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

It is with the deepest regret and a sense of irreplacable loss that we have to announce the passing away of K. Yasumatsu, Professor Emeritus, our friend, colleague and leader, on 25 January 1983.

Professor Yasumatsu, from Kyushu University, is universally accepted to be one of the leading entomologists of our time. After his retirement in 1971, he continued as before to be actively engaged in research in the field of taxonomy, ecology and biological control. He has always been a strong supporter of IOBC and his basic contributions in the field of pest management in rice, for instance, are of inestimable value.

The IOBC in mourning will always remember Professor Yasumatsu by the indissoluble bonds of admiration and friendship.

G. Mathys
IOBC Secretary-General

NEWS FROM THE REGIONAL SECTIONS

IOBC/EPRS Activity Report 1977-1982

The Second Session of the East Palaearctic Regional Section was held in Moscow in November 1980. The General Assembly elected for 1981-1983 was as follows:

- IOBC/EPRS President: Mr Y. Fadeev (USSR).
- Vice-President: Mr E. Lipa (Poland).
- Council members: Messrs G. Polyanov (Bulgaria), D. Benke (Hungary), H. Müller (GDR), T. Baiku (Romania), A. Smetnik (USSR), V. Landa (Czechoslovakia).
- Executive Committee: Messrs Y. Fadeev (USSR), E. Lipa (Poland), G. Polyanov (Bulgaria), A. Smetnik (USSR).
- Editorial Board Chairman: Mr G. Beglyarov (USSR).
- Standing Committee on Entomophagous and Phytophagous Insects of Weeds, Chairman: Mr A. Kaitazov (Bulgaria).

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

- Standing Committee on Microbial Means of Plant Protection, Chairman: Mr Y. Weiser (Czechoslovakia).
- Standing Committee on Integrated Systems of Plant Protection, Chairman: Mr T. Baiku (Romania).
- Standing Committee on Genetic and other new Selective Methods of Plant Protection, Chairman: Mr B. Nagy (Hungary).

Meetings 1977-1982

- EPRS General Assembly, first session (Moscow, USSR, April 1977).
- Council and Executive Committee, first meeting (Moscow, USSR, April 1978).
- Chairmen of Standing Committees, first meeting (Moscow, USSR, April 1978).
- Standing Committee on Microbiological Means of Plant Protection, first meeting (Prague, Czechoslovakia, September 1978).
- Editorial Board, first meeting (Leningrad, USSR, March 1979).
- Standing Committee on Entomophagous and Phytophagous Insects of Weeds, first meeting (Sofia, Bulgaria, July 1979).
- Standing Committee on Genetic and other new Selective Methods of Plant Protection (Budapest, Hungary, October 1979).
- Chairmen of Standing Committees, second meeting (Kiev, USSR, November 1979).
- Council and Executive Committee, second meeting (Moscow, USSR, November 1980).
- EPRS General Assembly, second session (Moscow, USSR, November 1980).
- Council and Executive Committee, third meeting (Moscow, USSR, November 1980).
- Standing Committee on Genetic and other new Selective Methods of Plant Protection, second meeting (Poznan, Poland, April 1981).
- Standing Committee on Microbiological Means of Plant Protection, second meeting (Prague, Czechoslovakia, May 1981).
- Chairmen of Standing Committees, third meeting (Tashkent, USSR, November 1981).
- Editorial Board, second meeting (Tashkent, USSR, November 1981).
- Standing Committee on Entomophagous and Phytophagous Insects of Weeds, second meeting (Poznan, Poland, November 1982).
- Council and Executive Committee (Moscow, USSR, November 1982).

The Council and Executive Committee, at their November 1982 meeting, considered the Secretary-General's activity report for 1981-1982, the financial report 1981-1982, the EPRS budget for 1983, and the proposal from Bulgaria to set up a Standing Committee on Biological Control of Forestry Pests and Diseases. Bulgaria had also proposed the establishment of the following temporary Working Parties within the framework of the Standing Committee on Entomophagous and Phytophagous Insects of Weeds:

- on the preparation of a catalogue of parasites and predators;
- on biological control in glasshouse crops;
- on the introduction of beneficial organisms.

Symposia 1979-1982

1. *Trichogramma* utilisation in integrated systems of plant protection, Bulgaria, July 1979.
2. Pheromone application to control *Laspeyresia pomonella*, *Grapholitha molesta* and *Grapholitha funebrana*, Hungary, October 1979.
3. Introduction and acclimatisation of effective entomophages, acariphages and phytophages of the main pests and weeds in EPRS member countries, USSR, November 1979.
4. Development of integrated systems of plant protection in EPRS member countries, USSR, September 1980. Twenty-eight reports were presented dealing with the application of biological control agents in integrated protection of cereals, glasshouse, fruit and vegetable crops, and viticulture. Several reports were devoted to the application of mathematical models in developing integrated systems (GDR), to the theoretical and practical aspects of economic thresholds (USSR), and to selective pesticides (Romania).
5. Insect viruses and prospects for their practical application in plant protection systems in EPRS member countries, USSR, November 1980. There were 18 reports from Bulgaria, Poland, Romania and USSR. Several virus preparations were shown to be effective control agents of agricultural and forestry pests. Further research should be directed towards: a) the mechanisation of virus preparation production, improvement of their formulations and application technology in various climatic regions; b) the search for new entomopathogenic viruses, their identification, virus diagnostics in natural insect populations, and effective evaluation of virus preparations with due regard to their side-effects. Member countries agreed to establish banks of entomopathogenic viruses in several institutes and to organise the exchange of strains for experiments in various agroclimatic zones.
6. Ecological basis for genetic control of codling moth and other pests, Poland, April 1981. Seven reports were presented dealing with the problems of releasing sterile male codling moths, methods of artificial rearing, and physical methods of controlling storage pests. Participants agreed on the need for closer cooperation with the WPRS on genetic and other new selective control methods.
7. Mass rearing of entomophages and acariphages and technology of their application in glasshouses, Poland, November 1982.

