsis* against *Oulema melanopus*, *Aphytis lingnanensis* against *Unaspis citri*, *Amitus hesperidum* and *Prospaltella opulenta* against *Aleurocanthus woglumi*, *Amitus spiniferus* to control *Aleurothrixus floccosus*, *Aphytis maculicornis* and *Coccophagoides utilis* against *Parlatoria oleae*, *Trioxys pallidus* against *Chromaphis juglandicola*, dung beetles to eliminate dung pads, *Neodusmetia sangwani* to control *Antonina graminis*, various predators and parasites to control *Lymantria dispar*, *Agasicles hygrophila*, *Vogtia malloi* and *Amynothrips andersoni* against *Alternanthera philoxeroides*, various enemies to control *Eichornia crassipes*, and hypovirulent strains of *Endothia parasitica* to control this fungus disease. Developments in the medical and veterinary area are also considered, particularly control of mosquito and snail vectors. The specific recommendations to expand biological control efforts, developed by a USDA and Land-Grant Universities committee, are listed.

Session on Introduction of Beneficial Organisms

R.I. Sailer: Progress report on importation of natural enemies of insect pests in the USA, pp 20-26

This paper is restricted to ongoing projects and those completed during the past 10 years. The numbers of species introduced via the four centres for importation of beneficial arthropods, and their target hosts are listed. The author then attempts to assess the benefits of the US importation programmes. He lists 22 pest species that have been partially or wholly controlled in one or more states; details relating to control agents, the degree of control or significance of the work follow in a discussion of each of the pests listed. An overview of the results of the US Natural Enemies Importation Programme 1968-78 is then given.

L.A. Andres & L.T. Kok: Status and prospects for biological control of weeds in the USA, pp 27-33

Information concerning the personnel and facilities presently devoted to work on the biological control of weeds in the USA is summarised, and the procedures and constraints under which American scientists operate in developing a biological control of weeds project are described. The status of several weed projects in the USA is noted, including those on *Carduus* spp., *Convolvulus* spp. and *Ipomoea* spp., *Salsola iberica*, *Euphorbia esula* and *Centaurea* spp.

A.I. Smetnik & S.S. Izhevsky: The introduction and practical application of beneficial organisms for pest control in the USSR, pp 33-34

37 species of beneficial insects and 11 entomopathogenic microorganisms have been introduced from 15 countries for

the control of 11 pests species in the USSR. Five pests are adequately regulated by entomophagous insects at present : *Icerya purchasi, Dialeurodes citri, Pseudococcus comstocki, P. gahani* and *Pseudaulacaspis pentagona*. Details of these species are given. Entomophagous insects to control *Leptinotarsa decemlineata, Quadraspidiotus perniciosus, Ceroplastes japonicus* and *Lopholeucaspis japonica* are under investigation. It has not proved possible yet to establish natural enemies of *Grapholitha molesta* or *Hyphantria cunea*.

S.S. Izhevsky : The application of pathogenic microorganisms for control of weeds in the USSR, pp 35-36

This brief review makes reference to the use of *Puccinia acroptili* to control *Centaurea repens, P. suaveolens* against *Cirsium arvense* and *Colletotrichum lagenarium* and *Fusarium oxysporum* against *Orobanche aegyptiaca*. Unfortunately, the success of using such fungal agents for control has been limited. A strain of Tobacco Mosaic Virus used to control *Solanum carolinense* in tea plantations is described.

Session on Biological Control in Glasshouses

G.A. Beglyarov : Advances in and outlook for the development of biological control to protect plants under glass in the USSR, pp 36-37

The successful production and use of *Phytoseiulus persimilis* to control spider mites under glass is described. For biological control of aphids, the species most studied are *Chrysopa carnea, Coccinella septempunctata* and *Aphidoletes aphidimyza*. The Chrysopids have not established on cucumber crops but are successfully used on lettuce, celerey, etc. Investigations have demonstrated that both *Encarsia formosa* and *Aschersonia* can suppress whitefly population increases, but an integrated programme based on a rational combination of biological and chemical methods is really needed. Mice and other rodents have been controlled by *Salmonella* and a bactorodenticide. Substantial data have been gathered on the possibilities of applying microbial antagonists and antibiotics to control plant pathogens under glass.

M.J. Tauber & R.G. Helgesen : Development of biological control systems for greenhouse crop production in the USA, pp 37-40

Most glasshouses in the USA are given over to flower production. The most important pests are whiteflies, two-spotted spider mites *(T. urticae)*, aphids *(M. persicae)* and a few Lepidoptera *(Trichoplusia ni)*, and the beneficial species utilised mainly include *E. formosa* and *P. persimilis*. Control programmes are reviewed relative to the special problems for certain geographical areas. The marketing process developed by industry to supply the needs of biological control is considered in the context of research, development and delivery. Recommendations to encourage the full implementation of biological control programmes for glasshouse crops in the USA are given.

Session on Use of Trichogramma

R.L. Ridgway et al. : Trichogramma and its utilisation for crop protection in the USA, pp 41-48

The significant expansion in research on *Trichogramma* that occurred in the United States in the late 1960's and the 1970's is the subject of this paper. Major topics considered include biosystematics, efficacy, including results of augmentative releases, a review of factors affecting efficacy, and interactions with natural predators, economic and social considerations and future prospects.

K.E. Voronin & A.M. Grinberg : The current status and prospects of Trichogramma utilisation in the USSR, pp 49-51

More than 8 m ha of vegetable, industrial, grain and fruit crops in the USSR are treated annually with *Trichogramma*. Selection of the various species, interspecific competition and mass production are briefly described. Storage and application of *Trichogramma* are then considered. The success of programmes to date and their cost effectiveness in relation to chemical treatments is evaluated. Research is continuing into means of increasing efficiency.

Session on Biological Control in Orchards

G.N. Aleksidze : Development of integrated protection of orchards in Georgia, pp 52-53

The integrated system of control developed in Georgian stone fruit orchards described involves : turning soil to destroy overwintering pests *(Grapholitha funebrana, Lycia hirtaria*, etc.) ; pruning to reduce the number of overwintering aphid eggs by about 30 % ; collecting winter nests and eggs of *Euproctis chrysorrhoea, Aporia crataegi, Malacosoma neustria* and *Lymantria dispar* to rear their parasites for subsequent release ; trapping to establish dates for control of fruit moths ; application of microbiological preparations alone or in combination with chemicals ; use of pheromones for disruption of behaviour. The compatibility of various insecticides and beneficial organisms is emphasised.

V.V. Vasilian : The use of biological methods for control of pests of fruit crops in Armenia, pp 53-54

The main pests of stone and top fruit are enumerated, and approaches to their control by biological means described. Attention has been given to the development of bacterial preparations, and in particular to B.I.P.-837. Combined application of B.I.P. and entobacterin with Sayfos and 20 % kelthane can control aphids and mites. Recent studies on *Trichogramma* are briefly reported, as are the species parasitising *Pseudococcus comstocki*, a pest in particular of mulberry.

B.A. Croft : Development, use and management of insecticide-resistant natural enemies of orchard pests in North America, pp 54-59

In apple orchards of North America, resistance to organophosphates has developed uniquely among certain secondary pests and natural enemies, but not among the major pests. Details of research developments on this phenomenon relative to biological control of orchard pests are discussed. The major integrated mite control programmes on apple in North America are tabulated.

Session on Forest and Shade Trees

R.E. Stevens : Natural enemies of bark beetles in the United States : Potential for biological control, pp 59-62

This discussion deals primarily with *Dendroctonus* beetles, with a short note on *Scolytus multistriatus*. *Dendroctonus* in the USA support an extensive array of natural enemies, which are listed in the text. In general, the prospects for applied biological control of bark beetles are not very good. The abrupt and massive increase in numbers

of beetles which occur in nature never appear to have been halted by natural enemies, but the biological control approach may have an application in certain integrated pest management programmes.

6. FORTHCOMING MEETINGS

Tenth International Congress of Plant Protection

The Tenth International Congress of Plant Protection will be held at Brighton, UK from 20-25 November 1983. The Congress is held under the auspices of the International Union of Biological Sciences and is organised in conjunction with the British Crop Protection Council. The theme of the Congress is 'Plant protection for human welfare' and the programme will cover recent progress in research on insect, disease and weed control and its practical application. Particular attention will be given to management of chemical or biological protection methods within integrated production systems.

Invited speakers will discuss subjects of broad general interest in four plenary sessions. The programme of concurrent sessions will be divided into six main subjects each of which will be subdivided into two or three topics. The first subject will be 'The incidence and effects of pests, diseases and weeds'. The second subject will be 'Discovery and properties of conventional and novel chemical control agents' and this will be subdivided into 'The discovery of crop protection chemicals', 'Non-conventional chemical agents' and 'New compounds, formulations and uses'. The second topic of this subject will consider the nature and use of non-conventional chemical agents for the control of insects, pathogens or weeds. The use of pheromones, herbicide antidotes, germination stimulants and growth regulators will be discussed. The next main subject will be 'Factors affecting the performance of pesticides in practice', and the fourth subject will be 'Environmental and safety aspects of pesticide use'. The fifth subject will be 'Non-chemical methods of crop protection' and will be subdivided into 'Biotic agents', 'Plant breeding strategies for crop protection' and 'Quarantine, eradication and legislation'. The first topic will be concerned with the use of arthropod natural enemies, pathogens for the control of weeds, fungal antagonists for control of pathogenic fungi and nematode-fungus interactions in pest control. The last subject will be 'Pest disease and weed management in integrated crop production'. Topics included in this subject will be 'Pest, disease and weed management in field crops', 'Perennial plantation crops', 'Forestry', 'Protected crops', 'Amenity and aquatic areas' and 'Vegetable and root crops'.

The language of the Congress and Proceedings will be English and there will be no simultaneous translation facilities. Participants intending to contribute research reports should notify the organisers, submitting a title and brief outline of content as soon as possible and not later than 1 December 1982. All papers presented at the Congress will be published in the Proceedings. The final date for receipt of final texts will be 31 May 1983. Further information and a detailed programme are available from the Congress Secretary, Mrs R. A. Bishop, Frank Bishop (Conference Planners) Ltd., 144-150 London Road, Croydon CR0 2TD, Surrey, UK.

7. ABSTRACTS

a) Plant Protection

Insect and Mite Control

ENTOMOPATHOGENS

N. Wilding (1981). The effect of introducing aphid-pathogenic Entomophthoraceae into field populations of Aphis fabae. Ann. appl. Biol. 99 : 11-23

During two warm, dry seasons (1975 and 1976) aphid-pathogenic species of Entomophthoraceae introduced into *Aphis fabae* populations on field beans established briefly but failed to spread. In cool moist seasons (1977 and 1978), the fungi, principally *Erynia neoaphidis* and *Neozygites fresenii*, spread more rapidly in treated than untreated plots. In 1977, the maximum aphid population in plots treated with fungi reached a mean of 9 000/plant on 19 July compared with 16 000/plant 1 wk later in untreated plots. The corresponding yield of beans in treated plots was twice that in untreated plots though only half that in plots kept free of aphids with pirimicarb. In two experiments in 1978, the maximum aphid population in treated areas was 700/plant, half that in untreated areas and 1 to 2 wk earlier. Yields from treated plots, however, were not significantly different from those from untreated plots. In nature, the fungi attack *A. fabae* populations in England only after they have become damaging, partly because fungal inoculum is sparse when the aphid population is small.

B.M. Philip, K.P. Vasudevan & A. Jacob (1981). Host range of two entomogenous fungi, Syncephalastrum racemosum Cohn ex Schroeter and Penicillium oxalicum Currie & Thom., and safety to certain crop plants. Entomon 6 (2) : 121-122

Infectivity of the entomogenous fungi *Syncephalastrum racemosum* and *Penicillium oxalicum* to certain rice pests were studied. Both the fungi infected *Nilaparvata lugens*, while *Penicillium oxalicum* could also infect the nymphal stages of *Leptocorisa acuta*. None of the other insects tested were infected by these fungi. These entomogenous fungi were found to be safe to seven crop plants viz., bittergourd, snakegourd, amaranthus, bhindi, brinjal, cowpea and rice.

A.J. Lingg & M.D. Donaldson (1981). Biotic and abiotic factors affecting stability of Beauveria bassiana conidia in soil. J. Invertebrate Path. 38 : 191-200

Beauveria bassiana conidia were stored in sterile and nonsterile soil under various temperature, relative humidity, soil water content, and pH regimes. Survival of the conidia was primarily dependent on temperature and soil water content. Conidia half-lives ranged from 14 days at 25°C and 75 % water saturation to 276 days at 10°C and 25 % water saturation. Conidia held at − 15°C exhibited little or no loss in viability regardless of water content, relative humidity, or pH. Conidia were not recoverable after 10 days from soils held at 55°C. Conidia survival in nonsterile soil that was amended with carbon sources, nitrogen sources, or combinations of carbon and nitrogen was greatly decreased and loss was often complete in less than 22 days, whereas sterile soil treated in the same manner showed dramatic increase in number, demonstrating that *B. bassiana* is capable of growth in sterile soil. The obvious fungistatic effect in amended nonsterile soils was possibly related to *Penicillium urticae* which was routinely isolated from the soils and is shown to produce a water-soluble inhibitor of *B.*

bassiana. The fungistatic effect was shown to be an active inhibition rather than due to competition.

Y. Takiguchi (1981). Pathogenicity of Beauveria tenella (Delacroix) Siemaszko to four species of Longicorn beetle (Coleoptera : Cerambycidae). Jap. J. appl. Ent. Zool. 25 : 194-195 (in Japanese)

The species considered are *Psacothea hilaris* Pascoe, *Anoplophora malasiaca* Thomson, *Acalolepta luxuriosa* Bates, *Apriona japonica* Thomson and *Batocera lineolata* Chevrolat.

B.S. Ekbom (1981). Humidity requirements and storage of the entomopathogenic fungus Verticillium lecanii for use in greenhouses. Ann. Ent. Fenn. 47 : 61-62

The experiments described in this brief communication were designed to determine the period of high humidity (about 100 %) necessary for infection of whiteflies with *V. lecanii*. Daily high humidity periods of at least 16 h were necessary to obtain mycelial growth and whitefly death. Infection over 50 % necessitated 20 or more h of high humidity.

M. Kučera (1981). The production of toxic protease by the entomopathogenic fungus Metarhizium anisopliae in submerged culture. J. Invertebrate Path. 38 : 33-38

The production of a toxic complex of proteolytic enzymes by *Metarhizium anisopliae* was evaluated with 29 nitrogen sources in modified Czapek-Dox medium in submerged cultures. The proteolytic complex is more constitutive than that of *Beauveria bassiana* and its production is influenced by the quality of complex natural media. The highest activity was attained with *Galleria mellonella* proteins. The proteolytic complex manifests proteolytic activity of two pH optima, 5.5 and 8.0. The ratio of these two activities differs markedly with the nitrogen source used, but the major proteolytic activity occurs at pH 5.5.

M.O. Odindo (1981). Dosage-mortality and time-mortality responses of the armyworm Spodoptera exempta to a nuclear polyhedrosis virus. J. Invertebrate Path. 38 : 251-255

Third-instar *Spodoptera exempta* larvae were fed on young maize leaves treated with 20 µl of a polyhedral inclusion body (PIB) suspension, at concentrations from 1.6×10^2 to 1.6×10^9 PIBs/ml. Daily observations were kept on mortality rates. A probit analysis on the results gave an LD_{50} value of 48.4 PIBs/larva (lower and upper limits 39.2 and 59.4 PIBs/larva, respectively), and an LT_{50} that varied from 146.2 to 221.3 h, depending on the dosage. LD and LT values obtained show the high pathogenicity of *S. exempta* nuclear polyhedrosis virus to its host.

B. Subrahmanyam & N. Ramakrishnan (1981). Influence of a baculovirus infection on molting and food consumption by Spodoptera litura. J. Invertebrate Path. 38 : 161-168

The effect of a baculovirus (NPV) infection on molting, neurosecretory activity, and food consumption of the tobacco leaf-eating caterpillar, *Spodoptera litura*, is studied. The virus was administered by allowing the larvae to feed on castor leaves contaminated with a purified polyhedral suspension (5.57×10^8/ml). Host larvae failed to molt more than once after infection. Infected last-instar larvae failed to pupate and had a prolonged larval stage. Activity of median neurosecretory cells (MNC) of the brain increased during disease development. However, the larval pupal molt was inhibited, possibly due to lack of release of neurosecretion from the MNC. The surface area of corpus allatum of last-instar larvae increased during infection indicating high activity. Infected larvae continued to feed almost until death. The indices of digestion and utilization were significantly lowered due to disease development.

A.L. Stacey et al. (1980). Field evaluation of Baculovirus heliothis on cotton by using selected application methods. J. Georgia ent. Soc. 15 (4) : 365-372

Elcar *(B. heliothis)* was evaluated for control of *Heliothis* larvae on cotton by using selected application methods.

