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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OBITUARY

After a very active life, both scientifically and privately, Professor Jan de Wilde died unexpectedly on 5 October 1983. It was only last year that he retired and two years since his international colleagues honoured his 65th birthday by organizing a symposium entitled « Insect Control of Tomorrow ». Besides his pure scientific work in the field of ecophysiology, he was one of the pioneers in developing integrated control nationally as well as internationally. Mainly due to his activities, the « Working Group for Integrated Control of Pests » was initiated in the Netherlands 25 years ago. Furthermore, he substantially contributed to the formation of the IOBC during the initial phases of its development and served as Vice-President for several years. He also actively supported the advance of entomology in developing countries, one of his most important contributions being the initiation and expansion of the International Centre of Insect Physiology and Ecology (ICIPE, Nairobi, Kenya).

Many workers in the field of integrated control will remember Professor Jan de Wilde as one of the corner-stones of entomological science of the last three decades.

J.C. van Lenteren

Secretary-General : G. MATHYS. 1, rue Le Nôtre, *FR-75016 Paris* (France)

Report of the Secretary-General – 1980 - 1983

Introduction

Some very encouraging developments occurred at the global level which are reflected in the establishment of 5 Working Parties, three of which are already active and dynamic, the 4th and 5th ones showing great promise. These Groups include the following research disciplines : Bruchids, Maize Pests, Quality Control, *Trichogramma* and *Heliothis*. The Secretariat has thus entered a new promising area.

As regards the establishment of new IOBC Sections a move has been made in this direction for Tropical Africa and Latin America. In the first of these two regions the Section is virtually established with 3 participating countries but the Statutes have not been received although a model has been sent to the coordinator in Yaounde (Cameroon). The still pending situation for Latin America will be developed later in this report.

Difficulties arose with the Organization's scientific journal Entomophaga. The bankruptcy of the publishing company Balthazar resulted in a withdrawal of many subscribers and members mainly from the Western Hemisphere Regional Section. The continuity of the publication has by now been secured and we have full understanding for the resentment of the researchers and their hopefully temporary decision to stay away. Provisions have been made to publish the backlog of the 1982 issues.

Finally, considerable efforts have been devoted to increasing the information exchange by expanding the volume of the IOBC Newsletters.

During the period under review IOBC had the deepest regret to lose an outstanding member and friend. On 25 January 1983 Professor K. Yasumatsu passed away. Professor Yasumatsu had been chairman of the South East Asian Regional Section. He is universally accepted to be one of the leading entomologists of our time.

Meetings of Statutory Bodies

8th IOBC General Assembly, Kyoto, 5 August, 1980

During the 1979 Council meeting in Washington the following candidates were proposed as members of the Executive Committee and later elected by postal ballot :

K.S. Hagen	President
G. Fadev	Vice-President
H. Mori	Vice-President
G. Mathys	Secretary-General
F.D. Bennett	Treasurer

This team had prepared the 8th General Assembly which was attended by 61 participants. The presidential address (Dr Hagen) has been published *in extenso* in the March 1981 (no. 19-20) issue of the IOBC Newsletter together with the report of the Secretary-General.

9th IOBC General Assembly

It is anticipated to organize the next General Assembly during the course of the XVIIth International Congress of Entomology (Hamburg, 20-26 August, 1984). The Assembly will be preceded by an Executive and Council meeting.

Investigations on the Potentials for Establishing New Regional Sections

Tropical Africa Regional Section

Contacts were established with the Scientific Secretary of the Inter-African Phytosanitary Council (Dr Mbiele, Yaounde, Cameroon). This turned out to be very fruitful and led to the establishment of a nucleus of 3 countries being prepared to form a Section (Central African Republic, Sierra Leone, Djibouti).

The Statutes of this body have not yet been received and it would be perhaps worthwhile to have further personal discussions in Yaounde and to help prepare the statutes.

Latin America Southern Cone Regional Section

At the occasion of the Symposium on integrated control organized in Chile jointly with the WHRS and the universities of Santiago (Nov. 17-20, 1981), there was a strong feeling for setting up a regional section linking Chile, Uruguay, Paraguay, Brazil, Argentina and possibly also Peru. The implementation of this project is still under consideration.

Technical Meetings Organized by IOBC

IOBC-GERDAT[1] Colloquium on Crop Loss Assessment and Economic Threshold Evaluation 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 have been published in Entomophaga 1982 (Special Issue).

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. The proceedings have been published in 1982 (Ed. INRA Publ., 1982 ; Les Colloques de l'INRA, no. 9).

Technical Meetings with which IOBC was Associated

International meeting for the strengthening of regional plant protection organizations with special emphasis on Latin America and the Caribbean, San José, Costa Rica, 13-17 June, 1983

IOBC was associated with this meeting which was sponsored by FAO, WMO[3], EPPO and IICA[4]. IOBC's participation in the scientific part allowed a consensus to be reached on a recommendation for action for the improvement of maize protection in humid tropical areas

1) GERDAT : Groupement d'études et de recherches pour le développement de l'agronomie tropicale.
2) INRA : Institut National de la Recherche Agronomique.
3) WMO : World Meteorological Organization.
4) IICA : Inter-American Institute for Cooperation on Agriculture.

(jointly with agrometeorologists), and a recommendation for mass production of *Trichogramma* at the Tropical Research Institute of Turrialba (Costa Rica).

Working Parties belonging to the Global IOBC

Working Party on Bruchids attacking Legumes (Chairman V. Labeyrie, FR)

According to the resolution taken at the occasion of the IOBC-sponsored International Symposium on the Ecology of Bruchids attacking Legumes (Tours, FR, 16-19 April, 1980) a Working Party on this subject was established. This Group met for the first time in Paris (IOBC Headquarters) on 19 February 1981 with a participation of 9 members. It was decided to facilitate the flow of information on bruchids and to devote research to three main areas :

1) Crop loss assessments.
2) Improving knowledge on six major species and the group specific to the Mediterranean area.
3) Investigations on bruchids not yet known but having an economic impact in certain areas.

International Working Group on Ostrinia (IWGO) (Chairman P. Anglade, FR)

In 1981 this strong international Group which was independent adhered to IOBC. Professor Chiang, current President of WHRS, was also chairman of the Group for 14 years (now honorary chairman). In 1982 (September 12-17) the Group (10 countries represented) met in Trnava-Piestany, Czechoslovakia ; it reached the conclusion that breeding for resistance is most promising and constitutes an economic means of control. Furthermore, biological control using parasitoids (*Trichogramma*, Tachinid flies) and/or entomopathogenic fungi has to be encouraged. The Group arranges its next meeting in France in September 1984.

Finally, it should be mentioned that IWGO issues regularly a very valuable newsletter.

IOBC Working Group on Quality Control of Mass-reared Insects (Chairman D.L. Chambers, USA)

The Group was established in 1981 and met in August 1982 for the first time in Gainesville, Florida. At this occasion quality control protocols for mass-rearing tephritids and moths were established. The meeting also allowed to systematize the treatment of quality control data.

The second meeting will be organized from 6 to 9 August 1984 at Wädenswil (Switzerland) under the joint chairmanship of Dr Chambers and Dr Boller (CH). Special emphasis will be put on the problems occurring in mass production and release of entomophagous arthropods as biological control agents.

IOBC Working Group on Trichogramma and other Egg Parasites (Chairman J. Voegelé, FR)

The formation of such a Working Group found strong support during the first Symposium on *Trichogramma* held on 20-23 April 1982 in Antibes, FR. The increasing importance of these parasites in practical biological control, the confusion in taxonomy, the development of convenient mass production methods, quality control of parasites reared in the laboratory, the ecological and behavioural problems, as well as lack of communication are some of the important points to be dealt with initially.

The Group is subdivided as follows :

Systematics-genetics	J. Voegelé, FR
Mass production and Utilization	S.A. Hassan, DE
Ecology-behaviour	J. van Lenteren, NL

Meetings will be organized in 1984.

IOBC Heliothis Biological Control Working Group (Chairman E.G. King, USA)

At the occasion of an international workshop on *Heliothis* management held in Hyderabad (November 15-20, 1981) it was decided to establish a Working Group which 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*. The Group issues Newsletters.

IOBC Newsletter

During the period under review the IOBC Secretariat has issued Newsletters 15-28 including 173 pages.

Entomophaga

According to the IOBC statutes, the Global Body has responsibilities for this publication. However, thanks to an arrangement with the WPRS the whole load of work of preparing the editions is secured by Mr Hurpin (FR) and in addition the whole costs of production and dispatching are borne by the WPRS.

Due to financial difficulties of the publisher (Balthazar) in 1982, considerable delays occurred in issuing no. 2 to 4 of volume 27, thus causing considerable embarrassment and accordingly a drop in subscribers. However, thanks to immediate action a new publisher (Lavoisier, Paris) has now taken over and everything will be settled in the near future.

Conclusions

Considerable progress could be made in the establishment of new dynamic global working parties. This is certainly a promising development. Furthermore important IOBC conferences and symposia were organized and it was thus possible to generate interest of the International Agricultural Research Institutes such as CIMMYT* for action programmes (Costa Rica mainly).

Intense activities have been deployed by the WPRS and the EPRS but to a lesser extent by SEARS and WHRS. We shall endeavour to correct this in the near future.

Not much progress has been made in the installation of new regional sections but there is evidence that Tropical African countries and the Southern Cone countries of Latin America are prepared to join efforts. However, the implementation of such projects is hampered by a lack of funds.

* CIMMYT : International Maize and Wheat Improvement Center.

IOBC International Working Group on Ostrinia nubilalis (IWGO). Newsletter 4 (1), May 1983, 37 pp

IWGO was created in 1968 and brings together entomologists and breeders, concerned with the selection of maize resistant or tolerant to *O. nubilalis*, from 14 countries : Austria, Bulgaria, Canada, China, Czechoslovakia, France, Hungary, Italy, Poland, Romania, Spain, USA, USSR, Yugoslavia. Egypt, India, Portugal and Philippines also temporarily participated in IWGO. The main IWGO project is the screening of inbred lines, exchanged between the participants (4 lines per country for 2 years), for their susceptibility to *O. nubilalis*.

Articles in this Newsletter include :

- P. Anglade and IWGO cooperators, pp 5-6. IWGO program and results of the screening of maize inbred lines for resistance to the European Corn Borer : 1981-82.
- C.S. Kania, pp 8-10. Working session of the Technical Committee of IWGO held in Martonvasar, Hungary, March 7-9, 1983.
- P. Anglade, pp 11-13. IWGO participation in the IOBC/EUCARPIA meeting, held in Capbreton, France, April 6-9, 1983, on « Breeding for resistance to insects and mites ». The papers presented are briefly described.
- A.M. Huger, pp 14-15. Interactions between the egg parasitoid *Trichogramma evanescens* and *Nosema pyrausta*, a microsporidian of the European Corn Borer (abstract only).
- M.S. Chiang *et al.*, pp 17-19. ECB and stalk rot resistant early maize inbred lines CSJ-1, CSJ-2 and CSJ-3.
- M. Hudon, pp 20-23. A visit to the INRA Centre, Colmar (France) with Dr M. Stengel, Entomologist, Sep. 1982.
- C. Kania, pp 26-30. Bibliography on *O. nubilalis* in Poland 1956-82 ; 31 references are listed, 26 of which are by Kania.
- H.K. Berger, pp 31-33. New data sheets. A specimen of the new data sheet is given.

IOBC Meetings 1983-1984

General Assembly in Hamburg, August 1984 (during the XVIIth International Congress of Entomology).

Executive Committee meeting, 20 November, 1983 (during the Xth Int. Congr. of Plant Protection, Brighton).

Council meeting, November 1983 (during the Xth Int. Congr. of Plant Protection, Brighton).

WEST PALAEARCTIC REGIONAL SECTION

IOBC/WPRS Commission on Identification of Entomophages. The Ninth Identification List of Entomophages, edited by E. Haeselbarth. IOBC/WPRS Bulletin 1983 VI (1), 49 pp (text in German, French and English)

This work has taken 10 years to complete, and includes reference to about 230 entomophagous insects, with information on hosts and prey and host plants. The list is based on the same principles as the preceding one (Liste d'Identification des Entomophages, no. 8, edited by « Commission de Taxonomie des Entomophages », IOBC 1971) and it differs only in detail, viz. the number of specimens identified and dates are omitted, but the taxonomists in charge of the identification are included. The list is divided into 3 cross-referenced parts : I. Parasite or Predator, II. Host or Prey, III. Host Plants. Other information listed includes the sex of the species determined, as well as the collection location (country, province, location).

Since 1981, responsibility for the identification service has been in the hands of the following, to whom future samples should be addressd :

- Entomophagous Diptera : Dr Benno Herting, Museum für Naturkunde, Arsenalplatz 3, DE 7140 Ludwigsburg.
- All other entomophaga : Dr Erasmus Haeselbarth, Lehrstuhl für Angewandte Zoologie, Amalienstr. 52, DE 8000 München 40.

This identification service is only for specimens from the region covered by IOBC/WPRS (Europe, Mediterranean countries, Near East). The names of host or prey of the entomophagous insects must be given. Biological and ecological data should also be added (host plants of the prey, etc.).

Through the identification service, WPRS is hoping to provide information on the abundance and effectiveness of different entomophagous species. This should close some gaps in our knowledge and stimulate further cooperation between ecologists and specialists in biological control.

IOBC/WPRS Working Group on Integrated Control in Viticulture. Summary of the Report of the IVth Meeting held in Gargnano, Italy, 10-12 March, 1981. IOBC/WPRS Bulletin no. hors serie, 96 pp (mainly in French)

The Working Group was formed in 1974, and this meeting was attended by 51 basic and applied research workers from France (17), Italy (14), Switzerland (7), Fed. Rep. Germany (7), Spain (3), Austria (2) and Hungary (1).

Following a brief outline of the development of integrated control in viticulture (A. Schmid, pp 5-6), there are reports from each of the Subgroups.

Subgroup on Vine Moths : R. Roehrich, 7-34

Biology

- Sites of pupation of *Lobesia botrana* (R. Causse & C. Vidal, 7-9). Pupation occurred largely in the foliage, either in the small dried leaves near the fruit, or between two leaves or leaf and fruit.
- Movements of *L. botrana* (R. Roehrich & J.P. Carles, 10-11). The relationship between trap types (sexual, food, etc.) and *L. botrana* population development is presented.
- Parasitism of *L. botrana* in Valencia (R. Coscolla, 12-13). In winter, parasitism was high and due mainly to *Dibrachys affinis*. First generation parasitism was much lower and due mainly to *Campoplex capitator*.
- Diapause in *Eupoecilia ambiguella* (E. Boller & U. Remund, 14-15). If short photoperiod during the larval stage arrests development, a heat treatment is necessary for pupation.

Damage

- Assessment of damage caused by vine caterpillars (V. Girolami, 16-18). A graph is given showing the relationship between % bunches of grapes attacked and loss expressed as % grapes harvested ; formulae for estimating crop loss are given.
- Relationships between attacks by *E. ambiguella* and *Botrytis cinerea* (E. Boller & U. Remund, 18-20). There was a direct relationship between fungal and insect attack.

- Relationship between captures of *E. ambiguella* and fruit attack (E. Boller & U. Remund, 21-22). Thresholds of 10-75 captures indicated the need for assessing egglaying, with a view to treatment.
- Relationship between captures of imagoes and attack in Alsace (C. Brechbuhler, 22-23). The threshold of 10 % attack by the first generation was only surpassed at captures exceeding 100 ; with 15 % at 300 captures.
- Results of sexual trapping in Venetia and Friuli (L. Dalla Monta, 24). The distribution of *L. botrana* and *E. ambiguella* and their periods of activity were recorded.

Establishing Treatment Dates

- Results of an enquiry on criteria considered when establishing treatment dates (A. Schmid, 24-26). Pheromone traps were the main criterion used, complemented by visual assessments.
- Modelling development of *L. botrana* in Midi-Pyrenées (J. Touzeau, 26-28). A « tortrix » model had been adapted to *L. botrana* and would be operational in 1981.
- Comparison of two methods of forecasting by heat sums (methods of Touzeau and Schmid) in Bordelais (R. Roehrich, 28-29). The two methods gave correct predictions in different years. It will be necessary to take vine phenology into account in Bordelais.
- Relationship between the flight of *E. ambiguella* determined by pheromone traps and egglaying (G. Schruft, 29-30). There were delays of 14 and 4-5 days, respectively, for 1st and 2nd generations, between maximum flight and egg hatching.

Trial with New Control Methods

- *Bacillus thuringiensis* against *L. botrana* (H. Marcelin & G. Vidal, 31). When applied at the time of the initial hatching of the 2nd generation, *B.t.* gave results comparable to those with chemical insecticides.
- Control of *L. botrana* using *B. thuringiensis*-based products (C. Brechbuhler, 31). Bactospeine, containing serotype 3, proved more effective than that containing serotype 1.
- Efficacy of *B. thuringiensis*, 1980 results (G. Haub, 31-32). Efficacy against the 1st generation was comparable to that of chemical insecticides, but less satisfactory results were obtained against the 2nd generation.

Insecticide Trials

Control of tortrix in 1980 (L. Tinkhauser, 32-33). Satisfactory control was obtained, but there was an associated increase in mite populations.

Conclusions

No collaborative experiments would be set up but two avenues of research would be explored : better assessment of risk at the field level, and biological factors regulating populations, particularly *D. affinis*.