Information Bulletins

The EPRS issued 4 Information Bulletins in 1980-1981 containing information on Standing Committees and Temporary Working Parties, reviews of experimental research, methodology in biological control, catalogues and identification lists, and data on economic thresholds, a review on pesticide selectivity and toxicity for beneficials, and a list of 184 species of predatory phytoseiid mites. Subsequent issues will contain lists of entomophages of several pests (codling moth, tobacco thrips, cotton pests), a review of sex pheromones used in control, as well as bibliographic material.

IOBC/SEARS: Summary Report of the First Meeting, Kuala Lumpur, Malaysia, 3 March 1982

This meeting of the South East Asian Regional Section (SEARS) was organised in conjunction with the International Conference on Plant Protection in the Tropics. There were 20 participants from 5 countries and FAO. IOBC/SEARS President, Dr T. Sankaran (India), took the chair, and the Vice-Presidents, Dr Banpot Napompeth (Thailand) and Dr Ahmad Yunus (Malaysia), were also present. The meeting considered the various means of promoting closer personal contact and technical collaboration amongst biocontrol

IOBC/WPRS

workers in the region. Participants gave brief outlines of the biological control work in their areas. Dr C.R. Baltazar highlighted research on *Plutella xylostella, Heliothis armigera* and *Promecotheca cumingi* in the Philippines; she added that no pesticide spraying is done on coconut palms in the Philippines. Dr D.B. Reddy drew attention to the successful biological control of *Promecotheca* in Sri Lanka with the help of CIBC and FAO. One of the noteworthy successes reported from Thailand by Dr B. Napompeth was the result of using a native moth, *Episammia pectinicornis*, to control the aquatic weed *Pistia stratiotes*. Mr. B. Wirioatmodjo summarised work on *Phragmatoecia, Sexava* and *Eichhornia crassipes* in Indonesia. Mr Tey Chong Lay reported that, in Sabah, a virus had been successfully used against oil palm bagworms. The integrated pest control program on rice, underway at the International Rice Research Institute, Manila, was explained by Dr P. Kenmore.

A questionnaire will be circulated to all members with the aim of establishing a directory of insect taxonomists in different countries in the Region, who would be able to help in the rapid identification of natural enemies. The FAO Regional Office in Bangkok (Maliwan Mansion, Phra Atit Road, Bangkok 2, Thailand) would be glad to help in the collection and dissemination of relevant regional news items. The need was stressed for an exchange of information on natural enemy introductions, whether established or not.

Dr Sankaran listed a number of major crop pests and weeds of the region which could be dealt with on a collaborative basis involving two or more countries. These included *Chilo* spp., *Cnaphalocrocis medinalis, Crocidolomia binotalis, Earias* spp., fruitflies, *Heliothis* spp., *Oryctes rhinoceros, Orseolia oryzae, Pectinophora gossypiella, Plutella xylostella, Phragmatoecia* spp., rice plant hoppers, *Scirpophaga incertulas, Spodoptera* spp. and *Tryporyza nivella*. Weeds included *Cyperus rotundus, Eupatorium* spp., *Lantana camara, Mikania* spp., *Orobanche* spp., *Striga* spp., *Eichhornia crassipes, Pistia stratiotes* and *Salvinia molesta*. Development of pesticide resistance in natural enemies is a subject for study in different areas. Resistant strains could be shipped from one area to another and better used in integrated control programs. Efforts should be made to increase the Institutional and individual membership of the Region and to establish Regional Working Groups. It was suggested that the next meeting of SEARS be held in Bangalore at CIBC.

IOBC/WPRS Proceedings of the 4th General Assembly, Antibes (FR), 12-15 October 1981. IOBC/WPRS Bulletin V (3): 1-228 (French, some English)

The General Assembly was attended by 73 participants, mainly from Western Europe but included delegates from Morocco, Yugoslavia, Egypt, Bulgaria and the USA. The opening speeches were made by General Lascan (representing the Mayor of Antibes), J. Marrou (Scientific Director of Plant Production at INRA) and Dr G. Mathys (IOBC/WPRS President).

President's Address (G. Mathys), pp 5-9

As retiring President of this body of researchers, who are united in their efforts to advance research across national frontiers, I would like to make a few reflective comments.

My first thoughts go towards the cherished memory of Emile Biliotti, tragically taken from his family and enumerable friends on 26 April 1978. His strong but gentle personality together with a keen direction for international cooperation were particularly beneficial to our Organization. His dynamism was felt by all members to the extent that the General Assembly in Madrid voted unanimously to renew his mandate as President. This unique occurrence in the Organization says more than any words of praise. It was while he held the post of President of Global IOBC that he died. Together with you, I would like to pay a tribute to this man who so strongly upheld the ideals and interests of IOBC.