S.A. Nasr & S. Elnagar (1980). The susceptibility of the cotton leafworm, Spodoptera littoralis (Boisd.) to different isolates of nuclear polyhedrosis virus. Z. angew. Ent. 90 (3) : 289-292

Two isolates of NPV were compared with regard to their effectiveness against *S. littoralis* larvae ; a non-specific NPV isolated from *Autographa californica* in the USA and a specific NPV isolated from *S. littoralis* in Morocco. The results show that *S. littoralis* responds readily to its specific NPV but not to that of *A. californica*.

H.F. Evans (1981). Quantitative assessment of the relationship between dosage and response of the nuclear polyhedrosis virus of Mamestra brassicae. J. Invertebrate Path. 37 (1) : 101-109

The response of all larval stages of *Mamestra brassicae* to NPV was measured. There was a 34,000-fold difference in LD_{50} values from the first (7 polyhedra) to the fifth instar (238,370 polyhedra) while late 5th- and 6th-instar larvae were virtually resistant to virus infection. Expressing results as LD_{50}/mg bwt removed 90 % of the observed variation in susceptible larvae. The calculated LD_{50} values for each instar were used to predict when full resistance to virus infection was likely to occur and provide a good descriptor of observed resistance patterns.

J.T. McClintock & C.F. Reichelderfer (1980). Treatment of a nuclear polyhedrosis virus of Autographa californica Speyer with 5-bromodeoxyuridine and determination of changes in virulence in 4 lepidopteran hosts. Abstract only. J. New York Ent. Soc. 88 (1) : 55-56

Treatment was initially carried out in *Trichoplusia ni*, and the effect of treatment assessed in this host along with subsequent effects on virulence in *Heliothis virescens*, *H. zea* and *Spodoptera frugiperda* (all Noctuidae).

J.M. Vlak, K. Van Frankenhuyzen & D. Peters (1981). Identification of a new nuclear polyhedrosis virus from Spodoptera exigua. J. Invertebrate Path. 38 : 297-298

A new NPV was isolated from diseased larvae of *S. exigua* that were found in Dutch greenhouses. The virus was specific to this species and cross-transmission to other Lepidoptera did not occur. Characterisation of the viral DNA leads the authors to conclude that it is a new, unique baculovirus. The potential of this newly found isolate in the biological control of *S. exigua* in Dutch greenhouses is now being investigated.

G.L. Nordin (1981). Dietary effects of Methoprene on Autographa californica nuclear polyhedrosis virus yield in Heliothis virescens. J. Kansas ent. Soc. 54 (3) : 489-495

Methoprene, a juvenile hormone analog, was investigated as a supplemental dietary constituent for increasing *in vivo* yield (per larva) of *Autographa californica* nuclear polyhedrosis virus inclusion bodies (PIB's) in *Heliothis virescens*. Methoprene-containing dietary treatments prolonged the fifth-stadium and prevented pupation. Combinations of virus and methoprene at 100 or 10 ppm resulted in statistically significant ($\alpha = 0.05$) increases in mean maximal larval weight and mean PIB yield/larva over controls. However, a linear regression of PIB yield per larva on maximal larval weight was inconclusive. A comparative feedback study of viral PIB's derived from larvae reared on control versus methoprene-containing diet against third-instar *H. virescens* indicated that methoprene had no significant effect on virulence.

S.G. Dhaduti & S.B. Mathad (1981). Effect of NPV of the armyworm Mythimna (Pseudaletia) separata on eri silkworm Philosamia ricini (Hutt.). Entomon 6 (2) : 115-116

Eri silkworm *Philosamia ricini* larvae were infected with NPV of the armyworm, *Mythimna (Pseudaletia) separata*, a serious agricultural pest, by three different routes viz. topical, intrahaemocoelic and oral. The larvae were treated with the following concentrations : 10×10^5 PIBs/l, 10×10^6 PIBs/l, 10×10^7 PIBs/l and 10×10^8 PIBs/l. The larvae subjected to three experiments showed neither symptoms nor mortality due to polyhedrosis infection. Thus it appears that the NPV of *M. (P.) separata* is safe to eri silkworm, *Ph. ricini*.

G.R. Stairs et al. (1981). Changes in growth and virulence of a nuclear polyhedrosis virus from Choristoneura fumiferana after passage in Trichoplusia ni and Galleria mellonella. J. Invertebrate Path. 38 : 230-235

An isolate of nuclear polyhedrosis virus from *Choristoneura fumiferana* was fed to neonate larvae of *Trichoplusia ni* and *Galleria mellonella*. It caused infection and mortality in both of these species. After passage in the alternate hosts, the isolate became increasingly virulent for these hosts. The passaged virus retained its infectivity for *Choristoneura* but diseased larvae did not wilt and at death they were found to contain only a few polyhedra indicating the virus had been changed.

H.A. Wood et al. (1981). Increased virulence of Autographa californica nuclear polyhedrosis virus by mutagenesis. J. Invertebrate Path. 38 : 236-241

A mutant of *Autographa californica* nuclear polyhedrosis virus (AcMNPV) with increased virulence in *Trichoplusia ni* larvae was isolated following replication of a random virus clone in the presence of 2-aminopurine. The LT_{50} of the mutant, designated HOB, was significantly shorter than those of either the wild isolate or parental clone of AcMNPV. Also, fifth-instar larvae infected with this mutant gained significantly less weight and consistently produced more virus occlusion bodies than larvae infected with the wild isolate or parental clone. No alteration in the *in vitro* replication of nonoccluded virions, occluded virus structural proteins, or DNA restriction endonuclease patterns were observed with the HOB mutant.

K.A. Tweeten et al. (1981). Applied and molecular aspects of insect granulosis viruses. Microbiol. Rev. 45 (3) : 379-408

The authors summarize studies that have examined the feasibility of using one group of baculoviruses, the GVs, as insecticides. They also present information on the biochemical and molecular properties of the GVs, much of which has been gathered because of the rigorous characterisations required by governmental agencies for registration of GVs as pesticides. Application as insecticides is dealt with under the following headings : insecticidal potential, susceptibility of economically important pests, large-scale application and field testing, comparison with chemical insecticides, other beneficial features as insecticides, limitations to commercial development and further investigations.

B.M. Philip & A. Jacob (1981). Further studies on influence of granulosis infection on the larvae of Pericallia ricini Fab. (Arctiidae : Lepidoptera). Entomon 6 (2) : 111-113

Granulosis virus infection in *P. ricini* resulted in a reduction in weight and length of larvae.

C. Payne (1981). The susceptibility of the pea moth, Cydia nigricana, to infection by the granulosis virus of the codling moth, C. pomonella. J. Invertebrate Path. 38 : 71-77

Laboratory studies demonstrated that neonate larvae of the pea moth, *Cydia nigricana*, are susceptible to infection with a granulosis virus (CpGV) isolated from the codling moth, *Cydia pomonella*. Comparative LC_{50} values for *C. nigricana* and *C. pomonella* are 1.90×10^5 and 1.54×10^6 capsules/ml of diet, respectively. The virus extracted from CpGV-infected pea moth larvae is serologically related, and probably identical, to CpGV.

M. Kobayashi & S. Kawase (1981). Quantitative analysis of the metabolism in the isolated pupal abdomens of the silkworm, Bombyx mori, infected with nuclear polyhedrosis virus. J. Invertebrate Path. 38 : 4-11

The rate of oxygen uptake and the amount of several main cell constituents were determined in NPV-infected and uninfected isolated pupal abdomens of the silkworm, *Bombyx mori*. The oxygen uptake in uninfected isolated abdomens increases for the first 2 days due to the effect of water injection, but thereafter it remains, almost unchanged at a relatively low level. When isolated abdomens are infected with an NPV, the oxygen uptake increases markedly from 3 days postinfection onward, being about three times that of uninfected isolated abdomens at late stages of infection. The amounts of cell constituents analyzed in the present study change little in uninfected isolated abdomens throughout the experiment. Infection of NPV leads to a marked accumulation of both DNA and RNA, and a loss of glycogen. The amount of protein, lipid, and sugar are scarcely affected by NPV infection. These results indicate that the activity of metabolism in uninfected isolated abdomens is not only low but also stable, and that infection of NPV results in an activation of host cell metabolism. It is considered that such isolated pupal abdomens provide an excellent opportunity to analyze both the process of NPV replication and the alteration of host cell metabolism resulting from NPV infection.

T. Saro et al. (1980). A granulosis virus of the tea tortrix, Homona magnanima Diaknoff (Lepidoptera : Tortricidae) : its pathogenicity and mass production method. Appl. Ent. Zool. 15 (4) : 409-415

Of 6 tortricid species tested, only *H. magnanima* was susceptible to infection with the virus. The inoculum showed high infectivity to newly-hatched larvae, and susceptibility decreased with larval development. A modification of the method used for mass production of the GV of *Adoxophyes orana* was successfully used for mass production of the virus, utilising about 100 mature larvae in a rearing container 28 × 20 × 6 cm.

C. Payne et al. (1981). The comparative susceptibilities of Pieris brassicae and P. rapae to a granulosis virus from P. brassicae. J. Invertebrate Path. 38 : 273-280

A comparison was made of the dosage-mortality responses of larvae of *Pieris brassicae* and *P. rapae* to infection by *P. brassicae* granulosis virus (GV). Bioassays with first-, second-, third- and fourth-instar larvae of both species revealed a marked difference in susceptibility between instars and between species. Median lethal dosages (LD_{50}s) for *P. rapae* larvae ranged from five capsules for the first instar to 662 capsules for the fourth instar. With *P. brassicae*, this range extended from 66 capsules to 2.3×10^7 capsules. The time-mortality responses of the two species were similar when fed virus dosages equivalent to an LD_{90}. Median lethal times (LT_{50}s) ranged from 5 days for first-instar larvae to 7·8 days for fourth-instar larvae. A comparison between a long-established laboratory stock of *P. brassicae* and a stock recently acquired from the field showed no significant difference in their susceptibility to GV. The implications of the pronounced species differences in susceptibility to GV infection are discussed in relation to the potential field control of *P. rapae* and *P. brassicae*.

D.T. Briese & H.A. Mende (1981). Differences in susceptibility to a granulosis virus between field populations of the potato moth, Phthorimaea operculella (Zeller) (Lepidoptera : Gelechiidae). Bull. Ent. Res. 71 (1) : 11-18

A laboratory bioassay was used to compare the susceptibility of 16 field populations of *P. operculella* in Australia. A difference of 11.6x was found between the most and least susceptible population, while a laboratory strain was more than 30x as resistant as some field populations. This variability might reflect the past history of exposure of different populations to the virus, which appears to be endemic. The implications for the use of this virus as a microbial control agent are discussed.

P.G. Hotchkin (1981). Comparison of virion proteins and granulin from a granulosis virus produced in two host species. J. Invertebrate Path. 38 : 303-304

A granulosis virus (GVH) originally isolated from *Pseudoletia unipuncta* in Hawaii enhances the infection of insect baculoviruses. A second granulosis virus (GVO) of *P. unipuncta* obtained from Oregon does not have this enhancing property. GVH infects *Spodoptera exigua* and other noctuid hosts and all virus isolates are antigenically identical. The author reports that the GVH produced in different host species (*P. unipuncta* and *S. exigua*) results in a minor change in enveloped virion proteins and no change in granulin when electrophoretic mobilities were compared.

W.R. Kellen & D.F. Hoffmann (1981). A pathogenic nonoccluded virus in hemocytes of the naval orangeworm, Amyelois transitella (Pyralidae : Lepidoptera). J. Invertebrate Path. 38 : 52-66

A small, nonoccluded virus was isolated from the granular hemocytes (= adipocytes) of moribund larvae of the navel orangeworm, *Amyelois transitella*, collected from almonds in northern California. The virus was readily transmitted perorally in laboratory tests and was highly pathogenic to neonate larvae ; however, third- and fourth-stage larvae usually acquired attenuated infections that retarded growth and delayed mortality. Large paracrystalline viral arrays filled the cytoplasm of granular hemocytes of diseased larvae. Attempts to transmit the virus perorally to larvae of nine other species of moths were unsuccessful. The virus is isometric, about 25 nm in diameter, and contains single-stranded RNA. It has been designated « chronic stunt virus » (CSV) and tentatively assigned to the picorna-like viruses.

C. Reinganum et al. (1981). A survey for pathogens of the black field cricket, Teleogryllus commodus, in the Western District of Victoria, Australia. J. Invertebrate Path. 38 : 153-160

A pathogen survey of the black field cricket, *Teleogryllus commodus*, in the Western District of Victoria, Australia, during 1979, revealed that cricket paralysis virus (CrPV) was present in 42.7 % of the 232 sites sampled. The fungus *Metarhizium anisopliae* was detected in 5.2 % of the sites and represents a new pathogen record for *T. commodus*. The distribution of both pathogens throughout the sites sampled appeared to be random. There was a positive correlation between sample size and the likelihood of detecting a pathogen, while analysis showed that approximately 30 % of the sites were probably virus free. The results are discussed in terms of the potential of CrPV and *M. anisopliae* as biological control agents for the black field cricket.

A.J. Delucca et al. (1981). Bacillus thuringiensis distribution in soils of the United States. Can. J. Microbiol. 27 : 865-870

During a 2-year study, samples of various types of soils were collected from 115 fields that had not previously been treated with *Bacillus thuringiensis* and which were remote from any large-scale aggregations of lepidopterous insects in rearing or grain-storage areas. An average of about 400 isolates were examined from each soil, and of 46,373 isolates examined, only 250 (0.5 %) were identified as *B. thuringiensis*. While it was almost impossible to ensure that a field had never been treated with *B. thuringiensis* or that drift from some nearby application had not reached the field, it is noteworthy that of the 250 isolates, 156 (62.4 %) were not var. *kurstaki*, the only variety that has been used commercially in the United States in about 10 years. This is a strong indication that the *B. thuringiensis* isolates observed were present naturally. To verify the procedures used, samples were taken from two adjacent experimental plots which had been treated about 12 months previously with formulations of var. *kurstaki* and var. *galleriae*, respectively. With practically no exception, the variety recovered from each plot was the variety applied, indicating that the varietal status of *B. thuringiensis* is stable in the soil.

C.S. Creighton et al. (1981). Comparative control of caterpillars on cabbage cultivars treated with Bacillus thuringiensis. J. Georgia ent. Soc. 16 (3) : 361-367

Twelve cultivars of cabbage were sprayed weekly with *Bacillus thuringiensis* Berliner, in two years. Comparisons of

cabbage looper, *Trichoplusia ni* Hübner, imported cabbageworm, *Pieris rapae* (L.), and diamondback moth, *Plutella xylostella* (L.), populations and respective feeding damage on treated and untreated cultivars were made. Based on tolerance to caterpillar feeding, treatment response was greater on some cultivars than on others. The best overall plant protection was achieved on treated cultivars of Red Meteor, Rio Verde, Harris Resistant Dannish, Market Topper, and Market Prize.

H.S. Salama et al. (1981). Development of some lepidopterous cotton pests as affected by exposure to sublethal levels of endotoxins of Bacillus thuringiensis for different periods. *J. Invertebrate Path. 38 : 220-229*

Three spore-δ-endotoxin preparations from *Bacillus thuringiensis* vars. *kurstaki* and *entomocidus* including a commercial biological insecticide, Thuricide, were studied with respect to their biological interactions with the lepidopterous cotton pests, *Spodoptera littoralis*, *Spodoptera exigua*, and *Heliothis armigera*. The biological effects of sublethal doses and the length of exposure time to low endotoxin concentrations were assessed during and after removal of toxin from the diet. Retardation in larval development, reduction in egg production of the moths, and fertility of the egg were observed together with significant reduction in pupal weight and appearance of deformities in both pupae and moth populations. The influence of exposure to sublethal toxin concentrations was also manifested in terms of decreasing the adult emergence, fecundity reduction, and prolonging the generation period. In the exposed insects, the percentage of larvae that survived and succeeded to pupate increased with the decrease in the toxin concentration and with the decrease in exposure time. The reduction of the pupal weight significantly increased with the increase in either toxin concentration or the duration of exposure. The longevity of the moths was not affected by larval treatment and the data showed no clear correlation with the concentration and time of larval exposure to the toxin.

J.B. Dimond & C.J. Spies (1981). Two-year effects of a Bacillus thuringiensis treatment of spruce budworm, Choristoneura fumiferana (Lepidoptera : Tortricidae). Can. Ent. 113 : 661-663

The authors report a new example of apparent multiyear effects of *B.t.*, based on low levels of defoliation in 1980 on trees treated in 1979. It is of particular interest that the effects were seen on treated plots as small as 40 ha ; that protection in the second year equalled that in the first year ; and that this occurred in an area having very heavy budworm populations in both 1979 and 1980. Possible reasons for multiyear benefits from *B.t.* treatments are discussed, but further work is needed to explain the results. If multiyear effects can be confirmed, it would help justify the high costs of *B.t.* treatments.