Reports of meetings issued by the Subgroup (8 in total) are listed, p 34.

Subgroup on Mites : M. Baillod, 35-48

Panonychus ulmi

- Forecasting (M. Baillod, 35-36). The relationship between winter eggs and attack in spring is discussed.
- Empty white eggs of *P. ulmi* (G. Haub, 36-37). The occurrence and significance of these eggs is described.
- Sequential sampling (M. Baillod, 37). In 90 % of cases, the decision to treat could be taken after examining 3 × 10 leaves or less.
- Distribution of *P. ulmi* (V. Girolami, 37). Studies are continuing on the choice of leaf to assess, and possible use of the parameter of % leaves infested.

Tetranychus urticae (A. Arias, 38-41)

- Hibernating populations. Because of the different places of hibernation, it is difficult to forecast spring attack based on overwintering populations.
- Diapause. Occurred between 30 Sept. and 30 Oct., with a photoperiod of 13-14 h and mean temperatures of 17-19°C.
- Population movements. Migrations to and from weeds are considered.
- Host plants. In Spain, the most important is *Cichorium intybus*.
- Correlations between symptoms – damage – yield – quality. Various correlations are listed.

Eriophyes vitis (W. Gärtel, 41-43)

Observations on *Typhlodromus pyri* are described.

Biological Control and Typhlodromes

- Enquiry on typhlodromes and assessment methods. Results from Switzerland, Germany and Italy are given.
- Ecology of Typhlodromes (G. Haub & E. Boller, 44-45). Weeds provide an important source of shelter and food for typhlodromes.
- Population dynamics (G. Haub & F. Benciolini, 45-46). Variation in population dynamics in different countries is discussed.

Secondary Effects of Pesticides

The safety of various acaricides, insecticides and fungicides is discussed.

Proposals for future work are listed. Other species will be included, such as thrips and scales.

Subgroup on Secondary Effects : J. Touzeau, 49-55

- On *Typhlodromus pyri*. Results of field trials in Wädenswil (E. Boller), Villeneuve (E. Guignard & M. Baillod), Tour de Peilz (E. Guignard & M. Baillod) and Geisenheim (G. Haub) are tabulated, and the toxicity of a number of products listed.
- On *Amblyseius aberrans*. Results of field trials in Roveredo (M. Baillod *et al.*) are given ; all products tested proved very toxic.
- On *Eotetranychus carpini* and *Botrytis cinerea* (J. Touzeau). In field trials in south-west France, all fungicides tested were safe excepting mancozeb.
- On *Uncinula* : Different results were obtained in 1979 and 1980.

Subgroup on Fungal and Bacterial Diseases : W. Gärtel, 56-59

- *Plasmopara viticola* and *Uncinula necator*. Present approaches to control are described.
- *« Ecological » products*. These products, based on sulphur and various plant extracts, and applied weekly to increase resistance of the vine to fungi, were not effective against mildew, but reduced *Uncinula* attack.
- *Botrytis cinerea*. Dicarboximide resistance problems are discussed. Good results have been obtained with *Trichoderma*.
- Wood fungi. These include *Phomopsis viticola* and *Eutypa armeniacea* and *Botryosphaeria*. Present control methods, including *Trichoderma viride* are mentioned.
- *Xanthomonas ampelina*. The increasing importance of this bacterium is described. There are no effective control methods at present.
- *Disease of unknown etiology*. A sudden wilt syndrome in Kerner vines is described.

Stalk wilt in Vitis vinifera : R. Theiler, 61-76, 38 references (in German)

This disease is not thought to be fungal or bacterial in origin. It is manifest, initially by small, sunken, brown spots on the grape stalks. The whole stalk is gradually affected, the spots becoming very sunken. There is a positive correlation between vine growth and attack. There is considerable variation in susceptibility both between and within varieties and different locations. Fertilisation has a marked effect, high levels of K and N favouring the disease. Meteorological conditions are also important, precipitation and temperature having the greatest effect. Attempts have been made at Wädenswil to develop forecasts based on the following criteria :

- cumulative precipitation during the first half of the year ;
- no. days between 1 Jan. and flowering ;
- midday temperatures during the middle of July.

Forecasts have been correct to within 5 %. In years with a forecast of attack below 50 %, treatments can be avoided. The effect of the disease in qualitative and quantitative terms is variable, from no significant loss to 20 %. Control methods include : a) cultural methods, such as reduced N and K fertiliser ; removing old wood ; grassing ; b) applications of Mg and Ca at the beginning of fruit formation, best results being obtained with $MgSO_4$ 2.5 or 5 %, applied such that the grapes are thoroughly wetted.

Relationships between soil factors and pest attack in vines : E. Egger & M. Borgo, 77-83, 17 references (in Italian)

The authors show that in vineyards a correlation exists between cultural factors concerning the soil and the appearance of diseases, phytophagous arthropods and physiological disorders, although it is not always easy to precisely assess crop losses. Moreover, there are conflicting reports indicating that various other elements may modify the effects of these cultural factors, including ecopedological and microclimatic phenomena, as well as cultural techniques such as fertilisation, irrigation, etc. There is a need for research efforts to be expanded and for standardisation in trial design and assessment methods, in order to obtain results which can be compared.

Problems of integrated control in vines in Italy : A. Tranfaglia & G. Viggiani, 85-89, 14 references (in Italian)

Notable progress has been made in integrated control of *L. botrana*, phytophagous mites and *Planococcus ficus*. Integrated control is practised on 200 ha in the Latium region. There has been a marked reduction in both insecticide applications and residues on grapes at harvest.

A list of the WG workers, together with their addresses and Subgroup involvements, is given on pp 91-95

IOBC/WPRS Working Group on Use of Models in Integrated Crop Protection

« The Development of Models for Practical Use in Crop Protection ». Coordinator : M.J. Jeger. IOBC/WPRS Bulletin 1983 VI (2), 78 pp (in English)

The aims of this Bulletin, which is complementary to the « Inventory of Models », are to provide a comprehensive introduction to the range of models and techniques of modelling likely to be found in crop protection, to appraise critically the reasons and justifications for modelling, to consider some of the wider implications of modelling, to provide a guide to the terminological differences that abound in the literature, and to encourage participation in the Group by crop scientists and other interested parties. The Working Group aims at the coordination, initiation and development of models, systems analyses and data bases for use in integrated pest and disease control. The contributions in the Bulletin fall into three main, although overlapping, areas : firstly, an overview of mathematical modelling in relation to the various objectives and activities of crop protection is given ; secondly, three approaches to modelling that stem from the viewpoints of population dynamics, crop physiology and decision theory ; thirdly, the status of models in crop protection, the extent to which they are, or are likely to be, used for practical purposes, and the provision of this information as part of a data base system. Summaries of the 6 contributions are given below :

M.J. Jeger (UK). Mathematical models : their nature and development to practical ends in crop protection. pp 3-17, 68 references

The author provides a personal commentary rather than a comprehensive review or classification of models. The main emphasis is on plant pathological rather than on animal pest problems, but examples are drawn as appropriate from other areas which have particular affinities, notably population ecology. This chapter raises several important questions concerning the objectives, identification, development and evaluation of models.

R. Rabbinge & N. Carter (NL & UK) Application of simulation models in the epidemiology of pests and diseases : an introductory review. pp 18-30, 40 references

This paper approaches modelling from the viewpoint of population dynamics and includes discussion on the following : mites, nematodes, *Alternaria solani*, *Helminthosporium maydis* and *Puccinia striiformis*. The need to adequately validate models is stressed in order to maximise their impact in pest control.

R. Rabbinge (NL). How to use combination models in crop protection, pp 31-45, 26 references

An introduction to combination models of pest and disease population dynamics and crop growth is given. Such

combined models have been developed for situations in specific crops, including cotton, alfalfa, apple and wheat, and can be used as a research tool to obtain a better insight and understanding of the effects of a pest or disease on its host. The examples presented, although preliminary, serve to illustrate how these models can be used. The summary model SUCROS is discussed in some detail, alone and in combination with population models for cereal leaf beetle *(Oulema melanopus), Erysiphe graminis* and *Tetranychus urticae*.

G.A. Norton (UK). A decision analysis/modelling approach to pest and disease management, pp 46-56, 12 references

This paper assesses the practical value in crop protection of systems analysis and modelling techniques in research and extension decision-making, rather than at the farm level. Flow diagrams showing the role of modelling, the regional factors influencing crop protection problems, and a descriptive analysis of a crop protection problem are given. There is diagrammatic representation of a decision model concerning the choice between calendar spraying and monitoring and spraying.

M.J. Jeger & J. Tamsett (UK). The status of models in crop protection : an analysis using data base systems, pp 57-76, 5 references

This chapter is concerned with an analysis of models submitted by December 1981 for the IOBC Inventory, and discusses the technical means employed in the analysis, and the accessibility of such information to those working in crop protection – it is not intended to identify or discuss individual models. It is clear that few models are being developed to practical ends in crop protection. Those which have found some use are mainly for forecasting individual events within the epidemic and are based on regression equations. The most important factors in determining the eventual management uses of a model are the original intentions of the model designer, the contact with empirical evidence at all stages of development, and the consideration given to the local conditions where the model is to be used. The analysis also demonstrates the potential usefulness of a data management system for models in crop protection.

Conclusions and Recommendations (M.J. Jeger, G.A. Norton, R. Rabbinge)

Conclusions were reached in three main areas : the need for interdisciplinary approaches and problem identification, the sequence of model development, and the evaluation of models in a practical context. It seems desirable to establish criteria which may help in deciding which modelling approaches are of most value, once the problem of concern is identified and the objectives adequately stated. The precise sequence of model development will vary depending upon the problem identified and involve different qualitative and quantitative phases and degrees of simplification, but the evaluative phase must operate at several points in the sequence. The evaluation of a model's utility in a practical context remains the least developed process, perhaps unavoidably, due to the few examples of disease or pest models being used in practical management. It is now important that the Group actively pursues the financial and logistical means to provide the necessary evaluations where appropriate, and to do so in a climate of rapidly changing farm management practices.

IOBC/WPRS Working Group on Use of Models in Integrated Crop Protection. Summary of the Report by M.J. Jeger on a Meeting held in Leuven, Belgium, 28 February-2 March, 1983, 13 pp (in English)

The meeting was opened and introduced by Rabbinge. He stressed the importance of crop protection levels, ranging from the bottom level, the « poor » crops, to the top, the « rich » crops, which are each constrained by different factors. Implementation of damage assessment models is now possible but depends on a recognition of the production level.

The activities of the subgroup on *Septoria* forecasting were outlined by Royle. Most attempts at forecasting have been of the short-term kind ; the subgroup is not seeking a common forecasting system, but stressed the need for universal standards of data. Collaboration had so far only been between the UK and Fed. Rep. Germany. Standard measurements are being used and standardised forms are used for all data collections. Royle gave examples from the UK of a rainfall × disease interaction with respect to spore yield. Less disease was found on high density crops than on medium or low density, possibly due to the fact that the high leaf area index in the high density crops interfered with the rainfall intensity and, hence, the efficiency of spore dispersal. Descriptions of their present and future plans with respect to *Septoria* were given by Forrer (CH), Daamen (NL), Lechapt (FR), Obst (DE), Leemans (NL) and Djurle (SE). The subgroup recommended that in view of the concern and active interest of a number of the modelling group in the problems of *Septoria* in winter wheat, a subgroup be formalised to initiate and coordinate work in this field.

Sabelis described his validation of a simulation model of the interaction between *Phytoseiulus persimilis* and *Tetranychus urticae* on cucumber. Various reasons were given for the insufficient control obtained. Inputs to the model are listed. The model has led to testable hypotheses : sensitivity analysis showed that relative changes in webbed area were very sensitive to the numbers of predators released but not to glasshouse temperature variation. Sabelis concluded that he is now in a position to recommend the numbers of predators to be released. Forrer reported on the interaction of wheat mildew with *Fusarium* and *Septoria*, and of *Septoria* with cereal leaf beetle. Five % of *Septoria* and 100 % of *Fusarium* infections were considered to be based on interactions. The relative growth rate of *Septoria* should be corrected if interactions are present.

Sigwald introduced models of virus transmission in potatoes : Potato Virus Y and Leaf Roll Virus are the most important in Sweden. He outlined his method of forecasting PVY, based on migration and % infected tubers, number of aphid species, efficiency factor of each species, date of flight and source of virus. The model gave good qualitative and quantitative relationships with the observed data. A simulator of barley powdery mildew, EPIGRAM, was introduced by Hau. The simulator does not cover the whole life cycle but ignores sporulation/dispersal. Some developments in the model were described. Gilligan gave details of models being developed for the biocontrol of soil-borne disease. The distinction between hyperparasitism (e.g. *Trichoderma* against *Rhizoctonia* on radish) and competition (e.g. for iron) was made. Simple probability models for infection or no infection were introduced and the effects of different modelling suppositions, e.g. non-random and clumped distributions, negative binomial distribution for hyperparasite. The multiplication rate of *Trichoderma* remains to be determined.

Touzeau described the models of diseases and pests in cereal crops that are being used by the plant protection services in France. Qualitative operational models are being used for apple scab and codling moth, while quantitative models are being developed for cereals. Prediction is considered a more difficult problem than monitoring. The objectives are short-term predictions of no more than 10 days. Touzeau described the structural arrangement of the French plant protection services. The systems network is aimed to be complete by 1985.

Lechapt considered the practical uses of models in France. Striped rust was used as an example. More comprehensive models are available but have not been used practically.

Daamen talked about the use of field evaluations in disease management systems. The sampling method used in the Netherlands was described. He then gave examples of survey results in different years. As a research tool, the relationship between yield and *Fusarium* ear blight was investigated. « Critical » point models for powdery mildew losses were used. Examples were also given of how a simple exponential model of disease increase may be modified to take account of a delay period, when weather is known, and a prognosis period, when weather is not known.

Pierre read a paper on the forecasting of cereal aphid infestations in western France.

The meeting was then open to general discussion and the following topics discussed : weather data, use of green leaf area in yield loss studies, qualitative versus quantitative studies, definition of crop production level and yield loss, strategy in model building, sampling and monitoring techniques, and terminology.

Finally, the participants involved in the implementation of EPIPRE in various countries each gave a short report on their experiences. These were Gijpens (BE), van Leeuwen-Pannehoek (UK), Touzeau (FR), Reinink (NL), Djurle (SE) and Forrer (CH), and this was followed by a general discussion on EPIPRE led by Rijsdjk.

The next meeting of the Working Group would be held in Basle in May 1984. Briefly, the general conclusions and recommendations were as follows :

1. circulation of IOBC Bulletins : be increased to a wider audience ;
2. modelling strategies : that information on the models be made available to the other IOBC crop-orientated groups, so that models may be tailored to suit specific aims and objectives ;
3. weather data : that the development of adequate automatic (micro) weather stations be stimulated, since on-site weather data collection is essential for the prediction of some pests and diseases ;
4. Sampling/monitoring techniques : that guidelines for monitoring by « laymen » be formulated ; further work on determining sampling procedures for different crop systems is necessary ;
5. Damage-loss relationships ; that guidelines be developed for assessing yield losses, identifying suitable measures of diseases and pests, defining production level-dependent damage relationships, and incorporating pest and disease interactions into such relationships ;
6. Terminology : physical dimensionality is essential (in SI units), and a « willingness to explain » and consistency are necessary in the use of biological terms.

IOBC/WPRS Working Group on Integrated Control in Glasshouses. Summary of the Report of the Meeting held in Darmstadt, 27-29 July, 1982. Convenor : N.W. Hussey. IOBC/WPRS Bulletin 1983 VI (3), 229 pp (in English)

This was a full meeting of the Working Group. Forty-two delegates from 17 countries attended. Discussions emphasised the biological control of agromyzid leafminers, problems in the use of *Encarsia* under energy-saving low-temperature cultural regimes and progress in the development of full integrated programmes of pest control on different crops. A significant aspect of the meeting was the attendance, for the first time, of workers from Japan and China, as well as colleagues from Mediterranean countries, including Spain, Italy, Sicily and Crete. This meeting marked the beginning of a change in the emphasis of the Group's work, which will become increasingly concerned with the adaptation of the biological control techniques now widely adopted in North Western Europe to other areas where protected crops are grown. The papers in this Bulletin fall into 9 sections as follows :

National Development of Biological Control

M.J. Berlinger et al. (IL). Greenhouse tomato pests and their control in Israel, pp 7-11, 10 references

The most harmful tomato pest in Israel at present is the tobacco whitefly, *Bemisia tabaci*, which transmits Tomato Yellow Leaf Curl Virus (TYLCV), the cause of a severe disease. The problem is so severe that growers are forced to spray pesticides every other day and sometimes daily during the first 3 months of the growing season. Other control methods briefly described include : yellow plastic mulch, painting glasshouse roof yellow, pressurised glasshouses, covering plants with perforated plastic tunnels, and breeding for resistance.

E. Kozirakis (GR). Present state of biological control on vegetable crops under plastic in Crete, Greece, pp 12-14

A 4-year programme for control of whitefly by *Encarsia formosa* and of spider mite by *Phytoseiulus persimilis* on vegetable crops under plastic was initiated in May 1982 : in a 900 m² house of cucumbers, and in a 1400 m² house of tomatoes. Results to-date are encouraging.