Let me now turn to the true pioneers of biological control who, as early as 1947, two years before the end of the War, foresaw the potential hazards posed by the exclusive use of chemical pest control*. The comments made in this respect in 1947 by UNESCO and IUBS merit quotation:

"The effective and material support of UNESCO is vital for the constitution of an International Service for research on beneficial insects and their use. Schematically, one might envisage:

- a central Office (3-4 entomologists) which would collate all documentation, establish research programmes and decide on the use of beneficial insects;
- local laboratories: the use of existing laboratories in certain countries already involved in this field, and the creation of new laboratories in certain areas of the world, which would only be possible with the cooperation of an international body."

These pearls of wisdom were cast at the International Congress of Entomology held in Stockholm in 1948, but it was a further 8 years before the IUBS commission, the renowned ICBC, came into being. It was led by two true pioneers, Messrs Balachowsky and Grison, who, in 1956, created the international organization, and continued by Biliotti-Delucchi and Biliotti-Brader.

Towards the end of the sixties, the growing interest which had given rise to IOBC in other continents led to its worldwide spread. Initially, IOBC's activities were restricted to the West Palaearctic region, but subsequently, other sections were created: Western Hemisphere, Southeast Asian, East Palaearctic and, more recently, Tropical Africa.

It should be recognised that the West Palaearctic Section, with its twenty Working Groups, three Commissions and institutional structure, is the most dynamic within IOBC. I will take this opportunity to pay tribute to the Section, but it would be wrong to think that the WPRS alone is active. Within the Southeast Asian Section, the Japanese are a dynamic element, but lack of funds has a paralysing effect. The first meeting of this Section will be held jointly with the FAO Panel on Integrated Control, in Kuala Lumpur in 1982. Next month, the Western Hemisphere Regional Section is holding a meeting in Santiago, while the East Palaearctic Regional Section is engaged in a number of research programmes in the COMECON countries.

Before making a few comments on the WPRS, I would like to answer the often asked question: but what does the Global Secretariat do? In fact, it operates in four ways: 1) by holding meetings of interest worldwide: mathematical modelling, symposium on bruchids (+ Working Group), Bellagio Conference, IWGO Symposium in Vienna. A colloquium on crop loss assessment and economic threshold evaluation in cotton, rice and maize is planned for 1982. Two conferences are also scheduled for April 1982, one at Antibes on *Trichogramma*, and the other in Prague on aphidophages and entomopathogenic fungi; 2) by coordinating the activities of its three Working Groups and striving to contribute to the field of vector control; 3) by publishing

* The scientific basis for an international organization for biological control (1949). IUBS Colloquium No. 5, 141 pp.

Newsletters and other reports; 4) by stimulating interest in establishing new regional sections.

Allow me now to return to the WPRS which, since 1956, has decisively determined the orientation of plant protection within its area. The advances made by research within the Working Groups has, throughout the years, led to substantial improvements in conventional systems, even though the Working Groups are mainly concerned with the search for solutions to specific problems, and are unable to take adequate account of the multiple phytosanitary interventions available within the framework of current production practices in a country or region. The one exception is that of arboriculture, for which integrated production has become a reality thanks to a great persevering effort. Based on sound research, this has allowed systems to be modified according to local conditions, and it is likely that this form of production will be adopted both for economic and ecological reasons.

Similarly, production in glasshouses is taking the same approach, representing a breakthrough in a system in spite of the difficulties which remain.

Finally, in viticulture and certain Mediterranean forest regions, an overall management might be envisaged, while for many field crops, the approach must be different in view of the variations between regions and the effects these have on the population dynamics of organisms. This is so in leguminous crops, for example. In these conditions, experimentation must contribute to the improvement of complex production systems, as has been done already for many years by Steiner in Baden Wurttemberg. This approach has been adopted also by the Netherlands and, more recently, by France and the UK.

This is a welcome development and fills a gap, often vehemently criticised, in the establishment of integrated systems in field crops.

With regard to diseases, the question of management has not progressed as hoped by the Athens General Assembly. For wheat, for example, there is a veritable battery of antifungal treatments, preferably systemic, which often greatly increase yield, for reasons as yet not understood, but the ecological consequences of which are considerable, revealing the shortcomings of this approach.

These developments are particularly striking in the Federal Republic of Germany. In these circumstances, the EPIPRE system developed by Zadoks in the Netherlands is particularly opportune; it clearly demonstrates how the technique of modelling allows a reduction in the use of pesticides.

These few reflections emphasise the strong points of the Organization and, at the same time, indicate the weaknesses presently being strengthened. Without becoming complacent, it should be said that the health of the WPRS can also be assessed in terms of the quantity and quality of its publications. I congratulate Mr Hurpin, the Secretary-General, the convenors and members of the Commissions and Working Groups and, of course, Mr Pelerents, whose activities extend well beyond that of Treasurer to the production of Bulletins and leaflets in conditions which it would be difficult to equal.

From dwelling on these thoughts, I have a feeling of deep gratitude towards you all and know that the pioneering efforts of 1947 were not in vain. I hope that this understanding between biologists will continue with the same impetus and in the same friendly atmosphere which has so greatly contributed to the attainment of our objectives of safeguarding the interests of growers and the environment.