K. Krishnaiah et al. (1981). Efficacy of Bacillus thuringiensis Ber. for the control of lepidopterous pests of vegetable crops. Entomon 6 (2) : 87-93

Formulations of *Bacillus thuringiensis* Ber. were evaluated for control of the major lepidopterous pests of okra, cabbage, egg plant and trailing beans in field trials during 1974-1978. On okra, weekly sprays of Dipel at 0.5 kg/ha reduced fruit infestations of *Earias vittella* Fabr. Spraying Dipel in a 10-day schedule during the fruiting period at 0.5 kg/ha suppressed the tomato fruit borer, *Heliothis armigera* Hüb., to the same extent as fortnightly applications of monocrotophos (0.5 kg/ha). Weekly sprays of Dipel (at 0.5 kg/ha) were quite effective in controlling the diamondback moth (*Plutella xylostella* L.) on cabbage, with efficacy comparable to that of fortnightly sprays of methamidophos and quinalphos (0.5 kg a.i/ha). Better control was achieved when Dipel was sprayed in combination with chlordimeform (both at 0.25 kg/ha). Populations of *Apanteles plutellae* Kurdj. were not affected by Dipel sprays. *Crocidolomia binotalis* Zell. was also effectively controlled on cabbage by weekly Dipel sprays. Dipel was ineffective against shoot and fruit borer, *Leucinodes orbonalis* Guen., on egg plant and pod borers, *Adisura atkinsoni* Moore, on trailing beans.

D.E. Johnson & B. Freedman (1981). Toxicity of Bacillus thuringiensis Spo⁻ Cr⁺ mutants for the European corn borer, Ostrinia nubilalis. Appl. environ. Microbiol. 42 (2) : 385-387

Inclusion bodies isolated from Spo⁻ Cr⁺ mutants of *Bacillus thuringiensis* were toxic for larvae of the European corn borer. Probit analysis revealed comparable toxicity between wild-type crystals (isolated from *B. thuringiensis* subsp. *kurstaki*) and crystals produced from two spore-free mutants of the same subspecies. Death of the larvae was due to starvation, presumably through δ-endotoxin-induced gut paralysis. Inclusion bodies pretreated with α-chymotrypsinogen were equally as toxic as native crystals for the insect larvae.

L.D. Tiwari & K.N. Mehrotra (1981). Effect of Bacillus thuringiensis on the pH of gut and haemolymph as well as on the sodium-potassium concentration in the haemolymph of Achoea janata L. and Spodoptera litura F. larvae (Lep. : Noctuidae). Z. angew. Ent. 92 : 61-66

A comparative study of the pathogenicity of *Bacillus thuringiensis* to *Achoea janata* and *Spodoptera litura* showed that *S. litura* is less susceptible to *B. thuringiensis*. Further, the data revealed that the two insect species differed in their response to *B. thuringiensis* with respect to change in sodium-potassium concentration and ratio in the haemolymph. The results strongly suggest that changes in pH of gut and haemolymph as well as disturbance of Na^+ and K^+ concentration and their ratio in the haemolymph are not related to the toxicity of *B. thuringiensis*.

Sha Cha-Yun et al. (1981). The role of the intestinal proteases of armyworm Leucania separata Walker in the pathogenicity of the crystals of Bacillus thuringiensis var. kenyae '7404'. Acta ent. sin. XXIV (3) : 237-243

Regurgitated gut juice from larvae of the army worm, *Leucania separata*, was extracted by acetone and chromatographed through a column of Sephadex G-75. Two eluted protease peaks were obtained, with differing disc electrophoretic patterns, but both showing protease activity in hydrolyzing crystals of *Bacillus thuringiensis* var. *kenyae* "7404". Pure crystals were hydrolyzed by gut juice at 30°C, and four hydrolysate fractions were obtained by chromatography with Sephadex G-200. Bioassay *per os* with army worm larvae showed the second hydrolysate fraction to have higher toxicity than the others, and, on disc electrophoresis, five clear and well-separated bands appeared.

J. Nishiitsutsuji-Uwo & Y. Endo (1981). Mode of action of Bacillus thuringiensis δ-endotoxin : effect on Galleria mellonella (Lepidoptera : Pyralidae). Appl. Ent. Zool. 16 (2) : 79-87

The general pathology of *Galleria mellonella* induced by *Bacillus thuringiensis* δ-endotoxin was studied in terms of

symptoms, relative roles of crystals and spores, hemolymph chemistry and the associated histopathology of the midgut. Bioassay using pure crystals and spores clearly demonstrated that the primary cause of dealth of *Galleria* larvae was the crystals and the presence of spores was only supplemental. Four hours after a single administration of crystals, changes appearing in the columnar cells of midgut epithelium were very similar to those observed in completely paralyzed *Bombyx mori* ; cells swelled losing their microvilli, burst or sloughed off into the lumen. Changes appearing in the goblet cells were different from those observed in *Bombyx mori* ; mitochondria came out from cytoplasmic projections which diminished in number in some cells. When cells sloughed off from the basement lamina, the projections were totally deformed. Mitosis and development of new columnar and goblet cells to replace the broken cells were more frequently observed in the regenerative cell-masses (nidi) than in those of normal epithelium. Although blood pH scarcely changed, the K^+ level rose up to 1.3 times. These results led to the conclusion that the reaction of *G. mellonella* to serotype VII is not that of a Type III host species.

M. Ohba et al. (1981). Production of heat-stable exotoxin by Bacillus thuringiensis and related bacteria. J. Invertebrate Path. 38 : 26-32

Heat-stable exotoxin production by 740 strains of *Bacillus thuringiensis* and related bacteria was investigated using the housefly, *Musca domestica*, from the following viewpoints : (1) the relationship between *B. thuringiensis* flagellar (H) serotypes and exotoxin production and (2) the exotoxin production by *Bacillus* species other than *B. thuringiensis*. Of 437 isolates belonging to 11 serotypes of *B. thuringiensis* which had been confirmed to produce parasporal inclusions, 35 isolates belonging to serotypes 1, 3a:3b, 4a:4c, and 10 produced heat-stable exotoxin. Exotoxin was not detected in the isolates of serotypes 3a, 4a:4b, 5a:5b, 5a:5c, 6, 7 and 8a:8b. No heat-stable exotoxin was demonstrated in 28 acrystalliferous isolates which possessed H antigens of *B. thuringiensis* serotypes 1, 3a, 4a:4b, 4a:4c, 5a:5c, 6, 7, 10, 11a:11c, and 12. A total of 270 *B. cereus* isolates which did not possess *B. thuringiensis* H antigen were examined and three isolates were found to produce heat-stable exotoxin. No heat-stable exotoxin was produced by *B. subtilis* (two strains), *B. natto* (one strain), and *B. megaterium* (two strains). These results indicate that the heat-stable exotoxin production in *B. thuringiensis* is a strain-specific property rather than a serotype (subspecies)-specific property.

M. Ohba et al. (1981). Two new subspecies of Bacillus thuringiensis isolated in Japan : Bacillus thuringiensis subsp. kumamotoensis (serotype 18) and Bacillus thuringiensis subsp. tochigiensis (serotype 19). J. Invertebrate Path. 38 : 184-190

Bacteriological and serological characteristics of three *Bacillus thuringiensis* isolates obtained in Japan were investigated. They formed typical rhomboidal parasporal inclusions but flagellar (H) antigens of these isolates were different from those of the known 17 H serotypes of *B. thuringiensis*. The three isolates were divided into two new serotypes (serotypes 18 and 19). The serotype 18 isolate (3-71) produced thermostable exotoxin and the inclusions of this isolate were toxic to larvae of the silkworm, *Bombyx mori*, but nontoxic to larvae of the mosquito, *Aedes aegypti*. The other isolate (119-72) belonging to serotype 18 produced inclusions nontoxic to larvae of *B. mori* and *A. aegypti* and did not produce thermostable exotoxin. However, other bacteriological properties of the isolate 119-72 were similar to those of the isolate 3-71. The serotype 19 isolate (117-72) produced inclusions nontoxic to larvae of *B. mori* and *A. aegypti* and did not produce thermostable exotoxin. Acid production from saccharose and the production of brownish purple pigment were observed in the two serotype 18 isolates, while neither of them was observed in the serotype 19 isolate. In other 29 biochemical properties tested, there was no difference among the three isolates. Based on these characteristics, the following two subspecies names are proposed : *Bacillus thuringiensis* subsp. *kumamotoensis* (serotype 18) for the type strain 3-71 and *Bacillus thuringiensis* subsp. *tochigiensis* (serotype 19) for the type strain 117-72.

M. Ohba et al. (1981). A new subspecies of Bacillus thuringiensis isolated in Japan : Bacillus thuringiensis subsp. tohokuensis (serotype 17). J. Invertebrate Path. 38 : 307-309

The bacteriological and serological properties of an isolate of *B.t.*, designated 78-FS-29-17, are described. It was isolated from the silkworm litters of sericultural farms in Fukushima Prefecture, Tohoku District, Honshu. It is of interest to note that the parasporal inclusions of this isolate disappeared in an old culture. 78-FS-29-17 was found to share no common flagellar (H) antigen with any of the known 16 serotypes of *B.t.* Also unique to this isolate was the negative results of Voges-Proskauer reaction and β-haemolysis on sheep blood agar. No toxicity to certain lepidopterous or dipterous insects could be demonstrated.

PARASITES AND PREDATORS

D. Gerling & Y.B. Mordechai (1981). Biological observations with Zeteticontus sp. (Hymenoptera : Encyrtidae) a parasite of Carpophilus hemipterus (L.) (Coleoptera : Nitidulidae). Proc. Hawaiian Ent. Soc. XXIII (3) : 351-354

Carpophilus hemipterus (L.) is a widespread nitidulid beetle, which together with a few allied species, occurs on decaying vegetation and fruit. This species may also be destructive to dried fruits and cereals in storage. In Hawaii, these beetles breed in large numbers in knocked-down pineapple fields where they feed upon the rotting stems. Once their food source has been exhausted, the beetles migrate to other places looking for new food sources. Large swarms of migrating beetles arrive in human habitations and cause a nuisance problem. A search for natural enemies of these pests has been undertaken, and the senior author was contacted and asked to obtain parasites of souring beetles from Israel to ship to Hawaii. This paper deals with some biological observations made during the project.

H.H. Cheng (1981). Additional hymenopterous parasites newly recorded from the darksided cutworm, Euxoa messoria (Lepidoptera : Noctuidae), in Ontario. Can. Ent. 113 : 773-774

The author (1977) reported on 10 species of insect parasites that were reared from field-collected larvae or pupae of the darksided cutworm, *Euxoa messoria* (Harris), in Ontario. Of those, eight species had not been previously recorded from this host. During subsequent studies at Delhi, Ontario in 1976 and 1977, more than 3000 larvae of this cutworm were collected from rye and tobacco fields and reared in the laboratory. From this work, four more species of primary endoparasites were newly recorded, namely, *Apanteles laeviceps* Ashmead (Braconidae), *Apanteles militaris* Walsh (Braconidae), *Campoletis* sp. (Ichneumonidae),

and *Meteorus communis* (Cresson) (Braconidae). *Arenetra* sp. reported in the earlier work appeared again and was determined to be *A. rufipes vernalis* Walley (Ichneumonidae).

C.M. Yoshimoto (1981). First record of Thripoctenoides from North America, with description of a new species (Hymenoptera : Eulophidae). Can. Ent. 113 : 723- 725

The genus *Thripoctenoides* is recorded from North America (Canada) for the first time, and *Thripoctenoides kaulbarsi*, a new species, is described. The latter is a brachypterous chalcidoid that presumably parasitizes Thysanoptera, thrips. Females were collected from a trap under Scots pine growing in a sandy soil ; the surrounding vegetation consisted largely of milkweed, goldenrod and grasses.

K.T. Khalaf (1981). Biology of Lanugo retentor (Hymenoptera : Ichneumonidae). J. Georgia ent. Soc. 16 (3) : 301-306

Males and females were able to mate on the day of emergence. The female mated only once during her lifetime, while some males mated more than once. The process of oviposition in the proper host involved a more or less constant sequence of activities whereby an experienced observer could tell when an egg had actually been laid. Old cocoons, containing pupae were suitable as hosts. *Lanugo* has two or three generations a year and overwintered in the last larval instar. The duration of the fall generation was 22-38 days and that of the fall-winter generation varied between 250 days and ten months. The early development of these two generations appears to be essentially the same and similar to that of the summer generation. The egg hatched after 37 hours with successive moltings occurring after *ca.* 3, 4, 5 and 6 days.

J.W. Press & B.R. Flaherty (1981). Reproductive potential of Bracon hebetor Say on three moth species, Ephestia cautella (Walker), Achroia grisella (F.) and Galleria mellonella (L.). J. Georgia ent. Soc. 16 (3) : 342-345

The population growth of the parasitic wasp *Bracon hebetor* Say on larvae of the almond moth, *Ephestia cautella* (Walker), was compared with that on larvae of the lesser wax moth, *Achroia grisella* (F.), and the greater wax moth, *Galleria mellonella* (L.). When the ratio of host larvae to *B. hebetor* females was small, greater numbers of *B. hebetor* progeny were produced on *G. mellonella* and *A. grisella*, while a large ratio of host larvae to *B. hebetor* females resulted in greater *B. hebetor* progeny production on *F. cautella*.

G. Mathew (1981). A new report of Pentalitomastix nacoleiae Eady (Hymenoptera : Encyrtidae) as a polyembryonic parasite of Parotis vertumnalis Guen (Lepidoptera : Pyraustidae) in Kerala, India. Entomon 6 (2) : 125

Pentalitomastix nacoleiae was first reported under the name of *Pseudolitomastix nacoleiae* as a parasite of the banana scab moth, *Nacoleia octasema*. It has been collected from Afghanistan, Assam in India and Fiji. *Parotis vertumnalis* is a leaf webber of the tree *Alstonia scholaris*.

S.A. Juliano (1981). Trichogramma spp. (Hymenoptera : Trichogrammatidae) as egg parasitoids of Sepedon fuscipennis (Diptera : Sciomyzidae) and other aquatic Diptera. Can. Ent. 113 : 271-279

At least two species of *Trichogramma* parasitize the eggs of *Sepedon fuscipennis* in freshwater habitats of central New York. *Trichogramma julianoi* parasitizes *S. fuscipennis* and *Elgiva sundewalli* Fries. *Trichogramma* sp. near *californicum* Nagaraja & Nagarkatti parasitizes *S. fuscipennis*, *E. sundewalli*, *Tetanocera* spp. and pyralid moths. *T. julianoi* was most active in early and late summer. *T.* sp. near *californicum* was most active in mid- and late summer. Another undescribed species, similar to *Trichogramma semblidis* (Aurivillius), occurs in the same habitats but does not parasitize *S. fuscipennis*. Its primary hosts are Stratiomyidae (Diptera). Mortality of *S. fuscipennis* eggs due to *Trichogramma* varied significantly over the summer and reached 43.6 % in late July and early August. A list of parasitoids reared from eggs of insects collected in freshwater habitats is given.

B. Hardin (1981). Tiny wasps – key insects in biological control. Agric. Res. 29 (10) : 11

This popular article briefly describes the work of SEA entomologist J. David Hoffman of the Biological Control of Insects Research Unit, Colombia, Mo., on *Trichogramma*.

Liu Siu-King et al. (1981). The parasites of the rice gall midge (Orseolia oryzae [Wood-Mason]) in Kwangtung Province and their susceptibilities to insecticide applications. Acta ent. sin. XXIV (3) : 274-281

The five species considered are : *Platygaster* sp. (gregarious endoparasite), *Platygaster* sp. (solitary endoparasite), *Neanastatus grallarius*, *N. oryzae* and *Obtusiclava oryzae*. The morphology of the various stages of these parasites is described and a brief account of their binomics is also given.

J.L. Capinera & W.J. Roltsch (1981). The predatory ant Formica neoclara : effect on within-field bean aphid distribution and activity in relation to thermal conditions. J. Kansas ent. Soc. 54 (3) : 578-586

Formica neoclara Emery preys upon lepidopterous larvae but attends bean aphids, *Aphis fabae* Scopoli. In a sugarbeet field at Ft. Collins, Colo., abundance of bean aphid was highly correlated with abundance of ants and ant nest entrances. Ladybird abundance was correlated with bean aphid abundance and ant numbers. We suggest that survival of bean aphids, or perhaps growth and reproduction, is enhanced by association with *F. neoclara*. Ant activity was influenced by thermal conditions. Ant activity at nest entrances that were exposed to incident sunlight decreased in response to high soil temperatures, while activity at shaded entrances remained relatively constant. There were significantly higher levels of activity at shaded entrances during mid-day but more activity at unshaded entrances in early evening. Overall ant activity on the soil surface was higher in early evenings as compared to morning and mid-day. The level of ant activity on aphid-infested plants also decreased at mid-day.