S. Michelakis (GR). The whitefly problem in Crete, Greece : the first experiments with Encarsia formosa in the plastic houses of the island, pp 15-24, 5 references

The development of the parasite population in relation to the pest was observed in 5 unheated plastic houses in Crete. Efforts should be made to develop a strain of *E. formosa* more suited to cooler conditions. The importance of early parasite introduction and deleafing was confirmed.

A. Nucifora et al. (IT). Advances in integrated control in Sicily, pp 25-31, 10 references

The authors summarise the results of research and development on IPM for whitefly, leafminers and red spider mite, in crops of tomato, eggplant, vegetable marrow, sweet pepper and gerbera, in unheated glasshouses in Sicily. Sticky yellow traps have provided good control, particularly when used in combination with quinomethionate treatments. These methods are compatible with parasite *(E. formosa)* and predator action.

K. Nakazawa (JA). Factors preventing the development of biological control in Japanese greenhouses, pp 32-35, 5 references

Although Japanese greenhouses extend to about 30,000 ha, biological control is only appled on 3 ha. The author analyses the obstacles to better pest control and discusses some ways to overcome these difficulties. *Phytoseiulus persimilis* is the only biocontrol agent used in practice at present.

W.J. Ravensberg et al. (NL). Developments in application of biological control in greenhouse vegetables in the Netherlands since 1979, pp 36-48, 17 references

The authors outline the factors limiting application of biocontrol in glasshouses in the Netherlands, and then briefly describe the progress made in the method of delivering beneficials. Biocontrol in cucumber, and then tomato, is described in some detail, followed by brief reference to control in sweet pepper. There is a summary table of integrated schemes for these crops in commercial glasshouses and in experiments in 1982.

E. Yano (JA). Constraints on the use of E. formosa in tomatoes in Japan, with special reference to the effect of temperature on its efficiency, pp 49-53, 4 references

The glasshouse whitefly invaded Japan in the early 1970's and is now one of the major glasshouse pests all over the country. The experiments summarised show that use of *E. formosa* in tomatoes is promising for all types of cultivation in Japan. Use of this parasite will need to be integrated with insecticides to control other pests such as leafminers and pirimicarb-resistant *Aphis gossypii*.

Constraints on Biological Control of Whitefly

J.C. van Lenteren & P.M. Hulspas-Jordaan (NL). Influence of low temperature regimes on the capability of Encarsia formosa and other parasites in controlling the greenhouse whitefly, Trialeurodes vaporariorum, pp 54-70, 37 references

Data from the literature have indicated that the lowering of greenhouse temperatures will make difficult, or impossible, biocontrol of whitefly by *E. formosa*. In this paper, the authors 1) review the literature, 2) summarise work on collecting and comparing whitefly parasites, 3) describe research to determine developmental and reproductive characteristics of whitefly and some of its parasites at the prospective low temperatures, and 4) give data on the migration capacity of *E. formosa* at low temperatures. The results show that biocontrol may be possible at the new temperature regimes without drastically changing the widely used present day system.

Li Tzu-Yin & Li Zhau-Hwa (China). Preliminary analysis life table for greenhouse whitefly (Trialeurodes vaporariorum), pp 71-83, 7 references

Six life tables are presented for whiteflies on potted cucumbers, with and without pesticide (fungicide + Rogor) applications. Mortality at the egg stage was zero, death occurring mainly in the 1st and 2nd instars. Because of insecticide spraying, only a few predatory spiders were found and no parasitism was observed.

C. Stenseth (NO). Cold-hardiness in eggs of greenhouse whitefly, pp 84-86

This paper describes laboratory experiments set up to test the cold-hardiness of eggs. Eggs are very sensitive at −6°C, only six days at this temperature eradicated them. Survival time at 0°C was limited. The hatching pattern after exposure to +6°C indicated prolonged survival at this temperature, and the mortality curve was of the sigmoid type.

Li Tzu Yin & U. Maschwitz (China). Sexual pheromone in the greenhouse whitefly, pp 87-100, 21 references

A female pheromone was discovered in *T. vaporariorum*. It attracted males over a distance of 5 to 10 mm in experimental cages, and released a resting behaviour in males. Males were not attracted by other males. The pheromone was extracted with nonpolar solvent both from empty glass tubes which had contained females for some time or from crushed females.

Xu-Ru-mei (China). Density effect on fecundity and mortality on greenhouse whitefly populations, pp 101-107, 7 references

There was a significant effect of density on fecundity, and it was evident that mortality increased with density. There was no significant interdependency of deaths.

Control of Leafminers

R.K. Lindquist & M.L. Casey (USA). Introduction of parasites for control of Liriomyza leafminers on greenhouse tomato, pp 108-115, 3 references

The 3 experiments described with the leafminer parasites *Opius bruneipes* and *Diglyphus pulchripes* were designed to evaluate introduction and sampling under different conditions likely to be encountered in commercial growing conditions during different seasons of the year in Ohio. The experiments illustrated that certain leafminers, *Liriomyza trifolii* in particular, can be suppressed on tomatoes by one or more parasite species.

R.J. McClanahan (Canada). Control of Liriomyza trifolii on greenhouse chrysanthemums, pp 116-123, 3 references

L. trifolii has been a serious pest of greenhouse chrysanthemums in Canada since early 1980. Sticky traps provide a highly visible means of leafminer control while, at the same time, providing a means of measuring the relative level of the population. During a 4-week period, it was estimated that the 75 traps in one house removed 89,000 leafminers from circulation. This control method is compatible with other chemical, biological or cultural means of control and does not leave any residue. Other insects are caught as well, including whiteflies, winged aphids, thrips and fungus gnats.

B. Nedstam (SE). Control of Liriomyza bryoniae by Dacnusa sibirica, pp 124-127, 4 references

Parasitisation increased when *Dacnusa sibirica*, a parasite of the tomato leafminer, *L. bryoniae*, was given a food supply of honey or honeydew in two experiments in glasshouse chambers. Access to a source of nectar (melon plants) had no significant effect, although the % parasitism was higher than in the control. All 3 treatments led to significantly lower levels of leafminer infestation.

M.P. Parrella (USA). Insect growth regulators for the control of Liriomyza trifolii and compatibility with a natural enemy, pp 128-133, 14 references

Reported herein are efficacy data for selected IGRs (RO 13-5223 1E, methoprene 5E and CGA 77622 5SC) and the potential for compatibility with the endoparasite, *Chrysocharis parksi*. In laboratory evaluations, all IGRs demonstrated good leafminer control capability and RO 13-5223 1E had no adverse effect on survival of *C. parksi*. However, striking differences were found comparing when the materials exerted their action. Preliminary data suggest that the phytotoxicity caused by CGA 77622 5SC and RO 13-5223 1E is attributable to the carrier and not to the active ingredient.

J. Woets & A. van der Linden (NL). Observations on Opius pallipes as a potential candidate for biological control of the tomato leafminer, Liriomyza bryoniae, in Dutch greenhouse tomatoes, pp 134-141, 5 references

A good level of control was achieved in spring crop tomatoes in Dutch greenhouses following early occurrence/introduction of *O. pallipes* at a rate of 3 % of the maggots of the preceding generation of tomato leafminer.

Biological Control of Aphids and Coccids

M.J.W. Copland (UK). Temperature constraints in the control of mealybug and scale insects, pp 142-145, 1 reference

The author outlines the approach at Wye to control *Planococcus citri*, *Saissetia coffeae* and *S. oleae* using *Cryptolaemus montrouzieri* and other predators and parasites. In particular, attention was paid to the relationship between temperature and biology. For each pest species and its control agents, they are trying to produce a simple computer programme which can calculate the number of parasites and predators to be released to control a pest population of a certain size within a defined period. The combination of biological control and microcomputers provides a unique solution for glasshouse pest control. The technique places a powerful diagnostic tool in the hands of the adviser and supplier of biological control agents which can ensure a greater degree of success and, therefore, acceptance of the technique.

L.S. Hansen (DK). Introduction of Aphidoletes aphidimyza from an open rearing unit for the control of aphids in glasshouses, pp 146-150, 3 references

Results of experiments from 1980-82 are summarised with the following conclusions : successful aphid control can be obtained by means of open rearing units for *A. aphidimyza* ; an overwintering population of the predator can render annual introductions of natural enemies superfluous, if an alternative food source is provided at the beginning of May ; the survival of vetch aphids, *Megoura viciae*, on the bean plants is crucial to successful control ; an extra supply of *A. aphidimyza* must be available in case the crop is already infested by aphids at the time of planting.

J.M. Rabasse et al. (FR). Progress in aphid control in protected crops, pp 151-162, 16 references (French summary)

Aphidius matricariae was shown to be specific and effective against *Myzus persicae*. Results are also reported of studies on epizootics of Entomophthoraceae, including *Erynia neoaphidis*, on aubergine. The scope of the latter agents may be limited by the difficulty of raising the humidity sufficiently on hot days, as well as by risks of adverse effects on the crop plants under such conditions.

Pathogens

G.N. Foster & N.E. Crook (UK). A granulosis disease of the tomato moth, Lacanobia oleracea, pp 163-166, 4 references

L. oleracea has been a major pest of glasshouse tomatoes in the Clyde valley in Scotland since 1977. The granulosis virus disease dealt with in this paper first appeared in 1978 ; it was hoped that the virus would offer an alternative to *B. thuringiensis* in integrated control, with the possible advantage of spread within the season and survival from one season to the next. Two experiments simulating commercial conditions showed that the spraying strengths of $10^8 - 10^9$ capsules ml^{-1} should be effective, but commercial trials carried out in 1981 proved disappointing.

P.M.J. Ramakers (NL). Aschersonia aleyrodis, a selective biological insecticide, pp 167-171, 16 references

The author describes experiments carried out in greenhouse cucumbers against whitefly. As a candidate biocontrol agent, *A. aleyrodis* showed some drawbacks, some advantages and some aspects needing further clarification. Drawbacks include the absence of an epizootic process under glasshouse conditions, and the fact that the fungus does not affect adult whiteflies. However, its high specificity makes it a suitable agent in IPM. Further research is needed on producing conidia of standard quality, the optimal chemical and physical conditions for the infection process, and the interaction between *Aschersonia* and *Encarsia* both at the level of the individual insect and in terms of population dynamics.

Integrated Control Programmes

M.J. Berlinger et al. (IL). Breeding for resistance to whiteflies in tomatoes – in relation to integrated pest control in greenhouses, pp 172-176, 9 references

Lycopersicon and *Solanum* accessions differ markedly in their resistance to whiteflies. The resistance seems to be polygenic and comprises various mechanisms, such as differences in pH, content of secondary plant substances, sticky exudations which may be toxic, etc. It would appear that breeding for resistance to whiteflies in tomato is possible but difficult and more research is necessary.

R.J.J. Pickford (UK). A selective method of thrip control in cucumbers, pp 177-180

Trials with mixtures of polybutenes and insecticides sprayed onto sheets of plastic on the ground below were successful in controlling thrips by killing the larval prepupae when they descend to pupate. This method leaves the natural enemies *Phytoseiulus* and *Encarsia* unaffected on the aerial parts of the plant as the mixture does not vaporise.

J.V. Cross et al. (UK). Integrated control of chrysanthemum pests, pp 181-185

The problems posed to All-Year-Round (AYR) chrysanthemums by red spider mites, aphids, thrips, caterpillars and leafminers are described. The authors then outline 4 different integrated control programmes which combine routine introductions of one or more biological control agents with carefully timed routine applications of selective pesticides throughout the summer. The four programmes are now being tested by growers on a commercial scale to assess their effectiveness and reliability.

S.A. Hassan (DE). A practical method to monitor pests and natural enemies in integrated control experiments under glass, pp 186-193, 6 references (German summary)

Plants were examined for the presence or absence of insects and mites without counting individual arthropods : viz. *Trialeurodes vaporariorum* and *Encarsia formosa*, *Tetranychus urticae* and *Phytoseiulus persimilis*, and *Thrips tabaci* on cucumber plants from 1977-80. Only the 1978 results are presented here. The method used proved to be time-saving, practical and to provide useful information for the development of integrated control programmes for crops under glass. Several pests were monitored at the same time.

N.W. Hussey (UK). Development of a management programme to ensure whitefly-free early-sown tomatoes in Guernsey, pp 194-195

Aldicarb would guarantee clean plants but is impractical in Guernsey due to contamination of soil water. Therefore, the programme proposed to protect early-sown tomatoes with adhesive yellow traps (1 per 5 ft of bench) and to treat for whiteflies during the first week of December when the plants are stood-out on the bolsters. This would permit planting in early January without hazard and ensure that any whiteflies invading the crop later would not produce scales ready for parasitism before the middle of February, when « dribbles » of *Encarsia* could commence.

Use of Pheromones Under Glass

J. van den Bos (NL). Experiences with pheromonal trapping of Lepidoptera in greenhouses, pp 196-202, 11 references

The unpublished results of various Dutch researchers are summarised : *Clepsis spectrana* (J. van den Bos), *Adoxophyes orana* (in collaboration with C. van der Kraan & P. van Deventer), *Spodoptera exigua* (in collaboration with C. van der Kraan & M. van de Vrie), *Phthorimaea operculella* (in collaboration with C. van der Kraan & P. van Deventer), *Chrysodeixis chalcites* (in collaboration with C.J. Persoons), and *Spodoptera littoralis* (in collaboration with M. van de Vrie & C.J. Persoons). All the evidence presented pointed to the fact that pheromone-mediated communication is less effective in greenhouses than in the open air. However, since it may be easier to create high overall pheromone concentrations in greenhouses than in the field, the former location would seem to be well suited for application of the mating disruption technique, provided that moth density is not too high to rule out the chance of random encounters and matings.

Mass Production

P.M.J. Ramakers (NL). Mass production and introduction of Amblyseius mckenziei and A. cucumeris, pp 203-206, 3 references

Using wheat bran as the primary food source and *Acarus farris* as a substitute host, it was demonstrated that 3×10^4 (*A. cucumeris*) or 10^5 (*A. mckenziei*) predatory mites (eggs excluded) can be produced per litre of rearing volume. The results of inundative and inoculative introductions of these predators into cucumber crops for control of *Thrips tabaci*, from 1978-82, are reported. Population dynamics are then discussed. In spite of cannabalism, populations of *P. persimilis*, *A. mckenziei* or *A. cucumeris* can coexist on the same plant or even leaves since their hunting behaviour differs radically. However, if mixed populations of the *Amblyseius* spp. are introduced, one species will gradually replace the other.

Modelling

M.W. Sabelis et al. (NL). Experimental validation of a simulation model of the interaction between Phytoseiulus persimilis and Tetranychus urticae on cucumber, pp 207-229, 22 references

This paper deals with the dose (timing) and site of predator release as a possible cause of inadequate control of *T. urticae* by *P. persimilis* in glasshouse cucumbers. Experiments on biocontrol in glasshouse cucumbers are discussed and the results are compared with simulations to assess the validity of the model. The model can be used to make general prescriptions for the dose of predators to be released in a spider mite patch of certain size, and also to optimize the dose, either where the pest-in-first method is applied or where both predator and prey are released simultaneously to create a buffer for forthcoming mite infestations.

FORTHCOMING MEETINGS

10th International Congress of Plant Protection, Brighton, 20-25 November, 1983.

Advancing Agricultural Production in Africa, Arusha, Tanzania, 12-18 February, 1984.

1st International Congress of Nematology, Canada, 5-10 August, 1984. Contact : Dr J.H. O'Bannon, Chairman, Program Structuring Committee, Irrigated Agriculture Research and Extension Centre, Prosser, WA 99350, USA.

17th International Congress of Entomology, Hamburg, Fed. Rep. Germany, 18-26 August, 1984. Contact : Professor C.A. Mound, British Museum (Natural History), Cromwell Road, London SW7, UK.

6th International Congress of Virology, Sendai, Japan, 1-7 September, 1984. Contact : International Congress Service, Chikusen Bldg. 6 F, 2-7-4, Nihombashi, Chuo-ku, Tokyo 103, Japan.

4th European Multicolloquium of Parasitology, Izmir, Turkey, 9-14 October, 1984. Contact : Dr Emel Tumbay, Secretary-General, EMOP IV, PK 81, Bomova, Izmir, Turkey.

BOOKS

Integrated Management of Insect Pests of Pome and Stone Fruits, edited by B.A. Croft and S.C. Hoyt. Environmental Science and Technology : A Wiley Series of Texts and Monographs. John Wiley & Sons Inc. (New York), 1983, 454 pp. ISBN 0-471-05334-1.

SELECTED ABSTRACTS

a) Plant Protection

1. INSECT AND MITE CONTROL

i) Entomopathogens

M.E. Martignoni et al. (1982). Baculovirus of Autographa californica : a candidate biological control agent for Douglas-fir tussock moth. J. econ. Ent. 75 (6) : 1120-1124

A strain of Baculovirus (nucleopolyhedrosis virus) recently isolated from *Autographa californica* (AcMNPV) was found to be virulent for the Douglas-fir tussock moth, *Orgyia pseudotsugata*. Based on polyhedron-to-bioactivity ratios, the news AcMNPV strain has nearly one third the activity of a Baculovirus (OpMNPV) isolated from *O. pseudotsugata*. OpMNPV is registered in the United States (with the name TM BioControl-1) as a biological insecticide for control of the Douglas-fir tussock moth in Douglas-fir and true fir forests of the western states. Sprayed at equal levels of activity with an aerial-application simulator, AcMNPV equals OpMNPV in efficacy. An analysis of survival time patterns shows that the disease caused by AcMNPV in *O. pseudotsugata* has a more acute course than that caused by OpMNPV. Compared with OpMNPV, AcMNPV has several advantages as a microbial insecticide. AcMNPV can be produced in a relatively simple system, costs less than OpMNPV produced in *O. pseudotsugata*, and has a wider host range than OpMNPV. The evidence strongly favours consideration of AcMNPV as a viral agent for Douglas-fir tussock moth control.