Three introductory papers were presented:

R. Pal (WHO): Realities and prospects for biological control of vectors of human diseases, pp 10-25, 27 references

The global strategy for health for all by the year 2000 is briefly outlined and the size of the problem of vector-borne diseases defined. Progress to-date in the WHO programme on biological control is then described. The control agents considered include bacteria (*Bacillus thuringiensis* and *B. sphaericus*), fungi (*Culicinomyces clavosporus, Coelomomyces iliensis*), protozoa (*Nosema algerae* and *Vavraia culicis*), nematodes (*Romanomermis culicivorax*), fish (*Gambusia* and *Poecilia*), predatory mosquitoes (*Toxorhynchites* spp.). WHO maintains close collaboration with IOBC, FAO, UNEP, SIP and CIBC, as well as with industry. Future priorities are outlined. It seems increasingly unlikely that effective vector control can be achieved by the use of a single method and, in any future control programme, all available methods must be integrated in the overall concept of pest management.

J. Ponchet (INRA, FR): Realities and prospects for biological control of plant diseases, pp 26-48, 97 references

Two main themes are reviewed, antagonism and cross-protection. Most of the literature on antagonism relates to that in soil, the main antagonists being *Pseudomonas* and *Trichoderma*. The use of *Trichoderma* against the soil-borne pathogens *Rhizoctonia solani, Sclerotium rolfsii, Sclerotinia, Verticillium, Fusarium, Pythium, Phytophthora, Phomopsis sclerotioides* and *Armillariella mellea* is described, as well as its use against certain aerial pathogens [*Stereum purpureum Botrytis cinerea, Sphaeropsis malorum, Phomopsis viticola, Heterobasidium (Fomes) annosum*]. Antagonism on seed coats is briefly considered, in particular, the use of *Chaetomium* to eliminate *Fusarium* from oat grains. The antagonistic effect of mycorhizae, especially against *Phytophthora cinnamomi*, is also dealt with. Cross-protection against viruses, bacteria and fungi is discussed and includes reference to the following diseases/agents: citrus tristeza, apple mosaic, TMV, *Agrobacterium tumefaciens, Erwinia amylovora, Fusarium oxysporum, Verticillium, Colletotrichum lindemuthianum*. Special attention is given to *Gaumannomyces graminis* in wheat and *Endothia parasitica* on chestnut, using *Phialophora radicicola* and hypovirulent strains, respectively.

R. Cavalloro (CEC): Coordination of integrated plant protection research by the Commission for the European Community, pp 49-55

The background to the CEC involvement in integrated plant protection from 1973 onwards is outlined. In 1978, research programmes on biological and integrated control in the fields of fruit, vegetable and cereal crops in 9 member countries were defined, with the aim of encouraging more rational use of pesticides and the substitution of less environmentally deleterious methods. At a later date, member countries were invited to submit relevant projects which would offer the possibility of practical application by the end of 1983. Because of budgetary constraints, of the 85 projects put forward, only 23 were selected. Up to 50% of the cost of the projects would be covered by CEC grants and contracts would last for 5 years. The Fed. Rep. Germany, France, Great Britain and Netherlands would collaborate on virus application in apple orchards; France, Italy and Greece on research in citrus and olives; Fed. Rep. Germany, UK, Belgium, France and Netherlands on integrated control in brassicas; Denmark and Netherlands on carrots; Belgium, France, UK and Ireland on cereals. In

addition to these collaborative research programmes, the Commission organises symposia and working group meetings, and collects, analyses and publishes results. Exchange visits between institutes are encouraged. A document entitled "Safety and registration of biological pesticides" has been prepared as the basis for a directive for member countries. "Euraphid", a cereal aphid forecasting system, has just been launched. A contribution on standardisation of biotechnological methods in integrated control in citrus is being published, and many other studies are underway, including standardisation of sampling methods and economic thresholds for various pests, development of forecasting models, use of entomophages, reducing herbicide usage. Thus the CEC, although aware of the many and varied problems still to be solved, is making great efforts at coordinating research on integrated control in member countries.

Two further non-scheduled papers were also presented:

M. Pavan (IT): History, realities and prospects of biological control and IOBC/WPRS, as seen by the Ministry of Agriculture and Forestry in Rome, pp 56-60

The International Commission on Biological Control, which later became IOBC, was set up in 1947; great advances have been made in the past 34 years and, in the view of the Italian Ministry of Agriculture and Forestry, these activities should be continued and intensified. The special problems associated with forestry in the Mediterranean Basin are noted and a number of recommendations made: 1) that the Commissions and Working Groups draw up a summary of results obtained to-date, especially those concerning practical application; 2) that a list be drawn up of the main problems facing protection in agriculture, forestry, zootechnology and public health in the Mediterranean, in order that new priorities may be defined and action stimulated; 3) to organise a meeting with other international organisations concerned with biological control in order to promote collaborative effort and minimise duplication of research; 4) to set up "operational units" from which member countries could draw advice on research and practical problems; 5) that a charter on natural resources for biological protection of production in agriculture, forestry, zootechnology and public health be prepared by IOBC, and used as an information source for activities in the region.

M. Baggiolini (CH): Biological control – Integrated control – Integrated production, pp 61-64

With the aid of a flow chart, the author briefly outlines the phases in development and optimisation of integrated production.

Report of the IOBC/WPRS Secretary-General: P. Ferron (FR), pp 65-75

After completing the formalities, the Secretary-General recalled the recommendations adopted by the 3rd General Assembly. There had been two important events in the past 4 years: an International Symposium on integrated control in agriculture and forestry, in Austria in 1979, and the decision, prompted by E. Biliotti and L. Brader, of the CEC to become involved in integrated control. Close links between the CEC and WPRS had been forged. Reference was then made to the increasing volume of publications by WPRS, and in particular, to the usefulness of Working Group convenors preparing regular summaries of activities. The need to preserve the specificity of the Organization for Biological Control within the context of integrated control was emphasised.