Chang Hyo Kim & Yozo Murakami (1981). Ecological studies on Formica yessensis Forel, with special reference to its effectiveness as a biological control agent of the pine caterpillar moth in Korea. III. Nest distribution and environmental conditions of nest sites. J. Fac. Agric. Kyushu Univ. 26 (1) : 9-19

Seasonal change of nest distribution of *Formica yessensis* in the hill and biotic and abiotic environmental conditions of nest sites was investigated in red pine stands in Gyeongsang-Nam-Do, Korea in 1973-77. The nests were scarce in the upper zone of slopes and concentrated in the lower and middle zones. Nest distribution changes seasonally but the density per unit area is relatively constant (0.014-0.022 per m^2). Active nests increase in number from spring to summer

by budding, then decrease in autumn by abandonment. The life span of nests was 1-4 months in most cases. Abandonment occurs more frequently in newly-founded and revived nests. Abandoned nests are re-utilized, the number of times the same nest was utilized being between 1 and 11. The humidity above ground and soil moisture are important factors for establishing nests. The content of organic matter was higher in soils at the lower and middle zones inhabited by the ant than in the upper zone, while the content of exchangeable Ca was lower in the former than the latter. In the upper zone, the density of pine trees is relatively low and that of *Zoisia* is higher than the middle and lower zones. Such conditions are unfavourable for establishing nests. The lower and middle zones, on the contrary, are favourable because of the relatively high density of pine trees, but sufficient light intensity and presence of suitable plants for nest cores such as long graminaceous grasses. *Arundinella hirta*, *Pinus densiflora* (red pine trees) and *Miscanthus sinensis* f. *purpurascens* as well as stones serve as the core for building nests.

Chang Hyo Kim & Yozo Murakami (1981). Ecological studies on Formica yessensis with special reference to its effectiveness as a biological control agent of the pine caterpillar moth in Korea. IV. Artificial colonisation of nests. J. Fac. Agric. Kyushu Univ. 26 (1) : 39-44

Two experiments of artificial colonization of *Formica yessensis* were conducted in several red pine stands of Gyeongsang-Nam-Do, Korea, in 1972 and 1977. The ant easily established in forests growing 10 to 20-year-old red pine trees at a relatively high density but admitting sunlight to the forest floor, and harbouring much bare ground and long graminaceous grasses. The ant favours soils with much organic material and rather high moisture content but not excessively wet.

R.N. Williams et al. (1981). Parasitism of the picnic beetle, Glischrochilus faciatus (Coleoptera : Nitidulidae), by the tachinid Hyalomyodes triangulifer (Diptera : Tachinidae). J. Kansas ent. Soc. 54 (3) : 521-522

The picnic beetle, *Glischrochilus faciatus* (Oliv.), was found to be parasitized by the tachinid, *Hyalomyodes triangulifer* (Loew). This is the first report of this parasite attacking a nitidulid and the first known parasite attacking a member of the genus *Glischrochilus*. Three (1.3 %) of 237 field-collected *G. faciatus* were parasitized. None of the 221 field-collected *G. quadrisignatus* were parasitized.

R.S. Mizell & T. Evan Nebeker (1981). Within-tree distribution of the pupae of Thanasimus dubius (Coleoptera : Cleridae), a predator of the southern pine beetle (Coleoptera : Scolytidae). Can. Ent. 113 : 387-394

Regression models of the form $lnY = b_0 + b_1 \ ln \ (X - c) + b_2 X$ are presented that describe the within-tree distribution of the pupae of *Thanasimus dubius* (F.), a clerid predator of the southern pine beetle, *Dendroctonus frontalis* Zimm. More *T. dubius* pupae/100 cm^2 of bark area were found in loblolly pine, *Pinus taeda* L., than in shortleaf pine, *P. echinata* Miller, and the number increased with increasing tree diameter class. Peak densities were found at a height of 1-4 m.

B.S. Ekbom (1981). Efficiency of the predator Anthocoris nemorum (Het. : Anthocoridae) against the greenhouse whitefly, Trialeurodes vaporariorum (Hom. : Aleyrodidae). Z. angew. Ent. 92 : 26-34

Anthocoris nemorum was raised on three different diets : 1. whitefly (*Trialeurodes vaporariorum*) larvae only, 2. *Myzus persicae* only, and 3. a mixed diet with both whiteflies and aphids. *A. nemorum* nymphs were able to complete development on all three diets. Duration of development was not significantly different for the three treatments. Instars 2 to 5 took about 21 days at 20°C. Cage trials of the effectiveness of the predator against the whitefly were done using tomatoes and cucumbers as host plants. Mortality due to predation was low and probably not high enough for whitefly control. *A. nemorum* was able to use the plants available for reproduction. The use of predators in the greenhouse is discussed.

A.D. Pawar et al. (1981). Field recovery of Eucelatoria sp. near armigera (Coq.) (Diptera : Tachinidae) from Heliothis armigera (Hübn.) (Lepidoptera : Noctuidae) in Karnataka, India. Entomon 6 (2) : 175-177

Field releases of *Eucelatoria* sp. near *armigera* (Coq.), a larval endoparasite, were made for biological control of *Heliothis armigera* (Hübn.) in Bangalore district (Karnataka). The parasite has been recovered four times from the field, indicating its establishment in Bangalore district against *H. armigera* infesting tomato, beans and arhar.

P.B. Martin et al. (1981). Seasonal occurrence of Rachiplusia ou, Autographa biloba and associated entomophages in clover. J. Georgia ent. Soc. 16 (3) : 288-296

Larvae of Plusiinae, primarily *Rachiplusia ou* (Guenée) and *Autographa biloba* (Stephens), were never at high densities, but were most numerous in clover during the spring. Likewise, adults of *R. ou* and *A. biloba* were most commonly caught in traps during the spring, although they also were caught during the winter. Adults of *R. ou* were commonly captured in traps baited with virgin females of tobacco budworm, *Heliothis virescens* (F.). One of 10 Plusiinae eggs found in clover was parasitized by *Trichogramma* sp. Eggs of another noctuid, *Anticarsia gemmatalis* Hübner were, however, numerous and heavily parasitized during the fall. Larval parasitoids, especially *Litomastix truncatella* (Dalman) and *Meteorus autographae* Muesebeck, were recovered from 35 % of the Plusiinae larvae. Very few diseased larvae were found. Predaceous arthropods were at high densities in clover. The most common predators encountered were *Coleomegilla maculata* (DeGeer), *Hippodamia convergens* (Guérin-Méneville), damsel bugs (primarily *Reduviolus roseipennis* (Rueter) and *Tropiconabis capsiformis* [Germar]), and *Geocoris* spp. (primarily *G. punctipes* [Say] and *G. uliginosis* [Say]).

K.A. Rouechdi & J. Voegelé (1981). Predation of Trichogramma by chrysopids. Agronomie 1 (3) : 187-190

The larvae of *Chrysopa carnea* Steph. attack eggs of *Anagasta kuehniella* Zell. parasitized by *Trichogramma* at whatever stage the parasite may be, showing no preference for parasitized or healthy eggs, although black parasitized eggs are less exploited than others. Eggs parasitized or not can assure complete development of the predator. It is necessary to protect *Trichogramma* from *Chrysopa* action during seasonal inundative releases.

G. Viggiana & P. Mazzone (1981). Recent introductions of parasites of Saissetia oleae (Oliv.) in Italy. Fruits Outre-Mer 36 (3) : 184-185

Metaphycus bartletti, imported from Israel for control of *Saissetia oleae*, was reared on *S. oleae* growing on potato sprouts and released into experimental field of citrus and olive in 1979. Subsequent investigations confirmed that the

parasite had reproduced during the summer. A further species, *M. swirskii*, released in 1977, was also found to be present. *M. bartletti* is a solitary or gregarious parasite of 3rd-stage nymphs and young females of *S. oleae*. These two parasites are presently being mass-reared at the Biological Control Centre, Portici, for large-scale release in citrus and olive in Italy.

G. Viggiani (1981). New records on releases and recoveries of Encarsia lahorensis (How.). Fruits Outre-Mer 36 (3) : 186-187

Since 1976, *E. lahorensis* has been mass-reared and released in various areas of Italy and the Mediterranean infested by *Dialeurodes citri*. Around Portici, the parasite spread 3-4 km from the release sites in 1-2 years, with parasitisation exceeding 20-30 %. In 1980, *E. lahorensis* was recorded in Naples, about 10 km from Portici. The parasite has also been released and recorded in Sicily, Corfu (Greece) and Sardinia.

A. Garrido et al. (1981). Effect of certain pesticides on the nymphal stages of Cales noacki How., a parasite of Aleurothrixus floccosus. Fruits Outre-Mer 36 (3) : 182-183

Forty pesticides were tested, including 32 insecticides, 4 acaricides, 3 fungicides and a detergent. Dimethoate, tetrachlorvinphos, phosalone, fentoate, fenitrothion, fenvalerate, summer oils, chlorfenvinphos, methyl-parathion, methidathion, malathion, carbophenothion-phosmet, chlorpyriphos, methomyl, fosmet and dichlorvos-dimethoate were all extremely toxic, while pirimicarb, cichloprate, chlorobenzilate, captafol and the detergent showed no toxic effects. The other products were intermediate in action. Care must be taken when planning an integrated control programme.

M. Yukinari (1981). Notes on the biology of Archippus semistructus (Lepidoptera : Tortricidae) and its parasites in Tokushima Prefecture. Jap. J. appl. Ent. 25 (2) : 127-129

The parasites listed include the Ichneumonidae *Campoplex homonae*, *Gregopimpla kuwanae* and *Trathala flavoorbitalis*, the Braconidae *Apanteles* sp., *Bracon adoxophyesi* and *Macrocentrus linearis*, the Chalcidoidae *Brachymeria* spp., the Bethylidae *Goniozus japonicus* and the Tachinidae *Zenillia* spp.

W.G. Des Vignes (1981). Notes on parasites and predators of Symmetrischema capsica, a pest of peppers (Capsicum spp.). J. agric. Soc. Trinidad & Tobago LXXXI (1) : 50-64

This paper deals with the life history and habits, laboratory rearing and shipments of parasites of *S. capsica*. Predators found during the study are mentioned. The following parasites were reared : *Agathis* sp., *Apanteles* sp. and *Bracon* sp., *Apsilophrys capsicum*, *Perisierola* sp. and an undetermined Eulophid. No hyperparasites were found.

W.G. Des Vignes (1981). Ecology and natural control of Symmetrischema capsica (Bradley & Povolny) a pest of peppers (Capsicum spp.). J. agric. Soc. Trinidad & Tobago LXXXI (1) : 31-50

The author analysed the population fluctuation of a pest of peppers *Symmetrischema capsica* in Trinidad. There is a relationship between climatic factors and parasite and pest populations. The factor of 'natural control' is discussed and a recommendation made for exotic parasite introduction into Trinidad.

J.-P. Nénon (1981). Use of entomophagous insects in biological control. Annee biol. 20 (3) : 227-254 (in French)

In this review article, the author first considers the general principles of biological control and in particular the use of entomophagous insects. Control of Homopterans, Lepidopterans and Hemipterans is then dealt with in some detail under the following headings : aphids by Coccinellids, Chrysopids, Syrphids and Hymenopterans ; scales by Coccinellids and parasites ; whiteflies ; sugarcane borers ; European corn borer ; olive moth *Prays oleae* ; *Ectomyelois ceratoniae* ; *Aelia* spp. Present trends in research are then summarised with respect to systems modelling, production of entomophages on synthetic media, and genetic manipulation of populations. There is an extensive bibliography.

R.G. Hislop & R.J. Prokopy (1981). Integrated management of phytophagous mites in Massachusetts (USA) apple orchards. 2. Influence of pesticides on the predator Amblyseius fallacis (Acarina : Phytoseiidae) under laboratory and field conditions. Prot. Ecol. 3 : 157-172

Forty orchard spray materials were evaluated in laboratory and/or field trials for toxicity to different strains of *Amblyseius fallacis*, the most important predator of the spider mites *Panonychus ulmi* and *Tetranychus urticae* in Massachusetts apple orchards. In laboratory trials, materials highly toxic to the Bishop strain were methomyl, carbaryl, phosalone, diazinon, demeton, dimethoate, fenvalerate, permethrin, formetanate hydrochloride, ammonium sulfamate, paraquat, and glyphosate. Materials of moderate toxicity were phosphamidon, dicofol, karathane, cyhexatin, and daminozide. Materials of low toxicity were malathion, phosmet, azinphosmethyl, methyl parathion, endosulfan, methoxychlor, propargite, fenbutatin-oxide, benomyl, dodine, glyodin, maneb, dikar, thiram, dichlone, captan, ferbam, maneb-zinc, simazine, dalapon, ethephon, NAA and calcium chloride. Benomyl leaf residues interfered with reproductive capability. In field research plot trials, phosalone, permethrin, and benomyl reduced the numerical response of *A. fallacis* to prey increase, resulting in spider mite build-up. Endosulfan, azinphosmethyl, phosmet, and methyl parathion had little effect on *A. fallacis* abundance, resulting in predator-prey ratios favorable to biological control of spider mites. In commercial orchards receiving combinations of phosalone, formetanate hydrochloride, ammonium sulfamate, benomyl, and/or glyodin, *A. fallacis* was unable to respond maximally to increasing spider mite abundance, necessitating repeated acaricide treatments. In commercial orchards receiving none of these materials, but instead treated with azinphosmethyl, phosmet, endosulfan, captan, and/or dodine, spider mites rarely exceeded the economic injury level, owing in large part to the more favourable *A. fallacis*-spider mite ratios.

C.M. Port & N.E.A. Scopes (1981). Biological control by predatory mites (Phytoseiulus persimilis) of red spider mite (Tetranychus urticae) infesting strawberries grown in 'walk-in' plastic tunnels. Pl. Path. 30 : 95-99

During 1978 and 1979, the control of red spider on strawberries by the predacious mite *Phytoseiulus persimilis* was studied at two sites in Hampshire where crops were grown in 'walk-in' plastic tunnels. An introduction of at least two predators per plant in March was required to control red spider mite in one experiment. In the second experiment, introductions of small numbers of predators (fewer than two per plant) in August controlled mites on newly-planted runners before diapause. Similar numbers of

predators introduced in the following March, 10 days after red spider mite eggs were seen, controlled mite infestations throughout the growing season. Controlling mites in the autumn before diapause was considered important.

BEHAVIOURAL CHEMICALS, OTHER MEANS, GENERAL PAPERS

M. Beevers et al. (1981). Kairomones and their use for management of entomophagous insects : X. Laboratory studies on manipulation of host-finding behaviour of Trichogramma pretiosum Riley with a kairomone extracted from Heliothis zea (Boddie) moth scales. J. Chem. Ecol. 7 (3) : 635-648

The purpose of this study was to examine the behavioural changes that kairomones elicited in *Trichogramma* and define their role in the overall host-finding sequence. There is a generalised diagrammatic scheme showing how the behavioural response of *T. pretiosum* females is altered by several types of kairomone distribution.

R. Sato et al. (1981). Simultaneous trapping of several fruit-tree pest insects by one trap baited with multiple sex lures. Jap. J. appl. Ent. Zool. 25 (3) : 176-181

Effects of sex lures of different insect species on trap catch of the peach fruit moth (*Carposina niponensis* Walsingham), the oriental fruit moth (*Grapholitha molesta* Busck), the cherry tree borer (*Synanthedon hector* Butler) and the Asiatic leafroller (*Archippus breviplicanus* Walsingham) were analysed when these sex lures were simultaneously used in one trap. The attractiveness of the sex lure of *C. niponensis* was not affected by the lures of *G. molesta, S. hector* and *A. breviplicanus*, while that of *G. molesta* was not affected by the lures of *C. niponensis* and *S. hector*, but was markedly inhibited by the lures of *A. breviplicanus* and the summer-fruit tortrix moth (*Adoxophyes orana fasciata*). *A. breviplicanus* was not affected by the lures of *C. niponensis, G. molesta* and *S. hector*, but the trap catches were markedly decreased when the lure of *A. orana fasciata* was used. *S. hector* was slightly affected by the lures of *G. molesta* and *A. orana fasciata*, and remarkably affected by the combination of four lures such as those of *C. niponensis, G. molesta* and *A. breviplicanus* and *A. orana fasciata*. Seasonal trends for trap catches of *C. niponensis, G. molesta* and *A. breviplicanus* were not affected by the simultaneous use of lures of *G. molesta, C. niponensis* and *S. hector* in each trap.