Y. Tanada et al. (1982). Unique virus morphogenesis and cytopathology of a baculovirus (hypertrophy strain) in larva of the armyworm, Pseudaletia unipuncta. J. Invertebrate Path. 40 (2) : 197-204

Nuclear polyhedrosis in tracheal cells caused by the hypertrophy strain of a nuclear polyhedrosis virus (HNPV) has many morphological and developmental features that distinguish it from that caused by the typical strain (TNPV). The most obvious difference is the morphogenic sequence due to the relatively slow virogenic development in HNPV-infected cells, in which are found extensive membranous profiles similar to viral envelopes, electron dense granules, large fibrous bodies, and microtubules. These structures also occur in TNPV-infected cells but are far less abundant and conspicuous. Fibrous bodies found in the cytoplasm and nucleus appear to be morphologically identical. Cellular distortion in a hypertrophied tracheal cell is seen as learing of mestracheon folds between cells, separation of septate desmosomes, and attenuation in the cellular sheath.

S.K. Burley et al. (1982). Structure of the Baculovirus nucleocapsid. Virology 120 (2) : 433-440

A low-resolution structural model of the nucleocapsid of *Spodoptera litura* granulosis virus, a member of the Baculoviridae family, has been determined using contrast variation methods in both electron microscopy and low-angle X-ray solution scattering. The cylindrical portion of the characteristic capsid surface is composed of a 12 start helix system of monomer subunits, giving rise to a relatively open stacked ring structure running parallel to the cylinder axis and repeating approximately every third ring. Structural proteins which appear distinct from those constituting the cylinder comprise the stacked ring-like assemblies which form caps at both ends of the nucleocapsid. Within the nucleocapsid, the double-stranded closed loop of DNA associates heterogeneously with a highly basic polypeptide to form a cylindrical core. The basic protein is thought to participate in condensation and protection of the genome both prior to and during encapsulation.

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

A review on granulosis viruses and their use in biological control.

G.F. Rohrmann et al. (1982). Characterisation of DNA from three nuclear polyhedrosis viruses pathogenic for Choristoneura sp. J. Invertebrate Path. 40 (2) : 237-241

Three nuclear polyhedrosis viruses isolated from larvae of the insect genus *Choristoneura* showed polyhedrins of 28-30,000 daltons, genome sizes of $78\text{-}82 \times 10^6$ daltons, and guanine plus cytosine contents of 47.9 – 49.4 %. It was demonstrated by comparison of restriction endonuclease fragment patterns that two of the viruses are closely related genetically.

I.N. Skuratovskaya et al. (1982). Properties of the nuclear polyhedrosis virus of the great wax moth : oligomeric circular DNA and the characteristics of the genome. Virology 120 (2) : 465-471

The authors present data demonstrating a correlation between the percentage number of double and triple-length virions determined for the preparations studied and the recovery from these preparations of double and triple-length oligomeric circular DNA molecules. Data on the cleavage of GmNPV DNA by restriction endonucleases are also presented.

D. Manjunath & S.B. Mathad (1981). Effect of sunlight on the infectivity of purified and non-purified NPV of the armyworm, Mythimna separata. Indian J. agric. Sci. 51 (10) : 750-756

In winter, the infectivity of the nuclear polyhedrosis virus (NPV) of the armyworm, *Mythimna separata*, remained unchanged in suspensions of the purified and non-purified samples with exposures to sunlight up to 1 and 4 h, respectively, and in dry films of non-purified samples up to 72 h. But the infectivity of the purified virus exposed for 4 h in both suspension and dry film was significantly reduced, and the virus showed no significant difference in resistance to inactivation by sunlight when exposed in either suspension or dry film. The reduction in activity of the purified virus was faster up to 12 h, and the virus was inactivated at 48 h. In summer, the activity of the purified NPV was signifi-

cantly reduced with 4-h exposure and was further reduced to nil at 12-h exposure. The reduction in virus infectivity was faster in summer than in winter. Obviously, when exposed to sunlight, the NPV was more stable in the non-purified than in the purified preparation and the purified virus would need stabilization against sunlight before being used for control of *M. separata*.

B.D. Hicks et al. (1981). Effects of red-headed pine sawfly, Veodiprion lecontei, nuclear polyhedrosis virus on rainbow trout, Salmo gairdneri, and Daphnia pulex. J. Environ. Sci. Health Part B 16 (4) : 493-509

The fish were exposed to the virus by intubation and topical application, and no ill-effects were observed. Similarly, no ill-effects were detected in *Daphnia pulex* when the same NPV was added to their culture medium. On the basis of these laboratory tests, this virus, when disseminated as a biocontrol agent, should present no hazard to rainbow trout or to aquatic invertebrate *D. pulex*, two species frequently used in toxicity tests of chemical pesticides.

M.A. Mohamed et al. (1982). Bioassay of the nucleopolyhedrosis virus of Neodiprion sertifer (Hymenoptera : Diprionidae). Great Lakes Ent. 15 (2) : 93-96

Linear regression analysis of probit mortality versus several concentrations of NPV of *N. sertifer* resulted in the equation $Y = 2.170 + 0.872X$. An LC_{50} was calculated at 1758 PIB/ml. The incubation time of the virus was dependent on its concentration.

H.F. Evans et al. (1981). Growth of nuclear polyhedrosis virus in larvae of the cabbage moth, Mamestra brassicae. Arch. Virol. 70 (3) : 207-214

Two methods of quantification were used : light microscopy to estimate numbers of polyhedra, and ELISA for virus protein antigen concentrations. There was a linear correlation between polyhedral counts and virus protein during the initial growth phase. Maximum polyhedral production ranged from 2×10^7 (1st instar) to 3.4×10^9 (5th instar). Virus antigen was detectable at least 24 h before polyhedra were observed under the microscope. Productivity ratios ranged from 83,000 in the first instar to 1352 in the fifth.

J.D. Podgwaite & H.M. Mazzone (1981). Development of insect viruses as pesticides : the case of the gypsy moth, Lymantria dispar, in North America. Prot. Ecol. 3 (3) : 219-227

Of the several types of biological control agents, the insect viruses appear to offer one logical alternative to chemical insecticides. The nucleopolyhedrosis virus of *L. dispar* is discussed in depth with regard to the research leading to its approval as an insecticide.

N.F. Moore & T.W. Tinsley (1982). The small RNA-viruses of insects : a brief review. Arch. Virol. 72 (4) : 229-245

The study of small RNA-viruses of insects has been stimulated from several directions. Firstly, in the utilisation of natural pathogens of insects as control agents. Secondly, there is the intriguing possibility that some small RNA-viruses of insects may be mammalian viruses. Thirdly, « inapparent infections » have been identified in useful insect species, such as honey bees. Finally, tissue culture studies have allowed the replicative mechanisms to be studied.

R.G. Luttrell et al. (1981). Microbial and chemical insecticides against the cotton leafworm. Arkansas Farm Res. 30 (2) : 10

The authors report on the efficacy of 2 microbial agents and 2 new chemical microbial agents and 2 new chemical insecticides against the cotton leafworm in 1979 : *Baculovirus heliothis* (Elcar), *Bacillus thuringiensis* (Thuricide), *Autographa californica* NPV, permethrin (Pounce), carbamate (Larvin) and carbaryl (Sevin). Thuricide was somewhat effective in reducing larval populations but the NPV appeared to be ineffective in controlling cotton leafworm.

J.J. Hamm & W.W. Hare (1982). Application of entomopathogens in irrigation water for control of fall armyworms and corn earworms on corn. J. econ. Ent. 75 (6) : 1074-1079

Four microbial control agents were tested on whorl stage corn against the fall armyworm, *Spodoptera frugiperda*, and one on corn silks against corn earworm, *Heliothis zeae*, by application of the pathogens through an overhead irrigation system. A fungus, *Nomuraea rileyi*, two species of microsporidia, *Vairimorpha* sp. and *V. heterosporum*, and the nuclear polyhedrosis virus of *S. frugiperda* (Sf NPV) produced infections in fall armyworms collected from the treated corn plants. Elcar, a commercial preparation of the nuclear polyhedrosis virus of *Heliothis*, infected corn earworm when it was applied through the irrigation system. When continuous infestations of fall armyworms were present, epizootics of the Sf NPV developed.

M.R. Bell & C.L. Romine (1982). Cotton leafperforator : effect of two microbial insecticides on field populations. J. econ. Ent. 75 (6) : 1140-1142

Field tests were conducted in 1978 and 1979 at Phoenix, Ariz., to evaluate two microbial insecticides, the nuclear polyhedrosis virus (Ac*M*NPV) from the alfalfa looper, *Autographa californica*, and the HD-1 strain of *Bacillus thuringiensis*, for control of cotton leafperforators, *Bucculatrix thurberiella* in cotton. Treating the cotton with a mixture of Ac*M*NPV + *B. thuringiensis* + feeding adjuvant on a *ca* 5-day schedule resulted in the greatest level of control, a 94 % reduction in the number of horseshoe stage larvae on leaves compared with untreated cotton. Reductions in the larval populations due to treatment with *B. thuringiensis* or *B. thuringiensis* + adjuvant ranged from 73 to 86 % in the tests. Treating the cotton with the virus or virus + adjuvant resulted in reductions of larvae on leaves ranging from 36 to 55 %, significantly less than treatments containing *B. thuringiensis*.

M.F. Potter et al. (1982). Influence of sweet bait-Bacillus thuringiensis var. kurstaki combinations on adult tobacco budworm. J. econ. Ent. 75 (6) : 1157-1160

Bacillus thuringiensis var. *kurstaki* was lethal to adults of *Heliothis virescens* when fed to moths in a sucrose solution. Results suggest that spores alone are capable of producing a lethal response, although mortality is enhanced when crystals are present. Sprays of *B. thuringiensis* (1.12 kg/ha) combined with sugar (5.6 kg/ha) were superior to *B. thuringiensis* applied alone or in combination with molasses in reducing longevity and fecundity of adults confined on treated cotton terminals or released onto treated plants in field cages. Reduced fecundity observed in *B. thuringiensis* treatments was apparently a function of shortened adult longevity.

S.P. Nolting & F.L. Poston (1982). Application of Bacillus thuringiensis through center-pivot irrigation systems for control of the southwestern corn borer and European corn borer. J. econ. Ent. 75 (6) : 1069-1073

Center-pivot sprinkler irrigation systems were used during 1978 and 1979 to apply *Bacillus thuringiensis* for second-generation control of the southwestern corn borer, *Diatraea grandiosella*, and European corn borer, *Ostrinia nubilalis*. Although a reduction in larval density and subsequent damage was attained for both species, the suppression was insufficient to warrant commercial use. Reduction of irrigation rates to the minimum attainable with commercial sprinkler systems provided no increase in borer control. Larval development time for *D. grandiosella* was increased from exposure to selected concentrations of *B. thuringiensis* in laboratory studies. This change, however, was of no measurable benefit to corn production in field situations. Although *B. thuringiensis* has many desirable attributes (low mammalian toxicity, etc.) for suppression of *D. grandiosella* and *O. nubilalis* populations when applied through center-pivot irrigation systems, the cost of the pathogen and its low relative efficacy in large quantities of water make it impractical.

A.-S. A. Ali & T.F. Watson (1982). Efficacy of Dipel and Geocoris punctipes against the tobacco budworm on cotton. J. econ. Ent. 75 (6) : 1002-1004

The efficacy of *Bacillus thuringiensis* in combination with *Geocoris punctipes* for control of *Heliothis virescens* on cotton was studied under greenhouse and field cage conditions. Various rates of *B. thuringiensis* (141, 282, 561, and 1121 g/ha) were evaluated in combination with predator densities ranging from one *G. punctipes* nymph per plant to one per four plants. Results indicated potential for good control with rates as low as 282 g of *B. thuringiensis* per ha and one *Geocoris* nymph per four plants.

D.J. Cooper (1983). The susceptibility of Etiella behrii to Bacillus thuringiensis. J. Aust. ent. Soc. 22 (2) : 93-95

A bioassay was carried out to determine the susceptibility of larvae of *Etiella behrii* to *Bacillus thuringiensis*. Third instar larvae were found to be highly susceptible, with an LC_{50} value of 3.11×10^2 viable spores/mm² (6.87×10^1 – 1.45×10^2 : 95 % confidence limits). The results indicate that with appropriate timing of applications, *B. thuringiensis* could be used to control *E. behrii* on seed lucerne crops.

D.L. Hostetter et al. (1982). Laboratory evaluation of adjuvants for use with Baculovirus heliothis virus. J. econ. Ent. 75 (6) : 1114-1119

Formulations of Elcar *(Baculovirus heliothis)* consisting of potential adjuvants were evaluated in standardized laboratory bioassay tests against 24-h-old *Heliothis zea* larvae. A cottonseed flour adjuvant consisting of 62.5 % cottonseed flour, 12.5 % cottonseed oil, 25 % sucrose, and 0.004 % Tween 80 caused significantly higher bioassay mortality rates than the other adjuvants evaluated or than a standard Elcar-water formulation. Evaluation of the individual constituents of this adjuvant indicated that the cottonseed flour or those combinations including cottonseed flour caused significantly higher mortality rates than did either the individual or combinations of cottonseed oil, sucrose or Tween 80. The compatibility and potential of selected gustatory, thixotrophic, protective and surfactant agents indicated that these agents may cause slight inhibition of the insecticidal activity of the formulations. The amount of cottonseed flour in the test formulations was directly related to insecticidal activity ; activity decreased as flour content was reduced from 15 % (highest) to 0.5 % (lowest). Formulations containing 7.5 % cottonseed or soybean flour provided the most consistent mortality rates and represented the upper limit of mixability. No differences in mortality rates occurred among a 7.5 % cottonseed flour, a 7.5 % cottonseed flour hydrolyzate, and a 5 % cottonseed flour formulation, indicating that the active factor(s) is (are) water soluble and is (are) not related to particulate size or content. The addition of various adjuvants to formulations containing Elcar increased bollworm bioassay mortality rates 8 to 10-fold in laboratory tests.

J.A. Shadduck (1983). Some considerations on the safety evaluation of nonviral microbial pesticides. Bull. World Health Org. 61 (1) : 117-128

The tactics and rationale of maximum challenge safety tests for nonviral microbial pesticides have been reviewed. Maximum challenge tests and a tier approach to data collection for regulatory purposes offer the best opportunities to detect the acute effects of entomopathogenic organisms in mammals. Premature condemnation of promising organisms that are based on incomplete results of maximum challenge tests must be avoided. Further investigations should be conducted on the role of mammalian immune response in resistance to entomopathogenic organisms and on the value of medium or long-term exposure tests.

S.K.N. Atuahene & H. Doppelreiter (1982). Histopathological observations on Beauveria bassiana in larvae of Lamprosema lateritialis. Z. ang. Ent. 93 (5) : 456-463

The histopathology of *Beauveria bassiana* in caterpillars of *Lamprosema lateritialis* – a major forest pest of Ghana – was investigated based on scanning electron and light microscopy. Germination of conidia occurred on the notum, primarily during the second day after the percutaneous application of an aqueous suspension. Fungal penetration took place either immediately following germination or later during extensive surface growth. After one week of infection, most tissues and organs of dead as well as living larvae were invaded by vegetative hyphae. The parasitic phase of hyphal growth within the host was accompanied by hemocytic reactions involving severely modified cells. Intensification of the internal fungal development and tissue destruction resulted in hyphal emergence from most body parts during mummification, which was followed by the production of conidia on the cuticle surface.

J.P. Latge et al. (1982). Fatty acid composition of Conidiobolus obscurus depending on the in vivo and in vitro development. J. Invertebrate Path. 40 (2) : 274-278

The fatty acid (FA) composition of *Conidiobolus obscurus* grown in *Acyrthosiphon pisum* is similar to the FA profile of the healthy aphid host. It is very different from the composition of the same fungus grown in artificial media, for both neutral and polar lipids. *In vitro*, the FA composition of *Conidiobolus obscurus* is highly dependent on the carbon source of the nutritive medium.

M. Kucera (1982). Inhibition of the toxic proteases from Metarhizium anisopliae by extracts of Galleria mellonella larvae. J. Invertebrate Path. 40 (2) : 299-300

Two proteolytic enzymes have been isolated from the culture filtrates of *M. anisopliae*. This report describes the action of protease inhibitors from different organs of *G. mellonella* on both isolated enzymes. The principal inhibitor possesses serine-protease inhibitory activity, and the other sulfhydryl-protease inhibitory activity. It is possible that these inhibitors act as a defense mechanism against the pathogen.