Report of the Treasurer: C. Pelerents (BE), p 76

Details in IOBC/WPRS Bulletin (1981), unnumbered, 57 pp.

The Treasurer's report and accounts were ratified and adopted by the Auditing Committee and General Assembly.

Elections and Constitutional Changes, pp 77-80

The principal officers elected were as follows:

- Council: President: M.J. Way (UK); Vice-Presidents: P. Jourdheuil (FR), L. Mellado (ES) and C. Pelerents (BE); Secretary-General: P. Ferron (FR); Treasurer: J. Freuler (CH).
- Auditing Committee convenor: H. Steiner (DE).

The Constitution would now read "The Regional General Assembly shall be called by the Council in ordinary session every four years" (rather than 3 years); "In general, Council meets every two years" (rather than annually).

IOBC/WPRS President's speech: M.J. Way (UK), pp 81-83

Professor Way recalled the great contributions made by his predecessors, Professor Balachowsky and Drs Biliotti and Mathys, as well as by the retiring Council members, particularly Drs J. Franz and L. Brader. Future activities of both existing and possible new Working Groups (particularly for Mediterranean countries), and publications, were then briefly mentioned.

Reports of Commissions' Activities

Commission on Identification of Entomophages: J.M. Franz (DE), pp 84-85

Originally in the charge of Professor Delucchi in Switzerland, this service would now be provided by the Institute of Applied Zoology in Munich (Dr Hasselbach), and in Stuttgart (Diptera). Professor Klinghauf (Darmstadt) was the Commission convenor. Because of financial constraints, the identification service would be limited to entomological material, the host of which had already been determined. Lists of identifications made in recent years would be published soon. The vital role of taxonomists in understanding biological systems was emphasised.

Commission on Mediterranean Forestry: M. Pavan (IT), pp 86-88

The meetings of the Working Groups on *"Formica rufa"* and "Vertebrate predators of insects", held in Varenne, Italy, in 1978, formed the basis for the Forestry Commission. At a meeting organised by the Italian Government in Palermo in 1980, under the aegis of the CEC, Commission delegates initiated an international collaborative program, in discussion with WPRS, to coordinate research on biological and integrated control of forest insect pests in the Mediterranean Basin. The following publications have been issued in Italian, and French and English copies are in preparation: general program, a charter on phyto-sociological forestry alliances drawn up by Professor R. Tomaselli, a list of forest insect pests for each country and plant species attacked, prepared mainly by Dr Mazzolli, a list of 108 insectivorous birds found in the Mediterranean zone with their respective distributions and phyto-geographic associations. P. Ceballos is preparing a summary on the nutrition of insectivorous birds in the region. The huge scale of problems in forestry in the Mediterranean, and the need for the WPRS Forestry Commission to concentrate efforts in this area, are stressed.

Commission on Publications: J.J. Drea, A. Dunn, B. Hurpin, G. Remaudière, pp 89-92

This article deals solely with the journal Entomophaga, the publication of which was taken up by Balthazar Publications in 1980. The cost of Entomophaga compares favourably with other similar journals, and there is a circulation of about 840 copies. A breakdown of the countries of origin of the 203 papers in volumes 23-26 reflects the truly international scope of the journal. Of these papers, 129 dealt with entomophages, 48 with entomopathogens, 16 with biological control of weeds and 10 with various aspects of integrated control. Since January 1978, 98 manuscripts (30%) have been completely rejected and 90% of the remainder were revised before publication. There is a delay of around 6 months from acceptance to publication.

Commission on Development and Valuation of Integrated Production: M. Baggiolini (CH) & J. Thiault (FR), pp 93-102

The long, medium and short-term objectives of the Commission are defined. A report of activities for 1977-1981 is then given, covering organisational, technical and information aspects, implementation of IOBC directives, use of an informative label introduced experimentally in Switzerland and France in 1979. Future activities are then discussed.

Reports of Working Groups

Working Group on Integrated Plant Protection in Orchards: H. Steiner (DE), pp 103-108 (in English)

The Commission on Development and Valuation of Integrated Production and the Codling Moth Group have been incorporated into this Working Group, bringing the number of members to 160 from 22 European countries. Brief summaries of the following meetings are given: 1) Heidelberg, 7-10 Nov. 1977, The use of integrated control and the sterile insect technique for control of codling moth; 2) Bologna, 26-27 Jan. 1978, Possibilities of an integrated control of fruit tree diseases, 3) Colmar, 30 May-1 June 1978, Test methods to estimate the effects of pesticides on useful arthropods in the orchard; 4) Colmar, 10-11 April 1979, as Colmar 1978; 5) Valence, 24-26 May 1979, Psyllid problems in pear orchards; 6) Vienna, 8-12 Oct. 1979, International Symposium on Integrated Control in Agriculture and Forestry; 7) Wye, 25-26 March 1980, Biological control in orchards in general and especially of the codling moth; 8) Zaragoza, 22-24 April 1980, Integrated plant protection in pear orchards; 9) Valence, 18-19 June 1980, Integrated crop protection; 10) Prague, 26-28 Aug. 1980, Integrated pest and disease control in hops; 11) Nyon (CH), 2-3 Sept. 1980, Influence of cultural measures on pests and diseases and on the quality of fruit; 12) Colmar, 31 March-1 April 1981, Test methods to estimate the side-effects of pesticides. Other publications include a 3rd edition of booklet no. 2 "Visual assessment in apple orchards" (in French and German), and of booklet no 4 "The beating method" 2nd edition (in German).