H. Noguchi et al. (1981). Field evaluation of synthetic sex pheromone of the oriental tea tortrix moth, Homona magnanima Diakonoff (Lepidoptera : Tortricidae). Jap. J. appl. Ent. Zool. 25 (3) : 170-175

Field trappings were conducted in using a three-component synthetic sex pheromone consisting of (Z)-11-tetradecenyl acetate (Z11-14Ac), (Z)-9-dodecenyl acetate (Z9-12Ac), and 11-dodecenyl acetate (11-12Ac) to develop a potent attractant lure for males of the oriental tea tortrix moth, *Homona magnanima* Diakonoff. Persistency of attractiveness on three kinds of dispensers such as chopped cotton rope, plastic capsule, and rubber septum was 2 days, 2 weeks, and 1 month, respectively. Addition of *E*-isomers of the pheromone components at a dose of less than 10 % did not affect the attractiveness. The optimum ratio of the two minor components, Z9-12Ac and 11-12Ac, coincided with their natural ratio, 3 to 1, but the optimum ratio of the major component, Z11-14Ac, was twice that of the natural ratio. Based on these results, a 60:3:1 blend of Z11-14Ac, Z9-12Ac, and 11-12Ac loaded on a rubber septum (3.2 mg in total) was recommended as an attractant lure for males of the oriental tea tortrix moth.

E.J. Villavaso & W.L. McGovern (1981). Boll weevil : disruption of pheromonal communication in the laboratory and small field plots. J. Georgia ent. Soc. 16 (3) : 306-310

A 93 % reduction in the number of female boll weevils, *Anthonomus grandis grandis* Boheman, captured in male-baited traps was obtained by the use of grandlure to disrupt pheromonal communication in the field. Laboratory olfactometer tests supported the field results.

W.J. Lewis et al. (1980). Status and potential use of behavioural chemicals in pest management. FAO Pl. Prot. Bull. 28 (4) : 121-138

This article was prepared at the request of the FAO/UNEP Panel of Experts on Integrated Pest Control and reviewed in the Ninth Session of the Panel in Wad Medani, Sudan, 9-13 December, 1979. The authors examine the reasons why semiochemicals have not, so far, been extensively developed ; these include previous experience with conventional chemical insecticides, lack of appreciation of the interactions among ecosystem components, lack of adequate appreciation of individual variability, registration regulations, organisational constraints and general economics. General strategies on the use of behavioural chemicals for monitoring/controlling pest populations or enhancing reproduction and performance of beneficial species are then considered. A summary of the discussions and conclusions of the FAO Panel of Experts on Integrated Pest Control is given.

R.M. Silverstein (1981). Pheromones : background and potential for use in insect pest control. Science 213 : 1326-1332

Following a general account of the pheromone story and pest control with pheromones, specific case histories in cotton, forest and shade trees and stored products are briefly described.

G. Szocs et al. (1981). Sex attractants for eight lepidopterous species. Z. angew. Ent. 91 : 272-280

During ten field screenings of olefinic compounds carried out in Hungary, sex attractants were found for *Swammerdamia* sp. as the mixture of Z-7-14 : Ac and Z-11-14 : Ac, *Agonopteryx alstroemeriana* (Cl.) as the mixture of Z-9-14 : Ac and Z-7-12 : Ac, *Isotryas hybridana* (Hb.) as the mixture of Z-11-16 : Ac and Z-9-14 :Ac, *Athetis lepigone* (Möschl.) as the mixture of Z-9-14 :Ac and Z-7-12 :Ac, *Caradrina clavipalpis* (Scop.) as the mixture of Z-7-12 : Ac and Z-9-12 :Ac, *Cucullia argentea* (Hfn.) as Z-7-12 : Fo, *Scotia crassa* (Tr.) as the mixture of Z-7-12 : Ac and Z-9-12 : Ac and *Rhyathia putris* (L.) as Z-9-14 : Ac, respectively.

Ding De-cheng et al. (1981). Studies on the kairomone influencing oviposition behaviour of Tetrastichus schoenobii Ferriere : source and extraction. Acta ent. sin. XXIV (3) : 262-267

The present paper is the first part of studies dealing with the chemical stimulant (kairomone) initiating oviposition behaviour of *Tetrastichus schoenobii*, an egg parasite of the yellow paddy borer, *Tryporyza incertulas* (Walker). The results demonstrate that the kairomone which elicits both the host-searching and oviposition behaviour by *T. schoenobii* female is located in both the hairs of the host egg mass and the anal tuft of the female moth. The active ingredient was successfully extracted by acetone-water (1:1) solvent, but cannot be extracted by n-hexane. If an acetone-water extract of the host egg-hairs was applied to a paper model

egg, the model egg would elicit both the antennal drumming and inserting ovipositor of the parasite.

Li Wen-gu et al. (1981) Pheromone of Pectinophora gossypiella : the effects of habituation on short distance response level of males. Acta ent. sin. XXIV (3) : 244-251

Exposure of male moths of the cotton pink bollworm, *Pectinophora gossypiella* (Saund.), to Gossyplure, the sex pheromone of *P. gossypiella*, resulted in diminishing short distance sexual response to natural female extract. The degree of habituation was proportional to the logarithm of the pheromone dosage. Habituation raised the responsive threshold of males to the sex pheromone. Nearly all habituation to pheromone occurred during the first ten minutes of exposure, but the time required for recovery from habituation was longer and was dosage dependent. Z-7, Z-11-Hexadecadienyl acetate, one component of Gossyplure, inhibited the male response to natural female extract more effectively than Gossyplure. The relation between habituation of sex behaviour response of males to sex pheromone and disruption of mating in fields under the conditions of dense or sparse population is discussed.

H.C. Chiang & L.K. French (1980). Host tolerance, a short-term pest management tool – maize and corn rootworm as a model. FAO Pl. Prot. Bull. 28 (4) : 137-138

Susceptible inbreds of maize suffered higher root damage and lodging than tolerant inbreds due to infestations of the western corn rootworm, *Diabrotica virgifera* LeConte. However, larval survival was much higher on the tolerant inbreds. This confirms Pathak's contention that tolerant crop varieties may be more inducive to pest population build-up than susceptible varieties. Thus, tolerance in host-plant resistance should be considered a short-term management tool.

D.L. Jermy (1981). Antifeedants for the Colorado beetle. I. Antifeeding constituents of some plants from the sagebush community. Insect Sci. Applic. 1 (3) : 237-242

A two-choice type bioassay was used to screen extracts from a number of plants of the sagebush community for their antifeeding properties against the Colorado potato beetle, *Leptinotarsa decemlineata* Say. The extracts of *Artemisia tridentata*, *Purshia tridentata* and *Chrysothamnus nauseosus* were fractionated for their antifeeding constituents. Known constituents of these plants (deacetalmatricarin, coumarins, cucurbitacins, polyphenols, polyacetylenes, and essential oils) were also screened. The results indicate that several chemical classes of compounds are responsible for antifeeding activity in each plant. Water soluble substances present in the waste marc after steam distillation of peppermint oil were highly active, too.

K. Purrini (1981). Nosema hylobii n.sp. (Nosematidae : Microsporida), a new microsporidian parasite of Hylobius abietis L. (Curculionidae : Coleoptera). Z. angew. Ent. 92 : 1-8

The morphology of a microsporidian parasite *Nosema hylobii* n. sp. is described by light and electron microscopy. The parasite invades the gut epithelial cells of adult *Hylobius abietis*. Some data on the prevalence of infection by the microsporidian *H. hylobii* in relation to other parasites found in *H. abietis* are also presented.

J.F. Anderson & R.M. Weseloh (1981). The gypsy moth in Connecticut. 2. Review of biological control studies. Conn. agric. Exp. Stn Bull. 797 : 6-14

Extensive studies have been carried out on natural enemies of the gypsy moth, *Porthetria dispar*, in an attempt to better understand their biology, behaviour and interrelationships with their hosts, to improve their effectiveness and to establish new exotic species. The biological control investigations reported include those on nuclear polyhedrosis virus, bacterial pathogens, local and exotic parasites and predators and sex pheromones.

H.K. Nakao et al. (1981). Introductions for biological control in Hawaii – 1977-1978. Proc. Hawaiian ent. Soc. XXIII (3) : 425-430

The Plant Pest Control Branch (formerly Entomology Branch) of the Hawaii Department of Agriculture has maintained a beneficial organism introduction program for about 75 years. This paper includes a list of insects introduced and/or released for biological control of weeds and insects during 1977 and 1978, with notes on the status of some pests and their purposely introduced natural enemies.

Nematode Control

M. Peloille (1981). Nematode-trapping fungi : predatory phenomenon, ecology and use in biological control, a review. Agronomie 1 (4) : 331-337

Scientists have been interested by nematode-trapping Hyphomycetes for more than a century but the systematic study of these organisms was not thoroughly undertaken before the 1950's. Nematode-trapping fungi develop different kinds of traps ; the most elaborate (constricting rings) seems to be the most effective. Different studies on the existence of a substance inducing trap formation have been done ; « nemine » is such a substance. Nematode-trapping fungi are ubiquitous. However, many biotypes have not yet been explored and several species are probably to be discovered. Many studies have been initiated because of the possible use of predatory Hyphomycetes in biological control. In France, two fungi are already commonly used in the biological control of nematode parasites of cultivated mushrooms and vegetables. The use of nematode-trapping fungi against animal parasites is just beginning. It seems that discrepancies in the results so far obtained are due, at least in part, to insufficient knowledge of the biology and ecology of these organisms.

Control of Fungi

Lii-jang Liu (1980). Maturity resistance, a useful phenomenon for integrated control of sugarcane rust. Sugarcane Path. Newsl. 25 : 11-13

Sugarcane rust, *Puccinia melanocephala*, has recently become a damaging disease in the sugar-producing countries of the Americas. Investigations have suggested that by taking into consideration both the effects of cane age and environmental conditions, the intensity of rust infection in susceptible varieties can be reduced greatly by planting in May instead of August.

C.E. Windels (1981). Growth of Penicillium oxalicum as a biological seed treatment on pea seed in soil. Phytopathology 71 : 929-933

When *Penicillium oxalicum*-treated seeds of *Pisum sativum* 'Little Marvel' were planted in either field or

autoclaved soil, the conidia germinated, a hyphal network formed, and the antagonist sporulated on the seed coat by the third day after planting. Small dark lesions and some discoloration of cotyledons were noted after removal of seed coats from *P. oxalicum*-treated seeds planted in autoclaved soil, but lesions were superficial. Conidia of *P. oxalicum* were observed, either singly or in groups, on tap and secondary roots and root hairs of plants from *P. oxalicum*-treated seeds planted in either field or autoclaved soil. In field soil no germinated conidia of *P. oxalicum* were seen on roots, but in autoclaved soil, conidia germinated and hyphae of *P. oxalicum* grew between root hairs and on the root surface. Thus, conidia of *P. oxalicum* applied to seeds appeared to be active and the resulting mycelial network apparently functioned as a seed protectant, but conidia on root surfaces in field soil were apparently dormant.

R.B. Dixit & J.S. Gupta (1980). Studies on the biological control of leaf blotch disease of barley by Streptomyces olivaceus. Acta bot. indica 8 : 190-192

This study deals with control of *Alternaria alternata*, the causal agent of barley leaf blotch, by *S. olivaceus*, an actinomycete isolated during phyllosphere studies of barley. Preinfection spraying with either a spore suspension or diffusates of *S. olivaceus* significantly reduced disease intensity.

C. Bazzi et al. (1980). Biological control trial of apple crown gall in Alto Adige. Inf. fitopat. 30 (6) : 3-6

Strain 84 of *Agrobacterium tumefaciens* proved ineffective in preventing crown gall due to the *A. tumefaciens* virulent strain IPV-BO 1144 in apple rootstocks M.7 and M.9. M.9 was the more susceptible of the two rootstocks to crown gall.

Y. Elad & Y. Hadar (1981). Biological control of Rhizoctonia solani by Trichoderma harzianum in carnation. Pl. Dis. 65 : 675-677

Wheat bran culture of *Trichoderma harzianum* was tested for control of *Rhizoctonia solani* in carnation in fields treated with methyl bromide. A linear correlation was obtained between rate of *T. harzianum* preparation applied to soil and degree of disease control. Disease incidence was reduced 70 % when the *T. harzianum* preparation was applied at 150 g (dry wt) per square meter. *T. harzianum* gave best disease control when applied and established in the rooting mixture before transplanting in the field. This method was superior to the broadcast application because it required lower rates of application.

E.A. Barnett & W.A. Ayers (1981). Nutritional and environmental factors affecting growth and sporulation of Sporidesmium sclerotivorum. Can. J. Microbiol. 27 : 685-691

Three of five isolates of *Sporidesmium sclerotivorum*, a mycoparasite of *Sclerotinia* spp., grew well on an agar medium containing mineral salts, glucose, thiamine, and glutamine or Casamino acids as the nitrogen source. The nitrogen requirement for two of the isolates was satisfied by NH_4Cl, Casamino acids, or glutamine. Glutamine was the best single nitrogen source. Only one isolate, CS-1, was used in further nutritional studies. The optimum concentration of glutamine for growth was 5 g/l. Glucose, mannose, mannitol, and cellobiose were excellent carbon sources. A glucose concentration of 20 g/l was optimum. Mannitol supported greater growth than glucose with Casamino acids as the nitrogen source but glucose was the superior carbon source with glutamine as the nitrogen source. Greatest growth was achieved with a combination of these carbon and nitrogen sources. *Sporidesmium sclerotivorum*, isolate CS-1, required thiamine for growth and sporulation. Biotin stimulated growth. The fungus developed maximally within the range of pH 5.0-5.5 and growth was greatly reduced at a pH below 4.0 or above 6.0. Control of acidity by the periodic addition of NaOH solution permitted substantially increased growth. The optimum temperature for growth was 22.5-25.0°C but production of macroconidia was greatest at 15-20°C.

W.A. Ayers et al. (1981). Germination of macroconidia and growth of Sporidesmium sclerotivorum in vitro. Can. J. Microbiol. 27 : 664-669

Macroconidia of *Sporidesmium sclerotivorum*, a mycoparasite of *Sclerotinia* spp., were induced to germinate by aqueous and ethanolic extracts of sclerotia of *Sclerotinia minor*. Paper chromatography of sclerotial extracts indicated the presence of several amino acids and carbohydrates, chiefly glucose. Glucose was identified as the principal germination stimulant in ethanolic extracts. Glucose, fructose, mannose, cellobiose, sucrose, maltose, trehalose, soluble starch, and glycerol at 0.1 % (w/v) stimulated macroconidia to germinate in 3-6 days at 25°C. Crude sclerotial extracts, and glucose combined with inorganic and organic nitrogen sources, supported germination of greater numbers of macroconidia than glucose alone. Yeast extract, Casamino acids, peptone, and several carbon substrates alone did not support germination. Macroconidia germinated well (>30 %) over the range of pH 3-7 ; maximum germination (>80 %) occurred at pH 5.0-5.5. Mycelial growth in a glucose – Casamino acids – mineral salts medium was also greatest in the range of pH 5.0-5.5, but growth fell off sharply below pH 4.5 and above pH 6.0. The fungus grew slowly on several complex agar media adjusted to pH 5.5.

W.A. Ayers & P.B. Adams (1981). Mycoparasitism of sclerotial fungi by Teratosperma oligocladum. Can. J. Microbiol. 27 : 886-892

Sclerotia of *Sclerotinia minor* were parasitized by *Teratosperma oligocladum*, a recently described dematiaceous hyphomycete. The mycoparasite was cultured on living sclerotia placed on water agar and on sclerotia in moist sand. It grew poorly on several common laboratory media but growth *in vitro* was enhanced by supplements of soil extract and, especially, by aqueous extracts of sclerotia. Sclerotia of *S. minor*, *S. sclerotiorum*, *S. trifoliorum*, *Sclerotium cepivorum*, and *Botrytis cinerea* were parasitized *in vitro*, but sclerotia of *Sclerotium rolfsii* and *Macrophomina phaseolina* were not. Macroconidia of *T. oligocladum* germinated on membrane filters placed on soil containing sclerotia of *S. minor* but not on soil without sclerotia. Sclerotia of three *Sclerotinia* spp. were infected within 2 weeks in soil infested with the mycoparasite. *Teratosperma oligocladum* parasitized and destroyed all of the sclerotia of *S. minor* buried in a natural soil by 10 weeks. Parasitism was equally good at 20 and 25°C, but occurred more slowly at 15°C. No parasitic activity occurred at 30°C. The morphology, cultural characteristics, and mycoparasitic habit of *T. oligocladum* indicated that it was similar in many respects to the mycoparasite, *Sporidesmium sclerotivorum*, and that it is a potentially useful agent for the biological control of sclerotial plant pathogens.