R.J. Milner & G.G. Lutton (1983). Effect of temperature on Zoophthora radicans : an introduced microbial control agent of the spotted alfalfa aphid, Therioaphis trifolii. J. Aust. ent. Soc. 22 (2) : 167-173

In vitro growth of *Zoophthora radicans* increased linearly from 10 to 25°C but was reduced at 30°C. Primary spore production from aphid cadavers at 100 % RH was determined after each 4 h interval for 32 h. The largest number of spores was produced at 25°C, with reduced production at 15, 20 and 30°C. No primary spores were formed at 35°C. At 25° C, the first primary spores were discharged during 0 to 4 h but at the other temperatures, this time was increased to 4-8 h. Peak rate of primary spore production occurred between 4 and 8 h at 20 and 25°C and between 12 and 16 h at 15 and 30°C. Mean total primary spore production per aphid at 25°C was 3.7×10^5. *Z. radicans* infected and killed spotted alfalfa aphids at all temperatures tested from 10 to 30°C. At 10°C, the final level of infection was lower than at the other temperatures, the minimum time to kill (2-4 days) was at 25°C. Aphids infected at low temperatures produced mainly resting spores, while at high temperatures, primary spores dominated.

ii) Parasites and Predators

I.W. McLaren & W.J. Rye (1983). The rearing, storage and release of Trichogramma ivelae for control of Heliothis puntiger on tomatoes. J. Aust. ent. Soc. 22 (2) : 119-124

An efficient method was developed for the mass-rearing of *Trichogramma ivelae* on eggs of *Sitotroga cerealella*. Parasitised eggs incubated for 6 d at 27°C with artificial illumination (12:12), and then for 6 or 7 d at 15°C in darkness, yielded active adult parasites after 2 or 1 h, respectively, following exposure to daylight at 23°C. This method was used to provide freshly-emerged parasites for field release. *T. ivelae* was released weekly at a rate of 100,000/ha at 1 site in 1980 and 3 sites in 1981 to combat *Heliothis punctiger* on tomatoes. In the release areas, damage at the first harvest ranged from 0.2-28.9° % infested fruit, a reduction of 98 and 55 %, respectively. It was concluded that the inundative release of *T. ivelae* for control of *H. punctiger* has commercial potential.

B. Pintureau (1982). Discovery of a mutation for vestigial wings in Trichogramma maidis. Ent. exp. appl. 32 (2) : 198-200

The (recessive) mutants have wing stumps of variable size and biological characteristics similar to the wild type or slightly modified (mortality rate, female sterility). A pure line « vestigial » is maintained in the laboratory.

J.H. Brower (1982). Parasitisation of irradiated eggs and eggs from irradiated adults of the Indianmeal moth by Trichogramma pretiosum. J. econ. Ent. 75 (6) : 939-944

Eggs of *Plodia interpunctella* either irradiated with 35, 50, or 100 krad or obtained from irradiated adults (5, 10, 15, or 50 krad), were exposed to adults of the egg parasite, *Trichogramma pretiosum*. In paired host preference tests, eggs irradiated with 35 krad were not preferred to control eggs, but those irradiated with 50 or 100 krad were preferred. Eggs from adults irradiated with 5, 10, or 15 krad were parasitized at the same rate as control eggs, but eggs from 50-krad irradiated adults were significantly less preferred. Eggs irradiated with 50 krad were preferred to eggs from adults irradiated with 50 krad. The data indicate that Indianmeal moth eggs killed by irradiation could be used for the rearing and release of *T. pretiosum* into commodity storages, or alternatively the use of *T. pretiosum* could be combined with the release of substerilized adult moths as part of an integrated control approach for Indianmeal moth population suppression in commodity storages.

W.C. Nettles, Jr et al. (1983). Effect of cations, anions and salt concentrations on oviposition by Trichogramma pretiosum in wax eggs. Ent. exp. appl. 33 (3) : 283-289

K^+, Mg^{2+}, Cl^- and SO_4^{2-} were important components eliciting oviposition by *Trichogramma pretiosum* in aqueous solutions in wax eggs. Ca^{2+} inhibited oviposition in a KCl-$MgSO_4$ solution. The solutions most active in stimulating oviposition were 124.7 – 36.5 and 83.1 – 24.3 mM, respectively, of KCl-$MgSO_4$.

M.R. Strand & S.B. Vinson (1983). Host acceptance behaviour of Telenomus heliothidis toward Heliothis virescens. Ann. ent. Soc. Am. 76 (4) : 781-785

The host acceptance behaviour of *Telenomus heliothidis* in the laboratory was investigated. Host acceptance was broken into seven discreet steps : host encounter, drumming, adoption of drilling posture, probing, drilling, oviposition and marking. Drilling and oviposition accounted for 81 % of the host acceptance time. Females interrupted up to 5 s after initiation of oviposition redrummed the host and completed host acceptance. Females interrupted after initiation of oviposition deposited an egg and exhibited host marking behaviour. The presence of an ovipositing female increased the drumming time of a second female which encountered the same host. The chemical mark of *T. heliothidis* was disregarded if a female was drumming a host when the mark was deposited by another female.

R. Kfir et al. (1983). Laboratory studies of competition among three species of hymenopterous hyperparasites. Ent. exp. appl. 33 (3) : 320-328

Competition tests were carried out in the laboratory among the hyperparasitic wasps *Cheiloneurus paralia, Marietta javensis* and *Pachyneuron concolor*, developing upon the primary parasite *Microterys flavus* in the brown soft scale. In single-species experiments, *Marietta* was the most efficient ; it eliminated the population of the host, whereas *Cheiloneurus* and *Pachyneuron* were not able to do so. In 2-species experiments, *Marietta* completely replaced *Cheiloneurus* within 6 weeks and *Pachyneuron* within 8. *Cheiloneurus* replaced *Pachyneuron* within 20 weeks. In 3-species experiments, *Cheiloneurus* was eliminated within 4 weeks and *Pachyneuron* within 9. During the course of all

experiments, the mortality rate of immature parasites and hyperparasites increased, and progressively more cells failed to give rise to either an adult *Microterys* or a hyperparasite. This was due to host feeding and superparasitism. *Pachyneuron* was able to use *Cheiloneurus* as a host but not vice versa. The superiority of *Marietta* may be partly due to the fact that it is capable of utilizing its competitors as hosts, whereas they cannot develop upon it.

V.K. Dilawari et al. (1981). Role of a braconid parasite and a viral disease in the population decline of armyworm, Mythimna separata during an outbreak. Indian J. Ecol. 8 (1) : 65-73

Field observations were recorded in eight villages during the peak population of the pest. Larval parasitism (*Apanteles ruficrus*, up to 95 %) and viral disease acted as important mortality agents and contributed to sudden decline of the population before the pupal stage and carry over to the next season. Observations in the same localities during 1981 showed that armyworm populations remained much lower except in two fields ; parasitism and disease incidence were also low.

J.M. Cullen & D.C. Hopkins (1982). Rearing, release and recovery of Microctonus aethiopoides imported for the control of Sitona discoideus in south eastern Australia. J. Aust. ent. Soc. 21 (4) : 279-284

The braconid parasite *Microctonus aethiopoides* was imported from Morocco in 1976 and released at sites in S.A. and N.S.W. in 1977 and 1978 for the biological control of *Sitona discoideus*. Rearing, release and recovery methods are described, including techniques necessary to overcome the problems posed by the aestivation of the host. The parasite has become established at several sites and is a promising control agent with a high searching capacity and rapid rate of increase relative to its host.

I.R. Kay (1982). Overwintering by three parasites of Heliothis armigera in southeast Queensland. J. Aust. ent. Soc. 21 (4) : 267-268

Overwintering by *Heteropelma scaposum* (Ichneumonidae), *Carcelia* sp. (Tachinidae) and *Microplitis* sp. (Braconidae), all parasites of *Heliothis armigera*, was observed in 1977 and 1978. *Heteropelma scaposum* and *Carcelia* sp. parasitising *H. armigera* in April and May overwintered in the host pupae and emerged from August to October. *Microplitis* sp. overwintered in cocoons and emerged mainly in August-September. This behaviour coincides with overwintering by *H. armigera*.

J.S. Noyes (1982). A new species of Zeteticontus from Israel and Kenya, a parasite of Carpophilus hemipterus. Bull. ent. Res. 72 (3) : 457-460

Zeteticontus utilis sp. n., an encyrtid parasite of larvae of *Carpophilus hemipterus* and *Urophorus humeralis* in pineapple fields in Kenya and of *C. hemipterus* larvae in decaying fruit in Israel, is described. The parasite has been released in an attempt to control *C. hemipterus* in pineapple fields in Hawaii and is to be released against the same pest in Ohio.

R.J. Madar & J.C. Miller (1983). Developmental biology of Apanteles yakutatensis, a primary parasite of Autographa californica. Ann. ent. Soc. Am. 76 (4) : 683-687

The developmental biology of *Apanteles yakutatensis*, a primary, gregarious, larval endoparasite of *Autographa californica* was investigated. Adult parasites live an average of 18.0 (females) and 16.5 (males) days when fed a 30 % honeywater solution. With water only, adult parasites (both sexes) live an average of 2.5 days. Three larval instars were observed. The first instar is mandibulate, while the others are hymenopteriform. Larvae require 162 degree-days above 10.5°C and pupae 85 degree-days above 9.4°C to complete development. Developmental time from egg to pupa is 10.5 days at 26°C. Host age at parasitization has no significant effect on development times of *A. yakutatensis* at 26°C. However, the host age at parasitization does affect the time required for the host to reach the prepupal phase, the stage from which larvae of *A. yakutatensis* exit the host. Hosts parasitized as fourth instar larvae exhibit a supernumary instar and require a longer time to reach the prepupal stage than do those parasitized as younger instars. Hosts parasitized as first instar larvae died. The number of *A. yakutatensis* larvae per host does not affect the percentage of parasite larvae successfully emerging from an individual host. There is a weak negative relationship between number of parasite larvae per host and mean weight of parasite adults.

R.A. Wharton & F.E. Gilstrap (1983). Key to and status of opiine braconid parasitoids used in biological control of Ceratitis and Dacus s.l. Ann. ent. Soc. Am. 76 (4) : 721-742

A key is presented to the 42 species of opiine Braconidae previously collected in biological control programs directed against *Ceratitis* and *Dacus s.l.* Diagnostic features and present nomenclatural status are also discussed for these species. *Biosteres oophilus* is treated as a synonym of *Biosteres arisanus*, and *B. watersi* as a synonym of *B. dacusii*.

K.V. Yeargan (1983). Effects of temperature on development rate of Trissolcus euschisti, a parasite of stink bug eggs. Ann. ent. Soc. Am. 76 (4) : 757-760

The effects of seven constant temperatures, ranging from 15 to 33°C, on the rate of development and emergence of *Trissolcus euschisti* were determined, using *Podisus maculiventris* eggs as hosts. The effects of two fluctuating temperature regimes also were studied. Males developed faster than females, and both sexes developed successfully from egg to adult emergence at constant temperatures ranging from 18 to 33°C. Although neither sex emerged as adults at a constant temperature of 15°C, both sexes emerged successfully under the fluctuating regimes of 14°C/22°C and 21°C/33°C. The low and high constant temperatures used in this study reduced the percentage of successful emergence of adult parasites. Developmental rates and other biological characteristics of *T. euschisti* are compared with those of *Telenomus podisi*, a sympatric scelionid parasite of pentatomid eggs.

C.G. Jackson & H.M. Graham (1983). Parasitism of four species of Lygus by Anaphes ovijentatus and an evaluation of other possible hosts. Ann. ent. Soc. Am. 76 (4) : 772-775

Eggs of the four species of *Lygus* that are important agricultural pests in the United States (*L. hesperus, L. lineolaris, L. elisus* and *L. desertinus*) were all heavily

parasitized by the mymarid *Anaphes ovijentatus*. Under laboratory conditions, *L. desertinus* was the most suitable host, whereas *L. elisus* was the least suitable. Eggs of *Nabis* spp. were seldom parasitized, nor were those of the threecornered alfalfa hopper, *Spissistilus festinus*. Two mirids collected from weeds in southern Arizona, *Polymerus basalis* and *Taedia marmoratus*, were added to the host list. The predaceous mirid, *Deraeocoris brevis*, was parasitized in the laboratory, and thus is a potential host in the field.

D.L. Evans (1983). Relative defensive behaviour of some moths and the implications to predator-prey interactions. Ent. exp. appl. 33 (1) : 103-111

Certain cryptic, palatable moths in the families Noctuidae, Notodontidae, Pyralidae and Sphingidae exhibited responses of apparently protective value 78-100 % of the time when touched on the dorsal wing surface. No interaction between the shape of the tactile stimulus and the elicited responses was found. Frequency of response to ventral wing touch was less than 40 % with the 2 noctuid species tested in this manner. Aposematic, distasteful moths in the families Arctiidae, Ctenuchidae, Yponomeutidae, exhibited behaviours of potentially defensive value 10-52 % of the time when touched on the dorsal wing surface. The unpalatable moths had higher thresholds for release of protective behaviour. Members of both groups exhibited angled flights, straight flights, dropping with catalepsis (i.e. « playing-dead »), and no visible response, but with the frequencies of these responses significantly different. Only certain unpalatable species produced a display without flight or dropping after the tactile stimulus. Flight durations and types were very variable. The mode of the flight durations elicited in palatable moths was 0.8 s but 0 s in unpalatable moths. Then the palatability of each moth species was determined using local wild-caught and hand-reared birds. Common grackles *(Quiscalus quiscula)* seemed more likely to accept moths unpalatable to other birds. There may be broad correlations between taxonomic groupings and the total defensive ensemble present in a moth. However, convergent strategies between phylogenetically unrelated moth species were observed.

W.P.J. Overmeer & A.Q. Van Zon (1983). The effect of different kinds of food on the induction of diapause in the predaceous mite Amblyseius potentillae. Ent. exp. appl. 33 (1) : 27-30

Colonies of the predatory mite, *Amblyseius potentillae*, fed on different kinds of food responded differently to short-day photoperiods with respect to entering diapause. Photoperiodic induction of diapause was normal in predators fed on wild type spider mites, *Tetranychus urticae*, or on pollen of ice-plant, *Dorotheanthus bellidiformis* (= *Mesembryanthemum criniflorum*), whereas predators fed on pollen of broad bean, *Vicia faba*, did not enter diapause. If ß-carotene was added to the pollen of broad bean, normal incidence of diapause was found.

S.V. Rajakulendran & F.W. Plapp Jr (1982). Synergism of five synthetic pyrethroids by chlordimeform against the tobacco budworm and a predator, Chrysopa carnea. J. econ. Ent. 75 (6) : 1089-1092

Five synthetic pyrethroids were tested alone and in combination with chlordimeform (CDF) for toxicity to *Heliothis virescens* and *Chrysopa carnea*. Insecticides-CDF combinations were highly synergistic against the tobacco budworm (TBW) with synergism levels ranging from 7 to 63-fold. CDF alone was highly toxic to *C. carnea*. All pyrethroid-CDF combinations were highly selective against the TBW except for phenothrin-CDF, and the degree of selectivity was greater at the LC_{90} than the LC_{50}. Based on these data, pyrethroid-CDF combinations may play an effective role in integrated pest management programs for TBW on cotton.

D. Jones et al. (1983). Can insecticides be integrated with biological control agents of Trichoplusia ni in celery ? Ent. exp. appl. 33 (3) : 290-296

Several registered and experimental insecticides were tested on a celery pest and one of its important predators for selectivity in favour of predator survival. The 1st, 3rd and last instars of the cabbage looper, *Trichoplusia ni*, and the 2nd-instar and adult of coccinellid predator *Hippodamia convergens* were tested with residues of methomyl, demeton, fenvalerate, diflubenzuron and penfluron. These insect stages were also tested against diflubenzuron and penfluron in residue-ingestion experiments. The latter two insecticides, which are benzoylphenyl urea insect growth regulators, offered the greatest selectivity. Adult predators suffered no acute toxic effects, while 2nd-instars approached equal tolerance with the most susceptible *T. ni* instars. Trends in populations of the pest and predator in celery fields indicated that predators were most abundant prior to the first marketable petiole, and that use of IGRs during this time would provide the greatest potential for integration of chemical and biological control.

iii) Behavioural Means

M.W. Sabelis & H.E. van de Baan (1983). Location of distant spider mite colonies by phytoseiid predators : demonstration of specific kairomones emitted by Tetranychus urticae and Panonychus ulmi. Ent. exp. appl. 33 (3) : 303-314

Phytoseiulus persimilis and *Metaseiulus occidentalis* are efficient predators of the two-spotted spider mite, *Tetranychus urticae*, *Amblyseius potentillae* and *Amblyseius finlandicus* are known to effectively control the European red spider mite, *Panonychus ulmi*. Experiments in a Y-tube olfactometer showed that these phytoseiids can walk upwind towards the far end of the arm containing air blown over leaves infested by their prey. Hungry females of *P. persimilis* and *M. occidentalis* reacted positively to the odour stream coming from bean leaves infested by *T. urticae* and they did not react to the air stream blown over apple leaves infested by *P. ulmi*. The reverse was the case for hungry females of *A. potentillae* and *A. finlandicus*. For a significant response it was necessary to use hungry predators, except for *P. persimilis*. Moreover, it was essential to use a sufficiently large number of spider mite infested leaves. The response of the predators was still significantly positive to the odour coming from infested leaves that had the spider mites removed. By one day after removal, there was no such positive response. Evidently, two-spotted spider mites and European red spider mites emit different chemicals that function as kairomones to particular phytoseiid predators. Based on our present knowledge of the defense mechanisms of these tetranychid mites, it is hypothesized that phytoseiid predators select particular tetranychid species so as to maximize their reproductive success.