Working Group on Fruit Flies of Economic Importance: E. Boller (CH), pp 109-121 (in English)

The history of the Working Group, which was established in 1978, its objectives (implementation of integrated control programmes for *Ceratitis capitata* and *Rhagoletis cerasi*) and internal organisation are briefly outlined. A list is given of participating specialists and laboratories (1979-1981). The long-term activities reported include: 1) the information pool of fruit fly specialists, which now comprises 142 from 37 countries or international organisations, is updated every two years and distributed, with research summaries, via the *Fruit Fly News Bulletin*; 2) implementation of integrated pest management programmes for *Ceratitis capitata*; 3) implementation of alternatives to the chemical control of cherry fruit fly in Switzerland. Short-term projects described include: 1) spectral sensitivity and colour vision of fruit flies, 1978-1979, in cooperation with the USDA; 2) quality control of mass-reared *Ceratitis capitata* (up to 1979); the Rapid Quality Control System is now being applied in several major medfly rearing facilities; 3) trap evaluation programme was initiated in 1979 for *C. capitata* and *Dacus oleae*, and results should be published in 1982. Meetings and publications are listed. The new convenor is Professor R. Cavalloro, Head of Biology Group, EURATOM Joint Nuclear Research Centre, IT-21020 Ispra, Italy.

Working Group on Integrated Control in Citrus: C. Benassy (FR), pp 122-127

Seven member countries collaborate in the Group: Spain France, Italy, Greece, Turkey, Tunisia and Morocco. The main objective at present is the use of indigenous or exotic entomophages (such as *Aphytis* spp., *Cales noacki, Amitus spiniferus, Prospaltella lahorensis*) to control whiteflies and scale insects (including *Ceroplastes, Parlatoria, Lepidosaphes, Unaspis, Aspidiotus, Aleurothrixus, Dialeurodes, Aonidiella, Chrysomphalus, Saissetia*). Future activities will concentrate on the establishment of economic thresholds and on supplementing and safeguarding beneficial insects. Ten references are listed.

Working Group on Integrated Control in Vineyards: A. Schmid (CH), pp 128-136

The results of the Subgroups for 1977-1980 are briefly outlined and include the following studies: improvement and simplification of assessment methods for *Panonychus ulmi*, studies on *Tetranychus urticae* and other phytophagous mites, biological control of mites using typhlodromes, vine moth damage to fruit, biology and sampling of vine moth and parasite populations, improvement of vine moth forecasting, fungal and bacterial diseases (*Plasmopora viticola, Botrytis cinerea* (control using *Trichoderma viridae*), *Phomopsis viticola, Eutypa armeniaca, Xanthomonas ampelina*), side-effects of pesticides, importance of *Sparganothis pilleriana*. Future objectives are listed, and 13 references.

Working Group on Pesticides and Beneficial Arthropods: S.A. Hassan (DE), pp 137-141 (in English)

The 5 meetings held from 1977-1981 are listed. The Group was established in 1975 with the primary aims to: 1) encourage research on the development of standardised methods to test the side-effects of pesticides on beneficial arthropods; 2) plan joint programmes to test the side-effects of pesticides on natural enemies; 3) support research on natural enemies resistant to pesticides; and 4) provide information to growers and planners of integrated control programmes. Standardised methods for testing side-effects have been developed and accepted for *Trichogramma cacoeciae, Coccygomimus turionellae, Phygadeuon trichops, Chrysopa carnea, Coccinella septempunctata, Leptomastix dactylopii, Drino inconspicua* and *Encarsia formosa*, and methods are in preparation for *Amblyseius potentillae, Phytoseiulus persimilis* and *Syrphus corollae*; future projects include Carabidae, Staphylinidae, Coccinellidae, Braconidae,

Aphidiinae, Typhlodromidae and Anthocoridae. About 20 pesticides are tested in the joint programme every two years, and the results of the first batch have been reported by J.M. Franz *et al.* (1980) in Entomophaga *25* (3): 231-236.

Working Group on Integrated Control of Soil-inhabiting Pests: C.A. Edwards (UK), pp 142-147 (in English)

There are currently 89 collaborating members from 10 countries, divided among 4 Subgroups: 40 in the Seedling Pests of Sugarbeet, 16 in the Pathogens of Nematodes, 18 in the Pathogens of Soil Insects, and 15 in the Role of Organic Matter in Pest and Disease Problems Subgroup. Results obtained since 1977 are evaluated and future objectives outlined, including: more attention to the role of organic matter in promoting natural control; the role of carabid beetles in control of sugarbeet aphids; experiments to investigate the effects of intercropping, dissemination of pathogens for pest control, further work on rotations, plant compensation for pest damage, and interactions between pests and diseases; preliminary attempts will be made to design a full integrated control programme for sugarbeet pests and diseases possibly with the help of modelling. An experiment is planned on sugarbeet comparing the effects of rotations, organic matter and a high dose of aldicarb on nematodes and their fungal parasites. Dissemination of pathogens for pest control will be tested. In addition, each Subgroup will be free to investigate small projects coordinated in at least 3 countries.

Working Group on Integrated Control in Cereals: F. Schütte (DE), pp 148-153 (in German)

The short and medium-term objectives of the Group are outlined, and include research on the following species: *Macrosiphum (Sitobion) avenae, Metopolophium dirhodum* and *Rhopalosiphum padi*. A summary of developments from 1977-1981 is then given, including the meetings held. The programme for the next 4 years is briefly mentioned.