G. Turhan (1981). A new race of Streptomyces ochraceiscleroticus in the biological control of some soil-borne plant pathogens. II. In vivo studies on the possibilities of using C/2-9 against some important diseases. Z. PflKrankh. PflSchutz 88 (7) : 422-434

The results of this study clearly demonstrated that C/2-9 effectively controlled all of the diseases tested in natural soils artificially infested with the pathogens through use of a very simple and cheap application technique. Adequate protection was realized by immersing seeds (cotton, watermelon, muskmelon, cucumber), or by dipping the roots and lower stems of seedlings (tomato, pepper, eggplant) into the homogenate of C/2-9 just before planting. The effectiveness of C/2-9 in controlling *Verticillium* wilt of cotton, pepper and eggplant was found to be 73.9, 71.4 and 73.9 % resp., *Fusarium* wilt of tomato, watermelon, muskmelon and cucumber 73.0, 86.3, 85.7 and 92.8 % resp., *Phytophthora* blight of pepper and tomato 73.3 and 71.4 % resp., *Colletotrichum* wilt of eggplant 78.2 %. C/2-9 can provide a practical approach to biological control of soil-borne diseases.

Control of Weeds

R.G. Emge et al. (1981). Epidemiology of Puccinia chondrillina, a rust pathogen for the biological control of rush skeleton weed in the United States. Phytopathology 71 (8) : 839-843

Populations of rush skeleton weed *(Chondrilla juncea)* from California, Oregon, Washington, and Idaho showed differential reactions to infection by the rust pathogen *Puccinia chondrillina*. Among seven collections of the pathogen, four different virulence patterns were expressed on the host populations. The optimal temperature range for germination of uredospores during a 4-h incubation on water agar was 11-18 C. The optimal dew period for infection was 16 h at 10-21 C. In a field plot in the second season following a single artificial inoculation, rusted plants produced 94 % fewer seeds, produced seed with 30 % less germinability, had a 24 % lower 1,000-seed weight, and had 89 % less biomass than rustfree plants. Virulent collections of *P. chondrillina* were increased and supplied to workers in the western United States for release in specific areas for biocontrol of *C. juncea*. Inoculations resulted in rust initiation, pathogen survival over winter and/or summer in each area, and natural spread of the pathogen to uninoculated areas. This is believed to be the first use of an exotic plant pathogen for weed control in the United States.

Y.P.S. Pundir (1981). A note on the biological control of Scurrula cordifolia (Wall.) G. Don by another mistletoe in Sivalik Hills (India). Weed Res. 21 : 233-234

Observations made on the hyperparasitism of *Viscum loranthi* Elmer on the parasitic weed *Scurrula cordifolia* (Wall.) G. Don in the Sivalik Hills suggest that the hyperparasite is providing effective biological control of the latter. Moreover, as the hyperparasite appears to attack only mistletoes, it can probably be introduced with safety into other localities where *S. cordifolia* is spreading.

P.M. Room et al. (1981). Successful biological control of the floating weed salvinia. Nature 294 : 78-79

The floating fern *Salvinia molesta* D.S. Mitchell (Salviniaceae) originated in southeastern Brazil, but since about 1930, it has been introduced into various tropical and subtropical regions where it has become as great a menace as the water hyacinth. Biological control of salvinia has clear economic and environmental advantages over other methods of control, but earlier attempts either failed or achieved inconclusive results. We report here successful control of the largest salvinia infestation in Australia using the beetle *Cyrtobagous singularis* Hustache (Curculionidae) and suggest why this beetle has potential for controlling salvinia infestations elsewhere.

R.G. Baer & P.C. Quimby (1981). Laboratory rearing and life history of Arzama densa, a potential native biological control agent against waterhyacinth. J. Aquatic Pl. Management 19 : 22-26

The native moth, *Arzama densa*, a biological control agent against waterhyacinth, was reared in the laboratory on a modified wheat germ-casein diet. Field-collected larvae placed on the artificial diet provided the stock colony for three consecutive laboratory generations. Laboratory-reared pupae were equal to, or significantly larger than, field-collected pupae. Adults reared from artificial diet-fed larvae developed normally and their rate of reproduction compared favorably with that of adults acquired from prepupae or pupae collected in the field. Augmenting natural populations of the moth with laboratory-reared individuals appears feasible since 200 females of the F_1 laboratory-reared generation produced about 51,000 fertile eggs.

I.W. Forno (1981). Effects of Neochetina eichhorniae on the growth of waterhyacinth. J. Aquatic Pl. Management 19 : 27-31

The effects of attack by the weevil *Neochetina eichhorniae* Warner on floating, anchored and rooted plant forms of waterhyacinth *(Eichhornia crassipes* [Mart.] Solms) were studied in a glasshouse where conditions approximated field values as closely as possible. Insect attack reduced petiole diameter and leaf density of floating plants, and petiole length and standing crop of those which were rooted. Although there was a reduction in the standing crop of anchored plants during autumn and winter, this plant form showed greater overall tolerance to insect damage. This could have resulted from growth during spring and summer compensating for damage during other seasons. It was concluded that *N. eichhorniae* might contribute to the biological control of waterhyacinth in Australia by limiting the dispersal of floating plants and by suppressing growth in established infestations.

G.R. Buckingham & B.M. Ross (1981). Notes on the biology and host specificity of Acentria nivea (= Acentropus niveus). J. Aquatic Pl. Management 19 : 32-36

The accidentally introduced European aquatic moth, *Acentria nivea* (Olivier), was reared in the laboratory for at least three generations. All females reared during this study had rudimentary wings and were flightless though winged flying females have been reported in North America. The larvae were fed leaves of Eurasian watermilfoil *(Myriophyllum spicatum* L.), one of the most important submersed weeds in the United States. High water temperatures were tolerated by the larvae for short periods, but they required temperatures below 22 C for development. *A. nivea* larvae in no-choice tests fed on a variety of aquatic plants that are summarized along with the plant species reported in the literature as natural or laboratory hosts.

S.F. Cook (1981). The Clear Lake example : an ecological approach to pest management. Environment 23 (10) : 25

After repeated failures to control midges and algae at Clear Lake, California, through conventional methods, a

small fish, the Mississippi Silverside, was introduced into the lake in 1967 as a possible means of biological control. Algal levels in the lake have since declined and the Clear Lake « Gnat » appears to be contained. Clear Lake may thus prove to be one of the first examples of successful ecological pest management.

S. Hasan (1981). A new strain of the rust fungus Puccinia chondrillina for biological control of skeleton weed in Australia. Ann. appl. Biol. 99 : 119-124

A strain of the rust fungus *Puccinia chondrillina* introduced into Australia in 1971 for the biological control of skeleton weed, *Chondrilla juncea*, attacked only the narrow-leaf form of this weed. Studies were, therefore, undertaken in the Mediterranean region to discover strains of the rust which will attack the other two Australian forms of skeleton weed, intermediate- and broad-leaf. Several strains of the rust were found to be highly virulent against the intermediate form. One of these strains from Manisa, western Turkey, was both highly specific to its host and safe for use as a biological control agent. This strain has recently been introduced into Australia for the control of the intermediate form of *Chondrilla*

H.L. Walker (1981). Factors affecting biological control of spurred anoda (Anoda cristata) with Alternaria macrospora. Weed Sci. 29 : 505-507

In greenhouse studies, spurred anoda [*Anoda cristata* (L.) Schlecht.] control by *Alternaria macrospora* Zimm. was influenced by stage of growth, inoculum concentration, and the temperature and duration of the dew periods following inoculation. Seedlings inoculated at the cotyledon to first-leaf stage were most easily controlled. Optimum dew periods for killing seedlings were $\geqslant$ 24 h at 20 to 30 C. Spray mixtures containing 2.5 to 10×10^5 spores/ml gave the best control. In field studies, *A. macrospora* significantly reduced the number and the dry weight of spurred anoda plants.

b) Public Health

S.P. Wraight et al. (1981). Efficacy of Bacillus sphaericus strain 1593 against the four instars of laboratory reared and field collected Culex pipiens pipiens and laboratory reared Culex salinarius. Can. Ent. 113 : 379-386

Culex pipiens pipiens and *C. salinarius* were found equally susceptible in laboratory tests to *Bacillus sphaericus* strain 1593 with LC50 values for the four instars ranging between 20 and 137 ppb (approximately 820 and 5600 spores/ml). Tests against field collected *C. p. pipiens* larvae revealed a regularly decreasing susceptibility with increasing larval age, the first instars being between 2 and 5 times more susceptible than fourth instars. In contrast, no significant difference in the susceptibility of second, third, and fourth instars were found in tests of laboratory reared larvae.

S.P. Wraight et al. (1981). Effects of temperature and instar on the efficacy of Bacillus thuringiensis var. israelensis and Bacillus sphaericus strain 1593 against Aedes stimulans larvae. J. Invertebrate Path. 38 : 78-87

Laboratory trials of *Bacillus thuringiensis* var. *israelensis* (serotype 14) and *B. sphaericus* strain 1593 against field-collected *Aedes stimulans* showed that susceptibility declined with increasing instar and decreasing temperature. Test results with *B. sphaericus* were more erratic than with *B. thuringiensis*, and the efficacy of the former declined more rapidly with decreasing temperature. *B. thuringiensis* was significantly more active than *B. sphaericus* under all treatment conditions. These results indicate that the effective use of this strain of *B. sphaericus* as a mosquito biological control agent may be limited to warm water situations against more susceptible species.

R.L. Frommer et al. (1981). The evaluation of Bacillus thuringiensis var. israelensis in reducing Simulium vittatum (Diptera : Simuliidae) larvae in their natural habitat with no extensive aquatic vegetative growth. Mosquito News 41 (2) : 339

A 35 min exposure of a 3.10 ppm (124,000 sp/ml) suspension of *Bacillus thuringiensis* var. *israelensis (Bti)* resulted in only a 25 % reduction in *S. vittatum* larvae 24 h following treatment 312 m downstream from treatment application. Increased exposure time to 70 min with 1.55 ppm (41,000 sp/ml) suspension of *Bti* resulted in a post-treatment reduction in the number of *S. vittatum* larvae along the entire 312 m test stream of 50-70 % at 24 h, 35-80 % at 48 h and 25-78 % at 72 h.

R.L. Frommer et al. (1981). The distribution of Bacillus thuringiensis var. israelensis in flowing water with no extensive aquatic vegetative growth. Mosquito News 41 (2) : 331

Fifty to eighty percent (1.5 to 2.5 ppm) of a desired 3.10 ppm (124,000 sp/ml) treatment concentration of *Bacillus thuringiensis* var. *israelensis (Bti)* was sustained over a 20 to 22 min time interval. Peak recovery occurred midway through a 35 min exposure period when treating a 312 m section of stream. Little, if any, spore residual remained in the test stream following treatment application, as noted by the rapid decline in recovered spores once application was terminated and by the near background count levels of spores remaining in stream eddies 24 and 48 h post-treatment.

L.A. Lacey & J.M. Lacey (1981). The larvicidal activity of Bacillus thuringiensis var. israelensis (H-14) against mosquitoes of the central Amazon basin. Mosquito News 41 (2) : 266

A standardized air-dried spore and crystal preparation of *Bacillus thuringiensis* var. *israelensis* (IPS-78) produced at the Pasteur Institute, Paris, was bioassayed under laboratory conditions against late instars of *Culex quinquefasciatus* and five other mosquitoes found in the vicinity of Manaus, Brazil. The LC_{50} and LC_{95} for *Cx. quinquefasciatus* were 0.042 and 0.33 ppm, respectively. When an LC_{100} concentration was administered to *Cx. quinquefasciatus* larvae, mortality was noticeable after 2 h and was complete within 12 h. The primary powder, R-153.78 produced 98.3 % mortality at 0.1 ppm compared to 65.0 % for the standard at the same conc. Five peridomestic and sylvatic mosquitoes responded variably to 01. ppm of the standard. No mortality was produced in *Cx. (Carrolia)* sp. ; *Trichoprosopon digitatum* responded with 43.3 % mortality and *Cx. mollis* and a mixture of *Limatus durhami* and *L. flavisetosus* responded with 63.3 and 63.6 % mortality, respectively.

J. Weiser & S. Prasertphon (1981). Four new microsporidia found in the mosquitoes Anopheles gambiae and Culex pipiens quinquefasciatus from Nigeria. Folia Parasitologica (Praha) 28 : 291-301

The microsporidia *Parathelohania africana* and *Amblyospora coluzzii* sp.n., with thick-walled spores in mucous

envelopes were found, respectively, in the salivary glands of adult mosquitoes of *Anopheles gambiae* from Central and Northern Nigeria. The corresponding supposed thin-walled form had kidney-shaped elongated spores. *Nosema salivaria* sp.n., forming large clusters of oval spores in the salivary glands, parasitized the same mosquito population. Two microsporidia, *Amblyospora nigeriana* sp.n. and *A. kadunae* sp.n., infecting the fat body were found in larvae of *Culex pipiens quinquefasciatus* from the environs of Kaduna.

A.W. Sweeney (1981). The effects of low temperature storage on the infectivity of Culicinomyces conidia for mosquito larvae. J. Invertebrate Path. 38 : 294-296

Because adequate shelf-life of stored inoculum is an important attribute of a candidate microbial agent, experiments were performed to determine whether the infectivity of *Culicinomyces* could be maintained by storage at low temperatures. Preliminary bioassays showed that the potency of conidia suspended in sterile distilled water was considerably reduced after 4 months storage at 4 and −20°C but not at −70°C. The ability to maintain the potency of *Culicinomyces* by storage at −70°C will enable an expansion of field tests to evaluate the fungus for mosquito control.

H. Ribeiro et al. (1981). First records of Coelomomyces and mermithids in mosquitoes of Angola, Africa. Mosquito News 41 (2) : 381

This is a brief account of present knowledge on the occurrence in Angola of fungi of the genus *Coelomomyces* and nematodes of the family Mermithidae, important potential biocontrol agents of mosquitoes. Four species of *Coelomomyces* were found.

A. Ali & B.H. Stanley (1981). Effects of a new insect growth regulator, UC-62644, on target Chironomidae and some nontarget aquatic invertebrates. Mosquito News 41 (4) : 692-701

A new IGR, UC-62644, was bioassayed in the laboratory against 4th-instar larvae of *Glyptotendipes paripes* and *Chironomus decorus*. A 25 % WP of this IGR was tested against midges in experimental ponds at 25, 50 and 100 g a.i./ha (5.5-22.0 ppb), and in a golf course pond at 100 g a.i./ha or 16.0 ppb. Impact of UC-62644 on nontarget invertebrates in the midge habitats was also studied.

The IGR caused 90 % mortality of *G. paripes* and *C. decorus* at 3.1-5.7 ppb. In experimental ponds, the WP produced an excellent control of midges. Even the lowest dose induced 99 % inhibition of total midge emergence, and control lasted for more than 4 wk. In the golf pond, 56-98 % of the total emergence was suppressed for 4 wk. The treatments also caused significant mortality of midge larvae.

In experimental ponds, Rotifera, *Cyclops* spp., *Daphnia* spp., *Chaoborus* sp., *Baetis* sp., corixids, notonectids, and coleopterous larvae and adults were affected but most of these nontarget invertebrates recovered within 2-3 wk after treatments except for *Cyclops* spp. and possibly corixids and beetles. Rotifers, ostracods, and oligochaetes in golf pond were not affected but *Cyclops* spp. and *Hyalella azteca* (Saussure) were sensitive to the IGR.

UC-62644 is the most effective IGR thus far tested against chironomid midges and has moderate and temporary adverse effects on the nontarget aquatic invertebrates.

R.L. Frommer et al. (1981). The influence of extensive aquatic vegetative growth on the larvicidal activity of Bacillus thuringiensis var. israelensis in reducing Simulium vittatum (Diptera : Simulidae) larvae in their natural habitat. Mosquito News 41 (4) : 707-713

The presence of extensive aquatic vegetative growth (*Potomogeton crispus* and *P. pectinatus*) had little effect on reducing the larvicidal activity of *Bacillus thuringiensis* var. *israelensis* (*Bti*) against *Simulium vittatum*. Following a 35 min exposure to 3.10 ppm (98,800 spores/ml) suspension of *Bti*, the reduction in *S. vittatum* larvae over a 96-h period ranged from 27 to 92 % along the entire 312 m length of the test stream.

R.L. Frommer et al. (1981). The effects of extensive aquatic vegetative growth on the distribution of Bacillus thuringiensis var. israelensis in flowing water. Mosquito News 41 (4) : 713-725

Test data from 2 field trials showed that extensive growth of *Potomogeton crispus* and *P. pectinatus* had varying effects on the movement of *Bacillus thuringiensis* var. *israelensis* (*Bti*) through a 312 m section of test stream. During one 35 min exposure time, 24 to 90 % (0.8 to 2.8 ppm) of a 3.10 ppm *Bti* treatment concentration was recovered over an 18 to 28 min period. However, during a second field trial, suspected stream channelization resulted in a significant increase in recovered spores ranging from 62,000 to 205,000 spores/ml (1.9 to 6.4 ppm, i.e., 61 to 206 %).