P.B. Baker et al. (1982). Monitoring of diamondback moth in cabbage with pheromones. J. econ. Ent. 75 (6) : 1025-1028

Studies were conducted in commercial and research cabbage fields during 1979-1980 to determine the potential of pheromone trapping for monitoring *Plutella xylostella* and determining subsequent larval population trends. Adult catches within fields indicated that seasonal trends were similar between traps on the border and those in the center, despite variation between trap counts. Differences between nearby plantings indicated that each field should be evaluated and treated independently. Peak flights for both seasons, as determined by pheromone catches, corresponded with those predicted by day-degree accumulations. In 40 % of the sampled fields for 1979-1980, adult catches correlated with subsequent larval populations which occurred 11 to 21 days later.

S.E. van Vorhiskey & T.C. Baker (1982). Trail pheromone-conditioned anemotaxis by the Argentine ant, Iridomyrmex humulis. Ent. exp. appl. 32 (3) : 232-237

Odour-conditioned anemotaxis was exhibited by Argentine ant workers, *Iridomyrmex humulis*, to sources of the major trail pheromone component, (Z)-9-hexadecenal (Z9-16 : ALD). More ants oriented toward and successfully located point or permeated-field sources of Z9-16 : ALD in wind than in still air. Trail pheromone-conditioned anemotaxis may effectively increase the communication distance of the trail beyond that allowed by chemotaxis alone.

P. Palaniswamy et al. (1982). Mating suppression of caged spruce budworm moths in different pheromone atmospheres and high population densities. J. econ. Ent. 75 (6) : 989-993

High densities of laboratory-reared *Choristoneura fumiferana* were placed in cages, surrounded by synthetic pheromone emitters, in a temperate conifer forest. Compared to controls, mating was suppressed for 3, 6, 12 pairs, and 12 males and 6 females per cage for release rates of 20 to 80 mg/h per ha. For the two highest population densities, mating suppression increased linearly with increase in pheromone concentration. As population density increased, at low pheromone concentration, mating suppression decreased, but at high concentration, mating suppression was unchanged. Changes in olfactory sensitivity and random encounters may explain part of these results. Also, female activity may explain some of the mating disruption at high pheromone concentrations.

W.G. Thwaite & H.F. Madsen (1983). The influence of trap density, trap height, outside traps and trap design on Cydia pomonella captures with sex pheromone traps in New South Wales apple orchards. J. Aust. ent. Soc. 22 (2) : 97-99

In order to standardize the use of sex pheromone traps for *Cydia pomonella* population monitoring in apple orchards, the influence of trap design, trap density, trap height and the use of outside traps were evaluated. The commercial Zoecon ICP trap was more efficient than a triangular shaped metal trap. Traps at a density of 1 per ha were adequate to estimate *C. pomonella* populations. Traps in the upper third of apple trees caught more moths than traps at head height when the 2 were in direct competition. When the high traps were removed, however, the low traps caught nearly as many moths as both high and low traps combined. Outside traps greatly reduced the movement of moths into monitored sites and also indicated the source of migrating moths.

G.L. Collmann & J.N. All (1982). Biological impact of contact insecticides and insect growth regulators on isolated stages of the greenhouse whitefly. J. econ. Ent. 75 (5) : 863-867

Greenhouse experiments revealed efficacy of 11 insecticides (two organophosphates, two formulations of a synthetic pyrethrin, two pyrethroids, three juvenile hormone analogues and two moult inhibitors) on an asynchronous population of *Trialeurodes vaporariorum*. To determine the mechanism of chemical control, it was necessary to study the susceptibility of seven discrete greenhouse whitefly stages to four of the insecticides in an environmental chamber. Permethrin was the most effective toxicant through its broad activity on whitefly life stages. Penncapthrin (microencapsulated resmethrin) was effective against 2nd and 3rd instars and had some activity against adults, but it allowed substantial adult emergence after the treatment of eggs, first-stage larvae or pupae. Enstar (juvenile hormone analogue, Prop-2-ynyl, 3, 7, 11-trimethyl 2, 4-dodecadienoate) controlled 2nd, 3rd, and early-pupal instars but was ineffective on eggs, first-stage larvae, pupae and adults. Diflubenzuron had no substantial effects on any stage. The nature of the toxicity of permethrin, Penncapthrin, and Enstar was of an immediate toxicity or a toxicity delayed to a subsequent immature stage. No toxicant produced adult sterility or affected longevity or fecundity.

R.A. Steinbrecht (1982). Electrophysiological assay of synthetic and natural sex pheromones in the African armyworm moth, Spodoptera exempta. Ent. exp. appl. 32 (1) : 13-22

Sensilla trichodea, with porous walls and two receptor cells, are the most abundant sensilla on the antennae of male *Spodoptera exempta*. Two synthetic pheromone components, Z-9-tetradecen-1-yl acetate (Z-9-TDA) and Z-9, E-12-tetradecadien-1-yl acetate (Z-9, E-12-TDDA), produced identical electroantennogram (EAG) responses with male antennae, and strong stimuli of either compound were found to adapt the response to the other compound. When nerve impulses were recorded from single sensilla trichodea, Z-9, E-12-TDDA usually was the key stimulus, Z-9-TDA being over hundred times less effective, but some receptor cells were equally sensitive to both compounds. The female pheromone gland was located in the ventral intersegmental membrane between the 8th and 9th abdominal segment. Measured by male EAG responses, the crude hexane extract of one female gland, on the average, was equivalent to 5 ng of Z-9-TDA or Z-9, E-12-TDDA. Individual variation, however, was extreme even between females of the same lot and age, and there were no significant differences in pheromone content between females of different age and physiological conditions.

L.J. Dapsis & D.N. Ferro (1983). Effectiveness of baited cone traps and coloured sticky traps for monitoring adult cabbage maggots : with notes on female ovarian development. Ent. exp. appl. 33 (1) : 35-42

During 1979, sticky-coloured stakes and baited cone traps were effective in monitoring 1st- and 2nd-generation adult

cabbage maggots. Baited cone traps were not effective after August 8, 1979, which appeared to be due to the increased amount of host material in the field. Male flies were attracted most to white and federal safety yellow coloured stakes while females were attracted most to federal safety yellow and 659 yellow. There was no relationship between the stage of female ovarian development and stake colour. In 1981, baited cone traps were placed outside the periphery of cruciferous plantings to reduce competition between host crop and traps. At a commercial farm, cone traps were very effective in detecting periods of adult activity. When properly used, baited cones are more effective overall than coloured sticky stakes.

K. Slama et al. (1983). Insect sterility induced by a broad-spectrum antiviral agent (S)-9-(2,3-dihydroxypropyl) adenine. Ent. exp. appl. 33 (1) : 9-14

Oral administration of 0.2 to 2.0 mg. g^{-1}, 24 h^{-1} of the antiviral nucleoside analogue (R,S)-9-(2,3-dihydroxypropyl) adenine in drinking water induced a dose-dependent suppression of the fecundity or complete sterility in adult females of the hemipteran insects *Pyrrhocoris apterus* and *Dysdercus cingulatus*. Smaller doses (0.01 to 0.5 mg. g^{-1}. 24 h^{-1}) administered to adult females caused sterility of the eggs, which was due to the disturbances of embryonic development. The egg sterility was fully reversible whereas an irreversible sterility of the females treated with larger doses of the drug was due to morphological aberrations in the ovaries. The fertility of adult females as well as growth and development of the young larval instars were not affected. There were strong inhibitory effects on proliferation and differentiation of the somatic tissues during metamorphosis. It has been emphasized that a possible mode of action of this compound may be substantially different from the common alkylating principle of other chemosterilants.

R.J. Steffens (1983). Combination of radiation and translocation-induced sterility for genetic control of fruit flies. Ent. exp. appl. 33 (3) : 253-258

Substerilizing irradiation doses together with inherited partial sterility due to translocations might be, in the long term, more effective than the Sterile Insect Technique. The « Combi-Fly » concept proposed here, integrates moderate radiation doses and inherited sterility to achieve actual control and introduce high genetic load in the field. Data on the sterility and quality of Combi-Flies are reported.

C.A.M. Campbell (1983). Antibiosis in hop (Humulus lupulus) to the damson-hop aphid, Phorodon humuli. Ent. exp. appl. 33 (1) : 57-62

Antibiosis to hop aphid was studied using three hop cultivars. Apterae were reared on Tolhurst (T), Fuggle (F) and Northern Brewer (NB) at 20, 25 and 15-20°C. At 20°C, aphids on T were smaller, less fecund, died younger, and had lower innate capacities for increase (r_m) than aphids on NB and F. At 25°C, aphids were smallest on NB but produced the most offspring. The second generation of aphids at 25°C was slower developing, smaller and suffered 38 % more larval deaths than their parents' generation. At 15-20°C, aphids produced fewest offspring on F. In all experiments, aphids had the highest r_m on NB. A logistic model of aphid population growth, incorporating leaf areas expanding linearly, showed that the susceptibility of NB to aphids may be masked by a relatively faster rate of increase in leaf areas on that cv. compared with T.

M.B. Dimock & G.G. Kennedy (1983). The role of glandular trichomes in the resistance of Lycopersicon hirsutum f. glabratum to Heliothis zea. Ent. exp. appl. 33 (3) : 263-268

Removal of the glandular trichome exudate from leaflets of the wild tomato *Lycopersicon hirsutum* f. *glabratum* PI 134417 by swabbing with ethanol resulted in loss of resistance to larvae of the tomato fruitworm *(Heliothis zea)*. An extract containing the exudate and little else was toxic to first-instar fruitworm larvae. Gas chromatographic analysis of extracts containing only the excised tips of the glandular trichomes revealed the presence of 2-tridecanone, a compound toxic to *H. zea* and other arthropods. The toxin was found to be nearly absent from the leaflet interior, being present in significant quantities only in extracts of leaflet surfaces. *H. zea* larvae were killed by fumes from the surface extract and from pure 2-tridecanone. The air surrounding PI 134417 leaflets was found to be rich in 2-tridecanone vapors. Fumigant action is a major avenue of their exposure to 2-tridecanone on the foliage of PI 134417. While larvae are quickly immobilized by fumes when placed on resistant leaflets, most recover within 24 h, casting doubt on 2-tridecanone as the sole defensive compound in PI 134417 against *H. zea*.

D.K. Reed et al. (1982). Insecticidal and antifeedant activity of neriifolin against codling moth, striped cucumber beetle and Japanese beetle. J. econ. Ent. 75 (6) : 1093-1097

Neriifolin, a known cardiotonic glycoside isolated from seeds of the yellow oleander, *Thevetia thevetioides*, was active both as a toxicant and feeding deterrent to the striped cucumber beetle, *Acalymma vittatum*, in laboratory and greenhouse studies. Protection of treated cantaloupe plants from feeding beetles was afforded for 7 days, and application through the roots indicated a systemic action. Against the codling moth, *Laspeyresia pomonella*, neriifolin retarded growth and caused greater than 70 % mortality of insects when fed diet treated with 3 ppm as neonate larvae. Effectiveness extended into the F_1 generation, causing decreased oviposition and egg hatch at all concentrations tested. It also acted as a contact toxicant with 100 % mortality at dosages greater than 50 mg/ml on young larvae. Neriifolin provided protection for 5 days on soybeans acting as a feeding deterrent against the Japanese beetle, *Popillia japonica*.

R.W. Mwangi (1982). Locust antifeedant activity in fruits of Melia volkensii. Ent. exp. appl. 32 (3) : 277-280

Melia volkensii fruit kernels contain antifeedant activity against *Schistocerca gregaria* nymphs and adults. Feeding activity is reduced markedly after 2nd-instar nymphs receive topical treatment with a 2 % aqueous solution of *M. volkensii* fruit kernel extract or when such extract is added to locust diet. The resulting feeding inhibition produces very poor relative growth, prolonged intermoult periods and high mortality, especially during ecdysis. Disturbances in haemolymph total carbohydrate and total lipid concentrations, almost similar to those observed during starvation in adult locusts, are also observed.

E.M. Tukahirwa & T.H. Coaker (1982). Effect of mixed cropping on some insect pests of brassicas : reduced Brevicoryne brassicae infestations and influences on epigeal predators and the disturbance of oviposition behaviour in Delia brassicae. Ent. exp. appl. 32 (2) : 129-140

Intercropping brassicas with taxonomically unrelated plant species reduced infestations of the aphid *Brevicoryne brassicae* and the rootfly *Delia brassicae* by over 60 % compared with those on brassicas grown in pure stand. Twice as many carabid and staphylinid predators of the immature stages of the rootflies were trapped on intercropped than on *Brassica* areas, but when they were excluded, similar reductions in rootfly eggs occurred suggesting that predation was not an important factor suppressing rootflies in intercrops. Similar numbers of female *D. brassicae* entered mixed stands, indicating that the response of the flies to host-plant stimuli was not disturbed by non-host plants. Flies were more active in the laboratory in mixed plantings than in stands of host plants or of non-host plants with host-plant odour blown over them, and their rate of departure from these treatments was correlated with their activity. Oviposition by *D. brassicae* was reduced in mixed stands. The proximity of host and non-host plants influenced the diversionary effects of the non-host plants on oviposition behaviour, so that when 50 cm apart or less, maximum reduction in oviposition occurred. Single row-intercropping, therefore, appears to be the best arrangement of plants for reducing rootfly attack and was most effective when the intercrop provided at least 50 % ground cover between the rows at the time of pest invasion.

iv) Techniques

N. Rishikesh & G. Quelennec (1983). Introduction to a standardised method for the evaluation of the potency of Bacillus thuringiensis serotype H-14 based products. Bull. W.H.O. 61 (1) : 93-97

Vector resistance and other constraints have necessitated consideration of the use of alternative materials and methods in an integrated approach to vector control. *Bacillus thuringiensis* serotype H-14 is a promising biological control agent which acts as a conventional larvicide through its delta-endotoxin (active ingredient) and which now has to be suitably formulated for application in vector breeding habitats. The active ingredient in the formulations has so far not been chemically characterized or quantified and, therefore, recourse has to be taken to a bioassay method. Drawing on past experience and through the assistance mainly of various collaborating centres, the World Health Organization has standardized a bioassay method (described in the Annex), which gives consistent and reproducible results. The method permits the determination of the potency of a *B.t.* H-14 preparation through comparison with a standard powder. The universal adoption of the standardized bioassay method will ensure comparability of the results of different investigators.

L.E. Volkman et al. (1982). Generalised immunoassay for Autographa californica nuclear polyhedrosis virus infectivity in vitro. Appl. Environ. Microbiol. 44 (1) : 227-233

A quantitative *in vitro* immunoassay for the infectivity of *Autographa californica* nuclear polyhedrosis virus was developed and performed in six different lepidopteran cell lines. The assay was not dependent upon cytopathic effect or polyhedron production, but rather upon viral antigen production and its recognition in a peroxidase-antiperoxidase staining procedure. The importance of using such an assay for accurately assessing infectivity in cell lines which produce polyhedra inefficiently was demonstrated. Differences among the cell lines in sensitivity to viral infection were clearly shown. Differences in the time required to produce infectious progeny were also noted among cells of the same cell line.

S.N. Thompson et al. (1983). Artificial culture of the insect parasite Pachycrepoideus vindemiae. Ent. exp. appl. 33 (1) : 121-122

Complete in *vitro* culture from egg to adult was obtained. Development required about 2 weeks under the artificial conditions at 30°C. Both male and female adults were obtained. These appeared normal but were slightly smaller than those reared on host material. However, insects reared *in vitro* were short-lived and fecundity was not determined.

J. Taylor et al. (1982). A light-trap with upwardly directed illumination and temporal segregation of the catch. Bull. ent. Res. 72 (4) : 669-673

The construction and functioning of a light-trap designed to catch only insects in flight at a height of greater than 5.5 m is described. The trap segregates the catch into hourly samples throughout the night.

L.R. Zavaleta & B.L. Dixon (1982). Economic benefits of Kalman filtering for insect pest management. J. econ. Ent. 75 (6) : 982-988

The efficiency and potential economic gains of filtering techniques for pest management problems are demonstrated by applying them to a life cycle model of the bean leaf beetle, *Cerotoma trifurcata*. The Kalman filter estimator utilized combined information from sample data with a model of a dynamic system to obtain estimates of the current state of the system. The sample data were obtained by a two-stage sampling scheme. Specifically, the west-southwest district of Illinois was the area of concern. Four primary sampling units (PSU) were chosen, and from each PSU, 10 samples were drawn. This process was repeated four times throughout the 1980 growing season. For the particular data set considered, use of a model of bean leaf beetle dynamics results in substantial gains in estimate efficiency and a reduction in the number of fields required to be sampled.

W.D. Guthrie (1982). Mass-rearing of crop pests with emphasis on stem and pod-borers. Insect. Sci. Appl. 3 (2/3) : 89-96

This paper reviews work on techniques in mass rearing of insect pests, especially stem and pod-borers. The account covers advances in rearing of insects on native host plants and on artificial diets and possible ways of use of these insects in host plant resistance research.