The report of the Subgroup on Cereal Aphid Ecology (by C.A. Dedryver, FR, pp 154-158) summarises activities for 1980, including: field and laboratory studies on cereal aphid biology; studies on predators *(Erisyrphus balteatus, Chrysopa carnea)*, parasites *(Aphidius rhopalosiphi, Toxares deltiger)*, and Entomophthorales *(Erynia neoaphidis, Entomophthora planchoniana, Conidiobolus obscurus)*; the role of insecticide and herbicide treatments; modelling populations; effects of aphids on yields.

Working Group on Integrated Control in Cereals in the Mediterranean Basin: M. Laraichi (Morocco), pp 159-167

France, Italy, Greece, Spain, Algeria, Morocco, Egypt and Iran participate in this Group, which is divided into two Subgroups dealing with wheat and maize. The activities of the former are covered in this report. The main pest species of *Eurygaster* and *Aelia* are listed, together with an indication of their importance in the respective countries and their taxonomic relationships. Population dynamics and bioecology are then considered, followed by control methods, both chemical and biological. Biological control agents studied include *Beauveria bassiana, Spicaria farinosa* and members of the families Phasiinae, Encyrtidae and Scelionidae. A table of 21 species of the hymenopterous oophages is given and includes: *Asolcus* spp., *Trissolcus* spp., *Telenomus* spp., *Gryon* spp., *Ooencyrtus* spp. The short and long-term objectives of the two Subgroups are then listed.

Working Group on Integrated Control in Brassicas: T.H. Coaker (UK), pp 168-172 (in English)

Activities since 1977 included publication of a Bulletin on the major achievements of the WPRS Group since 1972, and the granting of CEC contracts (1979-1983) for studies on *Hylemyia brassicae* population dynamics and on lepidopterans attacking brassicas. The development of methods for monitoring adult *H. brassicae* has occupied much of the collaborative effort. Physical and cultural control are considered, and a 12-year feasibility study on the Sterile Insect Technique for *H. brassicae* Control has been concluded. The possibility of control using inundative releases of *Aleochara* spp. has been assessed. Basic studies have continued on *H. brassicae* to provide information on the factors affecting adult emergence times, dispersion and oviposition. A descriptive model for *H. brassicae* is being established. Other activities included the development of methods for monitoring *Mamestra brassicae, Evergestis forticalis* and *Plutella maculipennis* using sex attractants, and insecticide evaluation procedures for *H. brassicae, Aleyrodes proletella*, cabbage aphids and caterpillars.

Working Group on Integrated Control in Glasshouses: N.W. Hussey (UK), pp 173-180 (in English)

Since the Group's formation in 1970, remarkable progress has been made in the commercial implementation of biological control techniques for whitefly and red spider mite, practical uptake in several countries now exceeding 50% of the heated glasshouse area. The two main research centres are at Leiden University (Netherlands) and Littlehampton GCRI* (UK), but 31 researchers from 11 countries participate in the Group. The division of research interests between countries is as follows: aphids, *Aphidiomyza* (FI, UK); aphids, *Verticillium lecanii* (UK, NL); whitefly, *Encarsia* (FI, SE, UK, FR, PT, USA); whitefly, *Verticillium lecanii* (UK, NL, FI); agromyzids, *Opius, Dacnusa, Diglyphus* (NL, UK, Canada); *Thrips tabaci, Amblyseius mackenziei* (NL, UK); tomato moth (UK); red spider mite, *Phytoseiulus* (FR, USA, NO, PT).

Working Group on Formica rufa: M. Pavan (IT), pp 181-183

Switzerland, Spain, France, Italy, Turkey, Luxembourg, Romania, Bulgaria, Czechoslovakia, UK, Fed. Rep. Germany, USSR, Poland, Canada, Finland and Portugal collaborate at present in this Group which acts within the framework of the IOBC Forestry Commission. Distribution maps for the various *F. rufa* species groups have been published, and an updated bibliography (1962-1982) was nearing completion. Two natural biogenetic reserves of 300 and 350 ha have been established in Italy from which large numbers of *F. lugubris* have been collected for introductions elsewhere.

Working Group on the Use of Pheromones in Integrated Control: A.K. Minks (NL), pp 184-189 (in English)

The 2nd (Harpenden 1977) and 3rd (Wädenswil 1979) meetings of the Group, which comprises some 40 members, are summarised. A collection of data on the technology of pheromone trapping (e.g. all possible types of material as traps, dispensers, quality of chemicals, carriers, antioxidants, etc.) is available. The idea of a pherobank, a central register and supply of pheromone compounds, has been dismissed as impractical. Preparation of a list of pheromo-

* Glasshouse Crop Research Institute.

nes/attractants of European insects with information about relevant chemical and biological characteristics is underway. It is hoped that a USDA set of regulations for the registration of pheromones and other behaviour modifying chemicals as pest control agents will serve as a model for other countries.