W.A. Ramoska et al. (1981). Effects of sand formulated Metarhizium anisopliae spores on larvae of three mosquito species. Mosquito News 41 (4) : 725-729

Larvae of mosquito species displaying different feeding behaviours were bioassayed with 2 formulations, floating and sand, of the spores of the fungus, *Metarhizium anisopliae*. Although both formulations worked equally well after 96 hours of incubation, more rapid mortality was obtained using the sand formulation with below surface feeding larvae while the floating preparation worked faster on surface feeders.

W.K. Reisen et al. (1981). Attempted suppression of a semi-isolated population of Culex tarsalis by release of irradiated males. Mosquito News 41 (4) : 736-745

During the summer of 1980, an attempt was made to numerically suppress a semi-isolated population of *Culex tarsalis* by releasing radiosterilized males. A total of 71,016 males was collected as pupae from a productive source, Poso West, sterilized by exposure to 6 KR of gamma radiation within 24 h of emergence and released at Breckenridge, 12.5 km east of Bakersfield in Kern County, California. The incidence of sterility in egg rafts oviposited by females collected in CO_2 augmented light traps increased significantly from 2.9 % prior to sterile male releases to 9.2 % during the release period. The mating competitiveness of the sterile males was estimated to be 1.1 based on the proportions of sterile males among all males and sterile egg rafts among all egg rafts. Even though the radiosterilized males mated competitively, the numbers released were insufficient to numerically suppress the target population.

H.J. Meyer & L.W. Learned (1981). Laboratory studies on the potential of Dugesia tigrina for mosquito predation. Mosquito News 41 (4) : 760-765

Different size ranges of planaria tested showed no significant differences in ability to consume larvae of mosquitoes. *Dugesia tigrina* more effectively reduced num-

bers of 2nd and 3rd instar mosquito larvae than 1st or 4th instar larvae on pupae. No significant mortality could be attributed solely to mucous secretions produced by the planaria ; however, when planaria were present the secretions served as a mechanical aid to temporarily entrap larvae which were subsequently fed upon. Chironomid larvae were more easily fed upon than mosquito larvae and *Gammerus* sp. were captured less frequently than mosquitoes.

J.D. DeMaio et al. (1981). Larvicidal activity of Bacillus thuringiensis var. israelensis against Aedes triseriatus in treehole and tyre habitats. Mosquito News 41 (4) : 765-770

Bacillus thuringiensis var. *israelensis (Bti)* was tested as a larvicide against the mosquito, *Aedes triseriatus*, under laboratory and field conditions. In distilled water and exposed tyre water, *Bti* was about 4 times more effective than it was in beech treehole water, oak treehole water, and shaded tyre water. The LD-50 for *Bti* in the treehole water and shaded tyre water was 0.4 ppm and the LD-99 was 3.0 ppm. Concentrations from 1.0 to 10.0 ppm *Bti* caused high mortality to mosquito larvae in all breeding habitats tested. A bioassay using laboratory-reared fourth instar *Ae. triseriatus* showed that under field conditions *Bti* loses most of its larvicidal activity in treeholes and tyres within 3 to 5 days. Small scale field trials with *Bti* using a Hudson sprayer in a tyre yard reduced *Aedes triseriatus* breeding by 98 %.

S.C. Hembree (1981). Evaluation of the microbial control potential of a Helicosporidium sp. (Protozoa : Helicosporida) from Aedes aegypti and Culex quinquefasciatus from Thailand. Mosquito News 41 (4) : 770-784

Aedes aegypti was used as an experimental host in which to determine dose-mortality efficiency of the pathogen. Its storage properties and its susceptibilities to degradation by various stressors likely to be encountered in the aquatic environment, such as heat, pH, salinity, detergents, and ultraviolet light were analyzed. The infectivity of the helicosporidian spore to the fall armyworm, *Spodoptera frugiperda*, by injection and reduced infectivity of the resulting spores was demonstrated. The infectivity of the pathogen for *Anopheles dirus*, *An. maculatus*, *Ae. taeniorhynchus*, and *Toxorhynchites splendens* was quantified. It was concluded that the agent was unlikely to be useful as a practical, cost-effective microbial control agent until various technological advances are made.

J.R. Finney et al. (1981). A mermithid parasitising Aedes decticus in Labrador. Mosquito News 41 (4) : 793-794

Specimens were collected from a grassy lake overflow site 2.5 km from Jean Rapids, Wabush, Labrador, in June 1981. Of seven mosquito species recorded, nematodes emerged only from larval *Ae. decticus*, with an infection rate of 33 %. This is the first record of *Ae. decticus* serving as a host for a mermithid parasite.

J.R. Finney & J.B. Harding (1981). Some factors affecting the use of Neoaplectana sp. for mosquito control. Mosquito News 41 (4) : 798-800

The two factors investigated in the present study were rate of settling of the nematode to the bottom of the mosquito habitat and roughness of the habitat substrate, where uneveness would decrease the chances of grazing larvae encountering nematodes. The results clearly showed that availability of the nematode to the host was markedly decreased when a substrate is present.

H.J. Meyer & L.W. Learned (1981). A field test of the potential of a local flatworm, Dugesia tigrina, for biological control of mosquitoes in temporary pools. North Dakota Farm Res. 39 (2) : 19-21

An indigenous flatworm species, *Dugesia tigrina* (Girard), was tested for use as a biological control of mosquitoes in temporary pools in North Dakota. Pools with mosquito populations were stocked with flatworms at densities ranging from 100 to 2000 per pool. Mosquito populations were monitored throughout the season. Flatworm populations were assessed at the end of the season. Flatworm populations increased over the season but mosquito populations were not effectively controlled by the flatworms.

J.Y. Standaert (1981). Persistence and efficacy of Bacillus thuringiensis H-14 against larvae of Anopheles stephensi. Z. angew. Ent. 91 : 292-300

The efficiency and persistence of a primary powder of *Bacillus thuringiensis israelensis*, produced experimentally at the industrial level, was evaluated in simulated field conditions in the laboratory as a larvicide against malaria vectors. The following factors were considered : development stage of *Anopheles stephensi* larvae, pH, organic matter. The CL 50 after 24 h was 12.8 ppb for the first larval stage but for the last, a higher concentration was required. The persistence of the lethal effect diminished over a few days according to the medium because of the reduction of spore viability or of denaturation of the spore-crystal complex and especially because of sedimentation of the product which reduced probable contact between the mosquito larvae and the biological insecticide.

U.A. Rubzow (1981). New genera and a new species of mermithids infecting fleas. Parasitologyia 15 (4) : 338-341

A new genus and a new species *Imosmermis morosovi* gen. sp. n. found in the flea *Xenopsilla gerbilli minor* Jordan are described. The genus *Imosmermis* differs from all known genera of Mermithidae by the absence of a mouth and reduction of stihostome and the dorsal chord. The body is long and very thin. A new genus *Aphanimermis* comb. n. for the species *Psyllomermis tshumacovae* Rubzov is created. This genus is characterized by a stylet, a highly developed lateral and ventral chord as well as a tail which is absent in other genera infecting fleas.

P.B. Morgan et al. (1981). Host-parasite relationship : augmentative releases of Spalangia endius Walker used in conjunction with population modelling to suppress field populations of Musca domestica L. (Hymenoptera : Pteromalidae and Diptera : Muscidae). J. Kansas ent. Soc. 54 (3) : 496-504

Augmentative releases of *Spalangia endius* Walker, conducted for 5 weeks against a field population of houseflies, *Musca domestica* L., produced 100 % parasitism by the 5th week. Population studies of the host insect enabled determination of ratios of parasites to host and percentage parasitism.

G. Döller & A. Gröner (1981). Safety test of nuclear polyhedrosis virus from Mamestra brassicae for vertebrates. Z. angew. Ent. 92 : 99-105

The purpose of this safety study was to determine whether the nuclear polyhedrosis virus (NPV) of *Mamestra brassicae* can replicate in vertebrates. We consider the production of antibodies against virions and/or polyhedrin (matrix protein) to be an indication of a virus replication

After feeding of NPV (purified polyhedra, biologically active virions and UV-inactivated virions) to NMRI-mice, no antibodies against virions or against polyhedrin could be detected within sixty days p.i. using RIA. After aerosol application of polyhedra, also, no antibody production could be observed. Therefore we conclude that no virus replication had taken place. Based upon these results, there is no hygienic risk from this point of view for the application of NPV in biological pest control, especially the NPV from *Mamestra brassicae*.

D. Rondelaud (1981). Biological control of Lymnaea truncatula Muller in Haute Vienne, France. Some factors limiting its application. Annls Parasit. humaine comp. 56 (1) : 45-56

Control of *L. truncatula* by introduction of predatory molluscs (*Zonitoides nitidus* and *Oxychilus draparnaudi*) was tried in 126 experimental units in Haute Vienne ; positive results were achieved in 107 units and negative in 19. At the beginning of the summer dry period, the grass is mown and left on the pasture to form a cover 10-15 cm thick. The predators are introduced at the rate of 20 per sq. metre. In this study, in 30 units where results were positive, the *Lymnaea* mortality rate averaged 98 %, against 53-82 % in units classed as negative. A detailed study of conditions in the 19 negative units disclosed six factors which influenced results : 1) high rainfall during the first 10 days of the experiment ; 2) presence of large stone blocks sheltering *L. truncatula* ; 3) quality of plant cover ; 4) preliminary treatment with molluscicides causing predators to eat weakened snails and to leave the healthy snails ; 5) presence of acarids on predators ; 6) trampling of predators by sheep moving repeatedly on steep slopes. Possible solutions are discussed.

A. Ali (1981). Bacillus thuringiensis serovar. israelensis (ABG-6108) against Chironomids and some nontarget aquatic invertebrates. J. Invertebrate Path. 38 : 264-272

A wettable powder formulation (ABG-6108) of *Bacillus thuringiensis* serovar. *israelensis* was tested against chironomid larvae in experimental ponds at 1, 2, 3, 4 and 10 kg/ha (0.25 – 2.5 ppm), and in a golf pond at 3 kg/ha (0.5 ppm). Significant reductions (18 – 88 %) in populations of Chrinomini and Tanytarsini experimental ponds, and 27-65 % reduction of midges in the golf pond occurred during the 4-week evaluation period. The highest dose in experimental ponds had no adverse effects on rotifers, *Cyclops* spp., *Daphnia* sp., ostracods, *Baetis* sp., corixids and notonectids, and Coleoptera. The nontarget invertebrates in the golf pond also remained unaffected.

c) Veterinary Entomology

G.M. Toyama & J.K. Ikeda (1981). Predation as a factor in seasonal abundance of Musca sorbens Wiedemann (Diptera : Muscidae). Proc. Hawaiian ent. Soc. XXIII (3) : 447-454

Seasonal fluctuations in abundance of *Musca sorbens* were observed on a dairy at Kawailoa, Oahu. Fluctuation in fly populations, which increased during May-October and decreased during November-April, appeared to coincide with the two seasons (summer and winter) of Hawaii. Examination of factors that could cause this seasonal fluctuation suggested a relationship between environmental changes in cow dung pats and biological control agents. This study was initiated to demonstrate the existence of seasonal fluctuation, and determine the cause for this seasonal variation in populations of *M. sorbens*.

S.E. Kunz (1981). Biological activity of Bay Sir 8514 against the stable fly in laboratory studies. Southwestern Ent. 6 (2) : 147

The eclosion of adult stable flies, *Stomoxys calcitrans* (L.), was inhibited when larval medium containing either 1st-, 2nd-, or 3rd-stage larvae was treated with the insect growth regulator, BAY SIR 8514 (2-chloro-N-[[[4-(tri-fluoromethoxy) phenyl] amino] carbonyl benzamide) at concentrations as low as 0.5 mg/929 cm^2 (ft^2). BAY SIR 8514 was most active against 3rd-stage larvae, disrupting the larval-pupal transition. Larval mortality increased when treatments were applied to either 1st- or 2nd-stage larvae.

D.A. Hendry & Y. Rechav (1981). Acaricidal bacteria infecting laboratory colonies of the tick Boophilus decoloratus (Acarina : Ixodidae). J. Invertebrate Path. 38 : 149-151

The authors report a blackening disease affecting about 5-10 % of ticks in laboratory colonies of *B. decoloratus* reared on tethered calves and then maintained at 26°C and 5 % RH. The results suggest that the gut of *B. decoloratus* is devoid of bacteria, and that the syndrome observed is a non-specific reaction of the ticks to bacterial infection. Although very effective acaricidal agents, the probability of bacteria being used in biological control is low, as an effective method of infecting ticks in the field is not yet available.

D.A. Rutz & R.C. Axtell (1981). Housefly (Musca domestica) control in broiler-breeder poultry houses by pupal parasites (Hymenoptera : Pteromalidae) : indigenous parasite species and releases of Muscidifurax raptor. Environ. Ent. 10 (3) : 343-345

Among seven species of pupal parasites of *M. domestica* recovered in five broiler-breeder farms in North Carolina, *Spalangia cameroni* and *M. raptor* accounted for 91 % of all the parasites collected. These two species also accounted for the majority of parasites previously collected at caged-layer poultry houses. Weekly sustained releases of an indigenous strain of *M. raptor* at both types of farm significantly increased housefly parasitism and decreased the housefly population. It is suggested that combined releases of *S. cameroni* and *M. raptor* might be highly effective in suppressing housefly populations.

8. BOOK REVIEW

The Pests of Crops in Indonesia, by L.G.E. Kalshoven, revised and translated by P.A. van der Laan (University of Amsterdam) with the cooperation of G.H.L. Rothschild (CSIRO, Canberra). 750 pp, 16 plates with full colour illustrations of 130 insect species, 493 black & white illustrations

Published by Ichtiar Baru – Van Hoeve, Jalan Majapahit 6, Jakarta, Indonesia. Price Swiss Francs : 127.00 (US $ 65.00). Obtainable from J.C. Baltzer A.G., Wettsteinplatz 10, 4058 Basle, Switzerland of from Van Tongeren, Postbus 8111, 1005 AC Amsterdam, Netherlands.

In this well written English edition of the late Dr L.G.E. Kalshoven's standard reference work, originally entitled De plagen van de cultuurgewassen in Indonesie, the text has been considerably revised, data of little current relevance has been deleted, while important information accumulated over the past 30 years has been incorporated. Emphasis is given to the ecological and practical aspects of pest problems. Indeed, the title is something of a misnomer since beneficial organisms are dealt with as well as species of, as yet, no economic importance, in addition to pest species. Pests of both food and cash crops are covered, including rice, coconut, cassava, maize, fruits, vegetables, cocoa, coffee, cotton, oilpalm and tobacco.

The text is laid out under the headings of the main animal groups. For each species considered, the Latin, English and local names, where appropriate, are given. This is followed by a description of the organism, the crops affected and damages caused. The biology and life cycle, with special reference to parasites and predators, are generally considered in some detail ; control measures are mentioned, although the author has omitted reference to pesticides as these are constantly subject to revision. Attention is given to attempts of biological control, with accounts of success or failure. Although the diagrams and drawings are taken from a number of sources, and so perhaps lack consistency in presentation, they are for the most part clear, accurate and drawn to scale, with the appropriate magnification indicated. The colour plates are similarly of a high standard, both in terms of subject and colour.

Annelida, Nematoda and Mollusca are dealt with in the first few pages. The main bulk of the book is given over to Arthropods and in particular to the insects. The Orders considered are : Orthoptera, Dermaptera, Psocoptera, Isoptera, Thysanoptera, Hemiptera, Odonata, Neuroptera, Lepidoptera, Coleoptera, Diptera, Hymenoptera and Embioptera. Within the Coleoptera, the use in biological control of certain endemic and introduced Coccinellids is reported, with particular reference to *Scymnus* spp., *Cryptolaemus montrouzieri* and *Chilocorus* spp. against coccid and aleurodid pests. The more important Tachinid (Diptera) endoparasites described include *Carcelia* spp. and *Bessa (= Ptychomyia) remota* and the latter role in the parasite complex of the coconut pest *Artona*. In 1925, *Bessa* was introduced from Malaysia to Fiji and led to the complete control of *Levuana iridescens* (a moth related to *Artona*) in coconut. *Argyrophylax fumipennis* is another important tachinid parasite of *Artona*. Most information on biological control is, as might be expected, to be found in the section on Hymenoptera. Among others, reference is made to : – the introduction to Sri Lanka from Java of *Macrocentrus homonae* to control the tea tortrix, *Homona coffearia* ; *Spathius apicalis* from Bogor to the New Hebrides where *Diocalandra* is an important pest ; *Dimmockia (= Sympiesis) javanica* and *Pediobius (= Pleurotropis) parvulus* to Fiji as a means of controlling *Promecotheca reichi* ; *Tetrastichus brontispae* to south and north Sulawesi to control the hispid *Brontispa* on coconut ; *Comperiella unifasciata* from Java to Sangihe to control *Aspidiotus rigidus* and to Fiji against *A. destructor* ; field trials with *Trichogramma japonicum* to control *Chilo* and *Tryporyza* in rice and sugarcane ; *Trich. minutum* to control *Heliothis* spp. on tobacco ; *Telenomus* spp. egg parasites of rice and sugarcane borers and *Spodoptera litura*. In all these cases, the author cites and summarises biological and ecological studies on the species in question, giving some insight into the host-parasite/predator-hyperparasite interactions. Many of the references to attempts of biological control may appear to be rather outdated (1920's to 1950's), but subsequent investigations have confirmed the establishment of certain species. For example, in 1925, *Leefmansia bicolor*, an important parasite of *Sexava* grasshoppers, was transferred from Ambon to Talaud in the S.W. Pacific region. Investigations reported in 1973 showed that the parasites were still present after 46 years. The final 20 or so pages of the main text consider birds (Ploceidae and Dicaeidae) and mammals (Insectivora, Chiroptera, Rodentia, Hystricidae, Carnivora, Artiodactyla and Primates).