R.J. Wood & L.M. Cook (1983). A note on estimating selection pressures on insecticide-resistance genes. Bull. W.H.O. 61 (1) : 129-134

It is useful to be able to measure selection pressures acting on resistance genes in insect vectors of disease, since it is thus

possible to predict future changes in frequency and to consider ways to minimize development of resistance. This note describes a method for estimating the selection coefficients, given two or more post-selection phenotype frequencies and knowing the number of generations between them. The method is applied to published data on *Anopheles labranchiae* under selection with DDT. The relative fitness (1-s) of the susceptibles compared with resistants was estimated by this method to be 31-38 %. This was an annual estimate, but if the number of generations per year is known, it is also possible to calculate a value per generation. A computer program for making these estimates is given. The calculations depend on the gene being effectively recessive, i.e. on the heterozygote being killed by the dose applied in the field. Another approach to estimation of selection is by determining the deviation in gene frequency from the Hardy-Weinberg expectations. By this method, the relative fitness (1-s) of the susceptibles in a population of *A. funestris* under dieldrin selection in the north of the United Republic of Cameroon has been estimated to be 40 %. There are difficulties with this method, however, because population mixing may result in deviations that mimic the effect of selection. Examples are discussed for *A. gambiae*, where population mixing may occur and heterozygote deficiencies for the dieldrin resistance gene have been observed. For both methods of estimation, it is essential to know the real effective dominance of the resistance gene in the wild, i.e. whether the resistance heterozygote is killed or not. This factor is important in the control of resistance.

L. Lambert et al. (1982). Greenhouse technique for evaluating resistance to the bandedwinged whitefly used to evaluate thirty-five foreign cotton cultivars. J. econ. Ent. 75 (6) : 1166-1168

A greenhouse procedure was developed for maintaining a culture of *Trialeurodes abutilonea* on cotton, *Gossypium hirsutum*. One US and 35 foreign cotton cultivars were evaluated for relative levels of resistance or susceptibility to bandedwinged whitefly colonization and emergence of adults. When compared with the commercial cultivar « Deltapine 16 » (DPL-16), one foreign cotton, « C-1211 » had significantly ($P = 0.05$) lower levels of whitefly colonization. Six foreign cultivars, « Lasani 11 », « M4 (N.T. Sind) », « 4S 180 », « CX 349 », « 138-F » and « 108-F » had levels of colonization that were not significantly different from DPL-16. None of the cultivars had significantly less adult emergence than DPL-16, and 17 had adult emergence levels that were not significantly different.

K.S. Pike & M. Glazer (1982). Strip rotary tillage : a management method for reducing Fumibotys fumalis in peppermint. J. econ. Ent. 75 (6) : 1136-1139

Strip rotary tillage, a cultivation practice consisting of alternating strips (30 to 50 cm wide) of tilled and nontilled mint, was evaluated to determine its effect on *Fumibotys fumalis*, a serious rhizome borer of peppermint, *Mentha piperita*, in the Pacific Northwest. Paired comparisons were made over a 2-year period (1980 and 1981) with standard-grown, solid-stand peppermint and peppermint subjected to strip rotary tillage. The results showed that tillage significantly reduced pest populations by *ca* 81 %, without causing agronomic injury to the crop. The method, although not new, is used currently by only a small number of growers. Its value has been in rejuvenating mint stands, establishing irrigation furrows, and controlling weeds. The new findings here provide another advantage of the method for growers confronted with the rhizome borer.

2. CONTROL OF WEEDS

T.J. McAvoy et al. (1983). Biological studies of Ceutorhynchus punctiger on dandelion in Virginia. Ann. ent. Soc. Am. 76 (4) : 671-674

Development of *Ceutorhynchus punctiger*, a weevil which feeds on dandelion seeds, was studied in relation to the phenology of dandelion in Virginia. Eggs were observed from when the flower bud rays were white (1st week of April) until the flower closed and the rays were dry and brown (2nd week of May). There were 3 instars ; mean duration of the 1st, 2nd, and 3rd instars was 4.7, 3.7 and 29.2 days, respectively. First instars were initially detected when the bud's outer sepals were open (1st week of April), 2nd instars midway through the open flower stage (4th week of April) and 3rd instars at the beginning of the stage when the flower closed and rays were dry and brown (4th week of April). Pupation occurred in the soil, the pupal stage averaged 14.2 days. Seed consumption/larva was 19.0 ± 8.9 from a mean of 157.4 ± 40.1 seeds/dandelion flower. Adults fed on leaves lived for an average of 96.5 weeks ; there was no significant difference between sexes. Adult feeding had minimal impact on dandelion seed production.

b) Public Health

R.E. McLaughlin et al. (1982). Effectiveness of Bacillus thuringiensis serotype H-14 against Anopheles crucians. Mosquito News 42 (3) : 370-374

Bacillus thuringiensis (var. *israelensis*) serotype H-14 was tested for efficacy against *Anopheles crucians* larvae in small ponds at a golf course, a woodland lake and along the edge of a rice field. Two commercial formulations were tested ranging from 0.25 to 6.0 kg/ha (1.5×10^8 to 3.0×10^9 International Toxic Units/ha). The higher rates ($1.8 - 3.0 \times 10^9$ I.T.U./ha) reduced larval counts 80-100 % in most tests. The lowest rates were always less effective. Variability between test plots was large. Differences in larval reduction between application rates were not statistically significant.

L.A. Lacey & S. Singer (1982). Larvicidal activity of new isolates of Bacillus sphaericus and Bacillus thuringiensis (H-14) against anopheline and culicine mosquitoes. Mosquito News 42 (4) : 537-543

Two isolates of *Bacillus sphaericus* (2013-4 and 2013-6) and one of *B. thuringiensis* H-14 (2013-9) from Romania were bioassayed in the laboratory against several species of culicine and anopheline mosquitoes. Second instars of *Culex quinquefasciatus, Anopheles albimanus, An. quadrimaculatus* and *Aedes triseriatus* exposed for 48 h to the 2013-4 isolate responded with LC_{50} values of 0.0015, 0.0187, 0.0527 and 0.0941 ppm of lyophilized primary powder respectively. Preliminary tests with 2013-4 against *Psorophora columbiae* indicated an LC_{50} of 0.0046 ppm. Similar results were obtained for the 2013-6 isolate against *Cx. quinquefasciatus, An. albimanus* and *An. quadrimaculatus*. Fourth instars of *Cx. quinquefasciatus, Ae. aegypti, An. albimanus, An. quadrimaculatus* and *Ae. triseriatus* exposed to a lyophilized primary powder of the *B. thuringiensis* isolate for 24 h responded with LC_{50} values of 0.061, 0.074, 0.095, 0.161 and 0.151 ppm, respectively. Exposure of fourth instars of *Ae. triseriatus* to 0.25, 0.5 and 1.0 ppm of 2013-9 *in situ* and subsequent incubation in the lab resulted in 34, 88 and 96 % mortality respectively. In comparative tests of Bactimos ®

primary powder, and 2013-9, relative toxicities of 5337, and 2345 ITU/mg were obtained. The *B. sphaericus* isolates compared favourably to other efficacious isolates reported in the literature.

T.O. Mitchell & C.J. Mitchell (1982). Susceptibility of Aedes pseudoscutellaris and Aedes polynesiensis to infection by Romanomermis culicivorax in the laboratory. Mosquito News 42 (3) : 396-400

The susceptibility of Fijian *Aedes pseudoscutellaris* and *Ae. polynesiensis* to infection with the mermithid nematode, *Romanomermis culicivorax*, was assessed under controlled laboratory conditions. Both mosquito species were equally susceptible to infection. Infection rates in fourth instar larvae, following exposure to infection as first instars, ranged from 88 to 96 % at a treatment ratio (worms : mosquito) of 5:1. Infection rates were 98 % in *Ae. polynesiensis* and 100 % in *Ae. pseudoscutellaris* at a treatment ratio of 10:1, and 100 % in both species at a ratio of 20:1. These are the first data available on the susceptibility of *Ae. pseudoscutellaris* to infection by *R. culicivorax*. Data presented could provide a baseline for determining dosage rates for field trials, should attempts be made to control these mosquitoes with *R. culicivorax*.

T.L. Merriam & R.C. Axtell (1982). Evaluation of the entomogenous fungi Culicinomyces clavosporus and Lagenidium giganteum for control of the salt marsh mosquito, Aedes taeniorhynchus. Mosquito News 42 (4) : 594-602

In laboratory tests, *Culicinomyces clavosporus* gave similar control (*ca* 55 %) of *Aedes taeniorhynchus* larvae in small containers partially filled with either dredged-spoil (1.8 ppt water salinity) or soil from an upland site (0 ppt water salinity) after 3 days when applied at 1×10^5 conidia/ml. When applied at a rate of 5×10^4 conidia/ml to 5 liters of distilled water in large containers filled with either soil type, *C. clavosporus* resulted in *ca* 45 and 86 % control of *Ae. taeniorhynchus* larvae at days 1 and 5 postreatment, respectively. Mortality of mosquito larvae in sentinel cages in the large containers of both soil types was 93 % at 5 days posttreatment. In field tests *C. clavosporus* conidia and hyphae applied at a rate of 1×10^{10} conidia/m^2 to the surface of salt marsh pools (water salinities ranged from 10.0 to 13.2 ppt) produced 100 % mortality of field-collected, 2nd instar *Ae. taeniorhynchus* larvae in sentinel cages in 3 of 5 treated pools within 24 h after application, and 98 % mortality of larvae in sentinel cages from the remaining pools within 72 h posttreatment. Dissection and microscopic examination of larvae in laboratory and field tests confirmed infection by *C. clavosporus*, but in the field tests, most larvae died before there was extensive mycelial growth of *C. clavosporus* in the haemocoel. *Lagenidium giganteum* did not infect *Ae. taeniorhynchus* larvae in laboratory tests conducted in different-sized containers filled with dredged-spoil (water salinity ranged from 1.6 to 1.9 ppt) and a field test in enclosures in a salt marsh pool (10.0 ppt water salinity).

W.A. Ramoska (1982). An examination of the long-term epizootic potential of various artificially introduced mosquito larval pathogens. Mosquito News 42 (4) : 603-607

The potential for long-term mosquito larval reduction by *Bacillus thuringiensis* serotype H-14, *B. sphaericus* and *Metarhizium anisopliae* was tested using laboratory simulations of flooded field breeding sites. Results showed that the capability of either bacterial species to reduce larval numbers was lost as early as 1 month after bacterial inoculation. Replicates receiving the fungal pathogen did show reduced mosquito emergence up to 150 days after fungus introduction, but by day 224, mosquito populations were not affected.

J.P. Spencer & J.K. Olsen (1982). Evaluation of the combined effects of methoprene and the protozoan parasite Ascogregarina culicis on Aedes mosquitoes. Mosquito News 42 (3) : 384-391

Mortality rates for test populations of *Aedes aegypti* were significantly increased with increases in concentrations of methoprene in the larval rearing media from 1.0 ppb (28 % average mortality) to 10 ppb (84 % average mortality). The mortality rates were not significantly changed when the protozoan parasite, *Ascogregarina culicis*, was used in combination with either concentration of methoprene against *Ae. aegypti* larvae. In contrast, mortality rates for *Ae. epactius* were not only significantly increased with increases in methoprene concentrations from 0.001 ppb (13 % average mortality) to 0.01 ppb (53 % average mortality), but also, the mortality rates at each IGR concentration were significantly higher when *Ae. epactius* larvae were first exposed to sporocysts of *A. culicis* and then to the IGR. Average mortality rates in this latter case ranged between 73 and 82 %. The combined effects of *A. culicis* and methoprene on the mortality rates for *Ae. epactius* appear to be additive. Methoprene appears to have no significant effect either on the infectivity of the sporocyst stage of *A. culicis* or on the level of parasitism that can be established by this parasite in *Ae. aegypti* and *Ae. epactius* populations.

W.K. Reisen et al. (1982). Attempted suppression of a semi-isolated Culex tarsalis population by the release of irradiated males : a second experiment using males from a recently colonised strain. Mosquito News 42 (4) : 565-576

Approximately 85,000 radiosterilized males from a newly established colony of *Culex tarsalis* were marked with fluorescent dust and released in a semi-isolated canyon in the arid Sierra Nevada foothills of Kern County, California, during the spring of 1981. Relative abundance and sterility were monitored in the test canyon and 2 adjacent comparison canyons. Radiosterilized males survived well, dispersed throughout the test canyon and comprised 30 % of all males collected. The 11 % sterility introduced into the test population after releases commenced was insufficient to suppress or delay the vernal increase in female relative abundance. Overall, radiosterilized males were uncompetitive (29 %) against native males for target females. The loss of competitiveness was attributed to the onset of assortative mating related to colonization, i.e. in both outdoor cage and mark-release-recapture experiments, sterile and native males mated more frequently with females of their own genotype.

E.-M. Meidell (1982). Effects of a synthetic juvenile hormone mimic on the reproduction of the tsetse fly, Glossina morsitans. Insect Sci. Applic. 3 (4) : 263-266

Topical application of the juvenile hormone mimic 1-75 to pregnant *Glossina morsitans* 15 or 20 days after emergence resulted in a significant increase in abortions of eggs and larvae of all developmental stages. Small doses (0.25 mg per fly) were sufficient to elicit a response which was more

pronounced if application occurred 20 days after emergence. Flies fed once on rabbit ears, which had been treated with 5 ng of the mimic per ear, resulted in abortions and the effect persisted for up to 40 days. The hormone mimic did not induce abortions in isolated pregnant uteri kept in organ cultures for up to 7 days.

H.A. Rafatjah (1982). Prospects and progress on IPM in world-wide malaria control. Mosquito News 42 (4) : 491-497

The author considers the major constraints to the application of IPM in malaria control : these include : overestimation of the requirements of integrated control, oversophistication of integrated control, insufficient conviction of the advantages of integrated control, misconception about the use of pesticides in integrated control, and insufficient consciousness of comparative costs, effectiveness, benefits and risks. The practical approach to implementation is dealt with under the headings of planning, application, and training and research. The status of integrated vector control in other health programs (onchocerciasis, schistosomiasis, urban yellow fever, dengue haemorrhagic fever, urban filariasis) is briefly mentioned.

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C.M. Ignoffo, A.H. McIntosh & C. Garcia. Biological Control of Insects Research Laboratory, USDA, Columbia, Missouri, USA. Susceptibility of larvae of Heliothis zea, H. virescens and H. armigera (Lep. : Noctuidae) to 3 baculoviruses

The authors compare the intraspecies and interspecies susceptibility of larvae of *Heliothis zea, H. virescens* and *H. armigera* to a unicapsid, single-embedded NPV ; a multicapsid, multiple-embedded NPV ; and a unicapsid granulosis virus.

J.D. Podgwaite, R.B. Bruen & M. Shapiro. USDA Forest Service, Northeastern Forest Experiment Station, Forest Insect and Disease Laboratory, Hamden, Connecticut & Science & Education Administration, Agricultural Research, Otis, Massachusetts, USA. Microorganisms associated with production lots of the nucleopolyhedrosis virus of the gypsy moth, Lymantria dispar (Lep. : Lymantriidae)

Samples of a gypsy moth nucleopolyhedrosis virus product, Gypchek, were taken each day during a 100-day production run and monitored for the presence of pathogenic bacteria and fungi. No primary pathogenic bacteria or fungi were detected but the presence of opportunistic pathogens indicated that assiduous monitoring of the virus production facility and rigorous quality control of production batches are necessary.

C. Stenseth & I. Aase. Norwegian Plant Protection Institute, Division of Entomology, As, Norway. Use of the parasite Encarsia formosa (Hym. : Aphelinidae) as a part of pest management on cucumbers

Experiments using the parasite *Encarsia formosa* to control *Trialeurodes vaporariorum* on commercially grown cucumbers are described.

A.J. Wapshere. CSIRO, Biological Control Unit, Montpellier, France. Discovery and testing of a climatically adapted strain of Longitarsus jacobaeae (Col. : Chrysomelidae) for Australia

A strain of *L. jacobaeae* was found at Annonay, Central France, where the climate is appropriate to the climatic areas in Australia where ragwort *(Senecio jacobaeae)* infestations occur. This strain was tested against a restricted group of composites, *Acacia* spp. and *Eucalyptus* spp. to confirm its safety for introduction into Australia.

R. Reimann & H.C. Miltenburger, Institute of Zoology, Cell Biology Laboratory, Technical University, Darmstadt, Fed. Rep. Germany. Cytogenetic studies in mammalian cells after treatment with insect pathogenic viruses (Baculoviridae). II. In vitro studies with mammalian cell lines

Mammalian cell-lines from Chinese hamster, Indian muntjac and mouse were inoculated with infectious supernatant of *Autographa californica* nuclear polyhedrosis virus replicated in *Mamestra brassicae* cell cultures. There was no adverse effect on cell proliferation, nor was a cytopathic effect induced in such cultures.

B.S. Sekhon & G.C. Varma. Punjab Agricultural University, Regional Research Station Faridkot ; Department of Entomology, Punjab Agricultural University, Ludhiana, India. Parasitoids of Pectinophora gossypiella (Lep. : Gelechiidae) and Earias spp. (Lep. : Noctuidae) in the Punjab

Observations of the parasitoids of cotton bollworms in the Punjab were made during 1978 and 1979. During the survey, eggs, larvae and pupae of *Pectinophora gossypiella* and *Earias* spp. were collected and reared ; 13 species of Hymenoptera were recovered and their seasonal occurrence observed.

G. Riba, S. Marcandier, G. Richard & I. Larget. INRA, Station de Lutte Biologique, La Minière, Guyancourt, France. Susceptibility of the European corn borer (Lep. : Pyralidae) to entomogenous hyphomycetes

The eggs of the European corn borer, *Ostrinia nubilalis*, are very susceptible to *Metarhizium anisopliae* and *Paecilomyces fumoso-roseus*. Under equivalent conditions, the 1st larval instars die more quickly but in a lower proportion than later instars. The diapausing caterpillars are very susceptible to mycosis.

P.J. McFadyen. The Alan Fletcher Research Station, Queensland Department of Lands, Brisbane, Australia. Host specificity and biology of Megacyllene mellyi (Col. : Cerambycidae) introduced into Australia for the biological control of Baccharis halimifolia (Compositae)

Multiple choice host preference testing of plants related to *Baccharis*, of desirable plants from a range of plant families, and of the host plants of other *Megacyllene* species, showed that *Megacyllene mellyi* was restricted to *Baccharis* spp. It was introduced into Australia in 1975 and released in 1978. Recoveries were made 3 years after release and some stems were killed, although damage was slight relative to the number of *B. halimifolia* plants in the release area.

R. Jebamoni Rabindra, M. Balasubramanian & S. Jayaraj. Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, India. The susceptibility of Tribolium castaneum (Col. : Tenebrionidae) to Farinocystis tribolii (Protozoa : Schizogregarinida)

Studies were carried out to investigate the relative susceptibility of different larval instars and adults of *T. castaneum* to *F. tribolii*, the dosage and time-mortality responses as well as the influence of the stage of the insect on the number and size of spores produced. The adults were less susceptible than larvae, and females were more susceptible than males. The number of spores produced increased with the stage of the larvae.

D. Rosen & R. Kfir. The Hebrew University, Faculty of Agriculture, Rehovot, Israel. A hyperparasite of coccids develops as a primary parasite of fly puparia

The authors report that *Pachyneuron concolor* (Hym. Pteromalidae) may develop as a primary parasite of aphidophagous fly puparia. Host selection in this species appears to be based on locating a soft-bodied host within a hard, dry shell, independent of whether the host is a dipterous pupa in its puparium or a primary parasite in its mummified host. The overall effect of *P. concolor* is detrimental. Its introduction into new areas should definitely be avoided.

M.L. Phillips. Long Ashton Research Station, University of Bristol, UK. Parasitism of the common earwig Forficula auricularia (Dermaptera : Forficulidae) by tachinid flies in an apple orchard

Earwigs were collected from an untreated apple orchard every 2 weeks from June to October 1979. Percentage parasitism at the times of collection was calculated from the numbers of parasitoids that emerged. Two tachinids, *Rhacodineura pallipes* and *Digonochaeta spinipennis*, parasitised earwigs. In the orchard, puparia of both tachinid species were hyperparasitised by *Dibrachys cavus* (Pteromalidae) and *Phygadeuon vexator* (Ichneumonidae).

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E.F. Legner & A. Silveira-Guido. Department of Biological Control, University of California, Riverside ; Department of Entomology, Escuela Agricola Jackson, Montevideo, Uruguay. Establishment of Goniozus emigratus and Goniozus legneri (Hym. : Bethylidae) on navel orangeworm, Amyelois transitella (Lep. : Phycitidae) in California and biological control potential

The external larval parasites, *Goniozus emigratus* and *Goniozus legneri* which were dominant on navel orangeworm, *Amyelois transitella* in south Texas and in Uruguay and central Argentina, respectively, were successfully established at experimental irrigated almond orchards in California's Central Valley in 1979. Coexistence with an earlier introduced parasite, *Pentalitomastix plethoricus*, occurred at all experimental sites. The data indicate a potential for *G. emigratus* and *G. legneri* in the biological control of navel orangeworm larvae during warmer periods. Thus, their establishment in almond orchards is desirable.

K.E. Frick, G.G. Hartley & E.G. King. Southern Weed Science Laboratory & Southern Field Crop Insect Management Laboratory, Stoneville, Massachusetts, USA. Large-scale production of Bactra verutana (Lep. : Tortricidae) for the biological control of nutsedge

Methods for large-scale rearing and handling of the tortricid, *Bactra verutana*, were developed for early-season augmentation of this insect to biologically control purple nutsedge, *Cyperus rotundus*, and yellow nutsedge, *C. esculentus*. A modified soybean flour-wheat germ larval diet, originally developed for the sugarcane borer, *Diatraea saccharalis*, yielded pupae equal in weight to pupae from larvae reared on the standard *Bactra* casein-wheat germ diet in an earlier test. With this method an average 2675 adults were produced per day for field release over a 95-day period.

Ben Ami Peleg. The Israel Cohen Institute for Biological Control, Rehovot, Israel. Effect of 3 insect growth regulators on larval development, fecundity and egg viability of the coccinellid Chilocorus bipustulatus (Col. : Coccinellidae)

The effect of 3 insect growth regulators – methoprene, diflubenzuron and RO 13-5223 – on the coccinellid *Chilocorus bipustulatus*, was studied in the laboratory. All 3 IGRs tested were harmless with regard to the longevity of *C. bipustulatus* adults. Fecundity was not affected by treatment with these chemicals but egg hatch was arrested ; however, when IGR-exposed beetles were transferred to an untreated environment they deposited viable eggs.

S. Keller & J. Wuest. Eidg. Forschungsanstalt für landw. Pflanzenbau, Zürich & Muséum d'Histoire Naturelle, Genève, Suisse. Observations on 3 species of Neozygites (Zygomycetes : Entomophthoraceae)

The morphology of *N. parvispora* from *Thrips tabaci* and of *N. cf. adjarica* from *Tetranychus urticae* is described in detail ; that of *N. fresenii* is limited to a description of the resting spores.

J.F. Vayssières. CSIRO, Biological Control Unit, Montpellier, France. Life histories and host specificities of the Echium bugs, Dictyla echii and Dictyla nassata (Hem. : Tingidae)

The life history of *D. echii* was studied in the field in south-west France, while further work on both species was undertaken in southern Portugal, where they occur together. Additionally, detailed studies of the life histories were made by rearing the bugs on, and subsequently examining, caged, attacked plants of *Echium plantagineum* in the laboratory and greenhouse at Montpellier. Testing of these 2 tingids indicated that under natural conditions they are restricted to a small group of boraginaceous plants. As no member of the Boraginaceae is an important crop plant in Australia, there is a little doubt concerning the safety of these 2 tingids as biological control agents for *E. plantagineum* in Australia.

S.A. Temerak. Insect Biocontrol Unit, Assiut University, Egypt. Longevity of Bracon brevicornis (Hym. : Braconidae) adults as influenced by nourishment on artificial and natural foods

Laboratory trials were undertaken to investigate the nutrition of *Bracon brevicornis* adults on artificial diets, *Sesamia* larvae, 5 host species (*Galleria, Ephestia, Sesamia, Spodoptera* and *Ostrinia*), in addition to starvation at 12, 15, 20, 25, 30, 35 and 40°C. The present investigation should serve as the basis for subsequent studies to manipulate the environment to make it favourable for parasitoid wasps, through spraying artificial food solutions.

ENTOMOPHAGA, volume 28 (3), 1983

H.S. Salama, M.S. Foda, Aziza El-Sharaby & M.H. Selim. Plant Protection & Microbial Chemistry Laboratories, National Research Centre, Dokki-Cairo, Egypt. A novel approach for whey recycling in production of bacterial insecticides

A simplified approach was devised to recycle sweet whey in production of spore-δ-endotoxin complex from certain entomopathogenic varieties of *Bacillus thuringiensis*. Supplementation of whey media with ground leguminous seeds and fodder yeast resulted in marked increase in the yields of endotoxin produced but the toxicity was not increased proportionally.

M.H. Badii & J.A. McMurtry. Division of Biological Control, University of California, Riverside, USA. Effect of different foods on development, reproduction and survival of Phytoseiulus longipes (Acarina : Phytoseiidae)

The effect of different prey mite species on development of the immature stages and on survival and oviposition of adult predator female *Phytoseiulus longipes* was studied. Considering the prey specificity, developmental period, and fecundity of *P. longipes*, it appears to be a promising bio-control agent for some *Tetranychus* species on low-growing crops.

L. Samsøe-Petersen. National Research Centre for Plant Protection, Lyngby, Denmark. Laboratory method for testing side effects of pesticides on juvenile stages of the predatory mite, Phytoseiulus persimilis (Acarina, Phytoseiidae) based on detached bean leaves

The method is based on detached primary bean leaves sprayed with the concentration recommended for the pesticide, or with demineralized water (controls). As soon as the spray has dried, adult spider mites *(Tetranychus urticae)* are placed on the leaves. Results permit classification of the pesticides according to the 4 categories of harmfulness used by the IOBC Working Group.

A. Villacorta. Instituto Agrónomico do Parana, Londrina, Brazil. Ovicidal activity of Metarhizium anisopliae isolate CM-14 on the coffee leaf miner, Perileucoptera coffeella (Lep. : Lyonetiidae)

Bioassays were conducted to determine the susceptibility of eggs of *Perileucoptera coffeella* to different spore doses of *Metarhizium anisopliae*. The fungus was highly virulent against eggs. Larval mortality by the fungus was 100 % in all cases. However, susceptibility to the fungus isolate used occurred only under high relative humidity.

C. Bernstein. Department of Zoology, University of Oxford, UK. Some aspects of Phytoseiulus persimilis (Acarina : Phytoseiidae) dispersal behaviour

Some of the processes that control or influence the movements of females of the predatory mite *Phytoseiulus persimilis* when dispersing between plants are studied. Experiments on the preference for light or shadow, carried out in a choice chamber, showed that individuals that have been starved for longer or in environments with lower relative humidities have a stronger preference for shaded places. The results are compared with similar data for the spider mite *Tetranychus urticae* in order to discuss their possible effect on the dynamics of the predator-prey system they form.

G.O. Furness, G.A. Buchanan, R.S. George & N.L. Richardson. Research Centre, Loxton ; Research Institute, Irymple ; Biological Services, Loxton ; Roseworthy Agricultural College, Australia. A history of the biological and integrated control of red scale, Aonidiella aurantii, on citrus in the lower Murray valley of Australia

In the lower Murray valley of Australia, the major insect pest of citrus, California red scale, *Aonidiella aurantii*, is controlled by a number of introduced hymenopterous parasites. Parasite introductions began in 1943, and continued until 1979. The biological control of this key pest has led to a decline in the incidence of secondary pests to the point where all insect pests of citrus are now regarded as being under effective biological control.

D. Livingstone & Md. Yacoob. Division of Entomology, Bharathiar University, Coimbatore, India. A new subgenus of Epoligosita (Hym. : Trichogrammatidae), an egg parasite of Tingidae (Het.) from southern India

The subgenus *Epoligositina* nov. of the genus *Epoligosita* with a type species *Epoligosita (Epoligositina) dulinae* sp. nov., a new record as an egg parasite of the morinda tingid, *Dulinius conchatus*, is described.

C. Lecomte & E. Thibout. Université F. Rabelais, Tours, France. Movement of Diadromus pulchellus (Hym. Ichneumonidae) in the presence of different olfactory stimuli mediating host searching

The male and female parasitoids' displacement were studied with air-borne odours given off by the healthy host-plant, the plant damaged by host-larvae feeding, or host-nymphs with their cocoon.

H.D. Catling, Z. Islam & B. Alam. Deepwater Rice Pest Management Project, Dacca, Bangladesh. Egg parasitims of the yellow rice borer, Scirpophaga incertulas (Lep. Pyralidae) in Bangladesh deepwater rice.

Studies on deepwater rice in Bangladesh from 1977 to 1980 showed that 61-89 % of the egg masses of the yellow rice borer, *Scirpophaga incertulas*, were attacked by hymenopterous parasites. Egg parasites clearly reduce the numbers of *S. incertulas* and, thus, improve the yields of deepwater rice.

E.J. Harris & R.Y. Okamoto. Tropical Fruit and Vegetable Research Laboratory, Honolulu, Hawaii, USA. Description and evaluation of a simple method for the collection of the parasite Biosteres oophilus (Hym. : Braconidae)

A simple method was developed to collect large numbers of the egg-larval parasite, *Biosteres oophilus*, for inoculative and inundative releases to enhance biological control of tephritid fruit flies.

T.R. Unruh, W. White, D. Gonzalez, G. Gordh & R.F. Luck. Division of Biological Control, University of California, Riverside, USA. Heterozygosity and effective size in laboratory populations of Aphidius ervi (Hym. : Aphidiidae)

Decline of allozyme variability in 7 laboratory populations of *Aphidius ervi* demonstrates that the effective population size is approximately one half the number of individuals used to renew the cultures each generation.

S. Grenier & G. Bonnot. Laboratoire de biologie INSA, Villeurbanne, France. Weight evolution of the parasitoid Lixophaga diatraeae (Dip. : Tachinidae) from the end of larval development to imaginal emergence. Weight estimations from measurements of the pupa

The observation of 550 individuals during post-larval development allows some biological features and weight relationships between different stages of *Lixophaga diatraeae* developed on *Galleria mellonella* to be defined.

Y.A. Duodu & B.W.L. Lawson. CIBC, West African Substation, Kumasi ; Department of Biological Sciences, University of Science and Technology, Kumasi, Ghana. Natural enemies of Acraea terpsicore (Lep. : Nymphalidae) in Ghana, with particular reference to the parasite Charops diversipes (Hym. : Ichneumonidae)

The arthropod parasites and predators of *Acraea terpsicore* were determined in the forest zone of Ghana. Some aspects of the interrelationships of *A. terpsicore* and its principal parasite, the ichneumonid *Charops diversipes*, are also studied.

F. Furuhashi & M. Nishino. Shizuoka Prefectural Citrus Experiment Station, Shimizu-shi, Japan. Biological control of arrowhead scale, Unaspis yanonensis, by parasitic wasps introduced from the People's Republic of China

In 1980, the Shizuoka Prefecture Government and the Ministry of Agriculture, Forestry and Fisheries, sent a mission to the People's Republic of China for a search for natural enemies of the arrowhead scale. The mission succeded in collecting 2 species of parasitic wasps of the arrowhead scale in China and both of them were introduced into Japan. It appears that both species of these parasitic wasps will become effective in controlling populations of arrowhead scales in citrus groves in the near future.

A.J. Wapshere. CSIRO, Biological Control Unit, Montpellier, France. Problems in the use of plant biochemistry for establishing the safety of biological control agents for weeds : the Chondrilla and Echium Heliotropium cases

In the case of *Chondrilla juncea*, the phytochemical data were insufficiently known to be of value and if they had existed would have been of little value in demonstrating quarantine safety for certain of the agents. However, in the case of the 2 Boraginaceae, there is strong evidence that studies based on phytochemical data would have confirmed specificity.

N.N. Hama & D.W. Davis. Department of Biology, Utah State University, Logan, USA. Lethal effects of high temperatures on non-diapausing pupae of Bathyplectes curculionis (Hym. : Ichneumonidae)

This study was designed to assess the impact of high temperature on non-diapausing *B. curculionis* pupae. This relates to temperatures and desiccation that occur in alfalfa fields, especially after cutting, which can adversely affect the parasite at sensitive stages of development. According to the findings of this study, temperatures in excess of 43°C, such as those found in dry unshaded areas, result in high mortality of non-diapausing *B. curculionis* pupae.

D. Livingstone & Md. Yacoob. Division of Entomology, Bharathiar University, Coimbatore, India. A new subgenus of Lathromeromyia (Hym. : Trichogrammatidae), an egg parasite of Tingidae (Het.) from India

The subgenus *Lathromeromina* nov. of the genus *Lathromeromyia*, with a type species *Lathromeromyia (Lathromeromina) tingiphaga* nov. is described and illustrated. Four species of tingid hosts and their host-plants are recorded.

AUX MEMBRES DE L'OILB ET AUX SOUSCRIPTEURS D'ENTOMOPHAGA

Nous avons le plaisir de vous informer que les efforts conjoints des organes responsables de la rédaction de la nouvelle maison d'édition « LAVOISIER ABONNEMENTS » ont permis de débloquer

les fascicules 2 à 4, volume 27 (1982) d'ENTOMOPHAGA

Ainsi, la parution du fascicule 2 (volume 27) sera assurée dans les semaines à venir, alors que les fascicules 3 et 4 réunis vous parviendront en janvier 1984.

Nous mesurons tout le préjudice que les auteurs d'articles, les abonnés et l'OILB dans son ensemble ont subi à la suite de la défaillance de l'ancien éditeur « Balthazar » qui n'a libéré les manuscrits qu'après l'engagement d'une action judiciaire de notre part. Ceci vous explique pourquoi il aura fallu plus d'une année pour rétablir la situation.

Nous nous réjouissons que l'édition soit maintenant entre les mains d'une maison de premier ordre et comptons sur votre fidélité à l'OILB et à Entomophaga.

Le Secrétaire Général
Dr G. Mathys

TO : MEMBERS OF IOBC AND SUBSCRIBERS OF ENTOMOPHAGA

We have pleasure in announcing that thanks to joint efforts of the editors and the new publishing house « LAVOISIER ABONNEMENTS » it has been possible to get hold of the manuscripts no. 2-4 of volume 27 (1982) of Entomophaga detained by the former publisher « Balthazar » who refused to hand them out. After legal action this intricate situation could be resolved, so that

no. 2 (volume 27) of Entomophaga (1982)

will be published during these next weeks and no. 3 and 4 (jointly) in January 1984.

We are aware of the many inconveniencies this delay has brought about for authors, subscribers and the Organization as a whole and wish to express anew our regrets.

With the new worldwide known editor we are confident that this type of accident will not happen again. May we therefore ask you to share this confidence in support of IOBC's endeavours and its scientific publication Entomophaga.

Yours sincerely,
Dr. G. Mathys
Secretary-General

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