Finally, there is a comprehensive and up-to-date bibliography, followed by two indexes. Firstly a host plant pest index which lists the crops by Latin, English and local names, and indicates for each crop the insects to be found on it, their whereabouts on the plant, together with a reference to the pages where they are described. This index is particularly useful in view of the fact that the pests are dealt with in order of taxonomic groups rather than by crop plants affected. A second general index lists the Latin, English and local names of all species mentioned in the text, with a reference to the page(s) where described, the page where illustrated as well as the page(s) where the species is further mentioned.

The objective of this work is to give access to information on the agricultural and horticultural pests in South-East Asia. It is intended as a reference work not only for entomologists, farmers and agricultural consultants, but also for specialists in other fields working within the framework of international organisations dealing with food and economic development in tropical areas. The objective is clearly met, and in addition the book provides some considerable detail on the beneficial species associated with certain of the pests together with indications on their value for biological control. This concise and compact treatise is to be thoroughly recommended.

9. ABSTRACTS FROM ENTOMOPHAGA

(Prepared by Courtesy of B. Hurpin, INRA)

ENTOMOPHAGA, volume 26 (4), 1981

S.A. Hassan, Institut für biologische Schädlingsbekampfung, Darmstadt, Germany. Mass production and utilization of Trichogramma. I. Production of the host, Sitotroga cerealella

A method for mass rearing the Angoumois grain moth, *Sitotroga cerealella*, for use as a host for the commercial production of *Trichogramma evenescens* to control the European corn borer, *Ostrinia nubilalis*, is described. Using about 12 kg wheat per week in the continuous rearing of *Sitotroga*, an average of 3.2 million eggs is produced per week.

R.A. Farrow, Division of Entomology, CSIRO, Canberra City, Australia. Aerial dispersal of Scelio fulgidus (Hym. Scelionidae), a parasite of eggs of locusts and grasshoppers (Ort. : Acrididae)

Scelio fulgidus, a hymenopterous parasite of Acrididae eggs, was discovered in samples of the aerial fauna, collected at 100-300 m altitude over grassland at a site in central western New South Wales at 2 sampling periods in October-November 1979. This aerial dispersal of individual *Scelio* results in a redistribution of this parasite over locust breeding areas and elsewhere and, on occasions, both parasite and host may migrate independently, by day and by night, respectively, on similar wind systems.

J. Weiser & J.S. Pillai, Institute of Entomology, Acad. Sci., Prague, Czechoslovakia & Institute of Microbiology, University of Otago, Dunedin, New Zealand. Tolypocladium cylindrosporum (Deuteromycetes, Moniliaceae), a new pathogen of mosquito larvae

Tolypocladium cylindrosporum isolated from *Aedes australis* in New Zealand, and another strain isolated from soil in Czechoslovakia, have shown pathogenicity for larvae of mosquitoes. Some morphological data show the variability of hyphae, conidiophores and conidia.

R.D. Hennessey. International Institute of Tropical Agriculture, Ibadan, Nigeria. Setal patterns of the wings of Aphelinus, Mesidia and Mesidiopsis (Hym. Aphelinidae), their value as taxonomic characters

This paper proposes a consistent terminology for the setal groups and hairless areas of the wings of aphelinids, based in part on terms introduced by taxonomists working on diverse chalcidoid families. It demonstrates that the array of setae posterior to the anterior veins is a composite of several groups occupying well-defined regions of the wing. It describes additional setal groups that have not been utilized as taxonomic characters and reports data on the inter- and intra-population variability of setal numbers within each group for several species.

Z. Mendel & J. Halperin. Division of Entomology, Hanot, Israel. Parasites of bark beetles (Col. Scolytidae) on pine and cypress in Israel

Ten species of hymenopterous parasites (4 Braconidae, 1 Eurytomidae, 5 Pteromalidae) were reared from logs of pine and cypress, naturally infested with 5 species of bark beetles : 3 on pine, 2 on cypress.

C.A. Dedryver. INRA, Laboratoire de Zoologie, Le Rheu, France. Biology of the cereal aphids in the West of France. II. Spatial and temporal distribution, and field pathogenicity of three species of Entomophthoraceae

The role of 3 species of Entomophthoraceae on cereal aphids in the West of France from 1975 to 1978 was compared. Almost all the infected aphids were killed by *Erynia neoaphidis*, *Conidiobolus obscurus* and *Entomophthora planchoniana*. The prevalence of *E. neoaphidis* is explained by its adaptation to the anholocycly of the aphids, by the broad spectrum of species it infects and by the numerous conidia it produces in a moist atmosphere. This species seems to have the best potential as a biological control agent in cereals but its mass production poses problems at present.

V.A. Trjapitzin. Zoological Institute, Leningrad, USSR. Key to palaearctic species of the genus Psyllaephagus (Hym. Encyrtidae)

The article contains a key to 42 species of the genus *Psyllaephagus*, parasites of *Psylloidea*, mainly from southern regions of the Palaearctic.

P.B. Martin, P.D. Lingren, G.L. Greene & E.E. Grissell. Entomological Fisheries Department, Tifton, GA ; Western Cotton Research Laboratory, USDA, Phoenix, AZ ; Systematic Entomology Laboratory USDA, Washington DC, USA. The parasitoid complex of three noctuids (Lep.) in a northern Florida cropping system : Seasonal occurrence, parasitization, alternate hosts and influence of host-habitat

Parasitoids of the cabbage looper, *Trichoplusia ni*, the soybean looper, *Pseudoplusia includens*, and the tobacco budworm, *Heliothis virescens*, were characterized during a one year period in a 3.2 ha model of a northern Florida cropping system including tobacco, soybeans and 18 other crops not treated with chemical pesticides.

R.A. Humber, G.J. Moraes & J.M. dos SANTOS. Boyce Thompson Institute, Ithaca, New York & CPATSA/EMBRAPA, Petrolina (P.E.), Brazil. Natural infection of Tetranychus evansi (Acarina : Tetranychidae) by a Triplosporium sp. (Zygomycetes : Entomophthorales) in Northeastern Brazil

Infections of *Tetranychus evansi* by *Triplosporium* sp. were observed on tomatoes from April through June of 1979 in Petrolina (Pernambuco), Brazil. Apparently, the pathogenic effect of the fungus together with the direct effect of the rain are important factors in reducing mite populations.

F. Rivière & R. Thirel. Centre ORSTOM, Institut de recherches médicales, Papeete, Tahiti. The predation of Aedes (Stegomyia) aegypti and Ae. (St.) polynesiensis larvae (Dip. Culicidae) by the copepod Mesocyclops leuckarti pilosa (Crustacea). Preliminary experiments as a biological control agent

The cyclopoid copepod *Mesocyclops leuckarti pilosa* (Crustacea), common in Tahiti in fresh water ground pools, has been recognized as an efficient predator of 1st stage larvae of polynesian *Aedes* when introduced into their breeding sites. In order to assess its potential as a biological control agent, the authors studied the life cycle and the feeding habits of this Cyclopidae. Experiments on its predatory habits were carried out in the laboratory and under natural conditions. The experimental results prompted a search for the practical application of *M. l. pilosa* as a biological agent against *Aedes (Stegomyia)* larvae, particularly in large artificial water containers and in crab holes.

M. Hayat. Department of Zoology, Aligarth Muslim University, India. On the identity and systematic position of the genus Dirphys (Hym. Aphelinidae)

The present note is based on a study of the type species, *Mesidia (Dirphys) mexicana* Howard, and is intended to clarify the systematic position of the little known genus, *Dirphys*.

Rami Kfir. Plant Protection Research Institute, Pretoria, South Africa. Effect of hosts and parasite density on the egg parasite Trichogramma pretiosum (Hym. Trichogrammatidae)

This study was conducted to assess the effect of different hosts and parasite density on the fecundity and the proportion of females and runts of *T. pretiosum*. It is suggested that in mass culture of *Trichogramma*, unduly high parasite densities should be avoided in order to reduce the effect of mutual interference and raise the output of female progeny.

J.R. Ables & S. Bradleigh Vinson. USDA Cotton Insects Research Laboratory & Department of Entomology, Texas A & M University, College Station, TX, USA. Regulation of host larval development by the egg-larval endoparasitoid Chelonus insularis (Hym. Braconidae)

Here are reported the results of a study conducted to determine whether parasitism by an egg-larval endoparasitoid, *Chelonus insularis*, would result in reduced host weight gain, whether the effects are similar in different hosts (the tobacco budworm, *Heliothis virescens*, and the yellow striped armyworm, *Spodoptera ornithogalli*) and to identify the source of the factor(s) responsible.

C.S. Gold & D.L. Dahlsten. Division of Biological Control, University of California, Berkeley, USA. A new host record for Tachinaephagus zealandicus (Hym. Encyrtidae)

Tachinaephagus zealandicus was reared from puparia of *Protocalliphora* n. sp. (Dip.), representing a new host record for this parasitoid.

ENTOMOGPHAGA, volume 27 (1), 1982

B.A. Croft & M.E. Whalon. Department of Entomology, Michigan State University, East Lansing, MI, USA. Selective toxicity of pyrethroid insecticides to arthropod natural enemies and pests of agricultural crops

Data on the toxicity and selectivity of synthetic pyrethroids to arthropod natural enemies and their host or prey are reviewed with emphasis on cotton, apple, alfalfa, cereal and vegetable inhabiting species. Generally they are variably toxic and selective (in relation to their hosts or prey) to species within most families of natural enemies. Exceptions are low to moderate toxicity and favorable selectivity to most hemipteran predators, and high toxicity and unfavorable selectivity to virtually all phytoseiid mites in comparison to their prey.

G.E. Bohart, F.D. Parker & V.J. Tepedino. Bee Biology & Systematic Laboratory, USDA & Utah State University, Utah, USA. Notes on the biology of Odynerus dilectus (Hym. Eumenidae), a predator of the alfalfa weevil, Hypera postica (Col. : Curculionidae)

The authors describe the nest construction and architecture, the prey collection and storage behaviour of *Odynerus dilectus* that exclusively utilizes weevil larvae of the genus *Hypera* as prey. This species may have potential as a biological control agent of alfalfa and clover weevils in the genus *Hypera* because of its rapid collection of weevil larvae, its gregarious nesting habit, and the apparent ease with which individuals can be transplanted.

L.C. Lewis & T.B. Johnson. Corn Insects Research Unit, USDA, Ankeny, Iowa & Department of Entomology, Iowa State University, Ames, Iowa, USA. Efficacy of two nuclear polyhedrosis viruses against Ostrinia nubilalis (Lep. Pyralidae) in the laboratory and field

Nuclear polyhedrosis viruses isolated from the alfalfa looper, *Autographa californica* and a mint looper, *Rachiplusia ou* were assayed against the European corn borer, *Ostrinia nubilalis* and applied to field corn for suppression of this insect. This is the first report of an insect virus being applied against the European corn borer. Although the results are variable, especially against 2nd generation larvae, potential for control or applied use has been demonstrated.

J.M. Rabasse & C.A. Dedryver. INRA Station de Lutte Biologique, Antibes & Laboratoire de Zoologie, Le Rheu, France. Factors affecting natural control of Aphis fabae populations in Brittany. 4. New data on the epizootiology of entomophthoroses on Vicia faba

This study on epizootics that occur in populations of the black bean aphid in Brittany, deals with data obtained between 1972 and 1974 using large samples (100 to 300 plants). The results concern mainly *Neozygites fresenii*. The disease appeared in the fields at the same time as the aphids themselves ; so it is possible that several species of winged aphid play a part in introducing the 1st inoculum into the field.

Jaime Yanes Jr, B.O. Cartwright, R.D. Eikenbary & W.D. Warde. Department of Entomology & Department of Statistics, Oklahoma State University, Stillwater ; Department of Entomology, Blacksburg, VA, USA. Preference for medium dense grass tussocks by Hippodamia convergens (Col. Coccinellidae)

The preference in the choice of hibernacula of the convergent lady beetle, *Hippodamia convergens*, was investigated with regard to morphological aspects of 2 introduced range grasses, *Panicum coloratum* and *Eragrostis curvula*. It was demonstrated that tussocks could successfully be designated as suitable for beetle aggregation.

S.Y. Young & W.C. Yeargan. Department of Entomology, University of Arkansas, Fayetteville, USA. Nuclear polyhedrosis virus infection of Pseudoplusia includens (Lep. Noctuidae) larvae : effect on post-larval stages and transmission

The authors report on the effects of *Pseudoplusia* NPV larval treatment on surviving soybean looper pupae and adults and the potential of these adults to initiate an epizootic in caged soybean.

D. Blumberg & E. Swirski. Division of Entomology, The Volcani Center, Bet Dagan, Israel. Comparative biological studies on two species of predatory beetles of the genus Cybocephalus (Col. Cybocephalidae)

The development, reproduction and longevity of *Cybocephalus micans* and *C. nigriceps nigriceps* were studied under laboratory conditions. The data contribute to a better understanding of the predators' dispersion in different climatic regions of Israel, as well as their value as biological control agents of coccids.

V. Delucchi, Institut für Phytomedizin der ETH, Zürich, Switzerland. Parasitoids and hyperparasitoids of Zeiraphera diniana (Lep. Tortricidae) and their role in population control in outbreak areas

There are 109 species of primary and secondary parasitoids associated with *Zeiraphera diniana* in the Central European Alps. Ninety species are primary, 6 facultative secondary and 13 obligate secondary parasitoids. The complex of parasitoids, together with the associated predators of *Z. diniana*, is unable to slow down the rate of density increase of the host in outbreak areas. The rate of increase of the natural enemies – which are univoltine – can never equal or exceed that of their host ; consequently, control by these natural enemies alone is not possible.

K.A. Bloem & K.V. Yeargan. Department of Entomology, University of Kentucky, Lexington, USA. Host-finding behaviour of Patasson lameerei (Hym. Chalcidoidea), a parasitoid of Sitona eggs (Col. Curculionidae)

Patasson lameerei females showed significant positive responses in olfactometer studies to chewed or damaged alfalfa and red clover plant material and to the feces of adult *Sitona hispidulus* weevils. No significant responses were obtained for the host eggs or the adult weevils themselves. A sequence of host finding by *P. lameerei* females is suggested.

W.E. Wallner, R.M. Weseloh & P.S. Grinberg, USDA Forest Service, Hamden & Connecticut Agricultural Experiment Station, New Haven, Connecticut, USA. Intrinsic competition between Apanteles melanoscelus (Hym. Braconidae) and Rogas lymantriae (Hym. Braconidae) reared on Lymantria dispar (Lep. Lymantriidae)

In the laboratory, competition was determined between *Apanteles melanoscelus* and *Rogas lymantriae* by rearing both in the same gypsy moth, *Lymantria dispar*, hosts. Each parasite attacked larvae previously parasitized by its competitor : neither parasite was excluded by the action of the other, but those that attacked first were more successful.

P. Stary & Ch. Erdelen, Institute of Entomology, Ceske Budejovice, Czechoslovakia & Institut für Pflanzenkrankheiten der Rheinischen Friedrich-Wilhelm-Universität Bonn, Deutschland. Aphid parasitoids (Hym. Aphidiidae, Aphelinidae) from the Yemen Arab Republic

Four parasitoid species on 10 aphid pests have been established in the Yemen Arab Republic. The parasitoid fauna closely resembles that of the Ethiopian region, with some penetration of Mediterranean elements.

L.A. Miller & R.A. Bedding, Department of Agriculture, New Town Research Laboratories, New Town & Division of Entomology, CSIRO, Hobart, Tasmania, Australia. Field testing of the insect parasitic nematode Neoaplectana bibionis (Nematoda : Steinernematidae) against currant borer moth, Synanthedon tipuliformis (Lep. Sesiidae), in blackcurrants

Spraying of water suspensions of *Neoaplectana bibionis* on established blackcurrant bushes infested with currant borer moth, *Synanthedon tipuliformis*, resulted in up to 90 % mortality of larvae. The cost of nematode application may be comparable to that of insecticides without any of the associated problems.

Editors and organizers of this issue : G. MATHYS and Elizabeth A. BAKER.