Working Group on Breeding for Resistance to Insects and Mites: P.R. Ellis (UK), pp 190-192 (in English)

The objectives of the Group are to expedite the development of resistant cultivars of crops which can be used in integrated control programmes and, where necessary, to set up project groups for people who are studying similar insect/host relationships. There are 2 Project Groups at present: 1) Breeding for Resistance to Cereal Aphids (H.J.B. Lowe), the activities of which have been largely confined to a Newsletter in which members discuss problems and announce progress; 2) Breeding for Resistance to Carrot Fly *(Psila rosae)* (P.R. Ellis) (16 members from 9 countries); this Group has met on 3 occasions to plan and discuss the results of collaborative experiments. Representatives from 5 countries collaborated in 1977 and 1978 in trials on the resistance of carrot cultivars to carrot fly attack, and results were published in 1981 (Ellis & Hardman, *Ann. appl. Biol.*, 1981, *98:* 491-497).

Working Group on Systems Analysis, Models and Data Banks in Integrated Pest and Disease Control: R. Rabbinge (NL), pp 193-198 (in English)

The Group was established in 1976, and there have been 4 meetings since then with 17-35 participants from 5-9 countries. The meetings serve: 1) the exchange of information, techniques, approaches and intensification of scientific ideas; 2) to develop a strategy to increase the use of these tools in integrated protection; 3) to integrate different crop protection and agronomical measures and to develop a system of integrated agriculture. EPIPRE, a supervised control system in wheat, has been developed in the Netherlands and gives recommendations on a field by field basis. This system is now being implemented in Belgium, Switzerland, France and Sweden. Much effort is being spent on disease and pest models of cereals (there is a Subgroup on *Septoria nodorum*) and similar developments are now being tried in fruit orchards and vineyards. An IOBC Bulletin on "Instructions on how to develop models for practical use in integrated pest management" should be available soon.

Report of a meeting to discuss the management of arable farming systems for integrated control of pests, diseases and weeds: C.A. Edwards (UK), pp 199-203 (in English)

Work done by IOBC/WPRS Groups has tended to concentrate on individual pests, crops or techniques and has often been limited by inability to take full account of the farming system as a whole. This meeting was held, therefore, to discuss how work might be developed within IOBC/WPRS whereby farming systems and appropriate elements of farming systems could be compared with special reference to their pest management practices. The following contributions were presented: Review of integrated control in the Netherlands (A.K.M. Minks); Rotations and pest control (C.A.A.A. Mahenout); Integrated weed control (H.F.M. Aarts); A pest and diseases management system for wheat, EPIPRE (V. Leeuwen); An integreated arable farming system, Netherlands (P.H. Vereijken); An integrated arable farming system, FRG (H. Steiner). It was recommended that an IOBC/WPRS Study Group be set up for 1-2 years to investigate the possibility of a collaborative project on management of arable farming systems for integrated control of pests, diseases and weeds.

Recommendations of the IVth General Assembly (Antibes, FR, 12-15 October 1981), pp 204-207 (English), pp 208-211 (French)

The main recommendations were as follows:

I. 1. to prepare and publish an information leaflet on the aims and achievements of the Organisation;
2. to study the possibilities for publishing the results of certain activities through collaboration with well recognised publishing companies;
3. to contact the CEC (Commission for the European Communities) to discuss the possibility of channeling some or all CEC activities on integrated control through IOBC/WPRS;
4. to ensure multidisciplinary approaches in areas such as public health, phytopathology, weed management and plant breeding;
5. to improve the information given to the general public and farmers and to seek their active support for integrated plant production systems;
6. to support the establishment of the Regional Section for Tropical Africa;
7. to increase cooperation between the various Regional Sections.

II. 1. that Council makes every effort to augment funds available to IOBC;
2. to maintain the high standard of *Entomophaga;*
3. to re-establish the Identification Service for Beneficial Arthropods;
4. that the Commission for Mediterranean Forests reports on ongoing activities related to effective management and protection;
5. to establish study groups on: integrated protection in cotton; integrated protection in oil seed rape; biological control of *Corythucha ciliata* of plane trees; biological and integrated control of plant diseases; biological and integrated control of weeds; management of arable farming systems for integrated control of pests, diseases and weeds.

III. 1. that standards used for the commercialisation of fruits and vegetables be studied anew;
2. that further guidelines be prepared on the promotion and registration of selective and biotechnical control measures;
3. that the Council consults with organisations such as WHO, FAO, OECD, CEC and EPPO to study the development and implementation of specific recommendations on the above.

Appendices: List of Institutional Members of IOBC/WPRS: pp 214-217.
List of IOBC/WPRS Bulletins issued since 1972: pp 218-219.
List of participants: pp 220-228.

IOBC/WPRS Working Group on Integrated Control of Soil Pests. Summary of the report of a meeting held in Stuttgart, FRG, 27-29 January 1982. Convenor: C.A. Edwards; local organisation: A. el Titi and H. Steiner

The meeting was attended by 41 participants from Europe, and began with a plenary session when past work of the Group was reviewed and the decisions of the IOBC/WPRS General Assembly (Antibes, FR, October 1981) discussed. The 4 Subgroups then met to discuss their 1980-1982 research and collaborative programs and decide on their 1982-1983 programs.

Pathogens of Nematodes Subgroup (B. Kerry)

The main purpose of this year's meeting was to discuss the general techniques used to study nematophagous fungi in soil, and to standardise the methods used in co-operative studies. Past and future work considered included: 1) the survey of nematophagous fungi: the occurrence of *Nematophthora gynophila* and *Verticillium chlamydosporium* in cyst-nematode infested fields in Europe; 2) Introduction of *V. chlamydosporium* into soil: following disappointing results obtained in Germany, UK and Denmark, it was concluded that these studies be discontinued until more is known of the survival of *V. chlamydosporium* in soil and factors affecting parasitism; 3) Effect of the fungicide captafol on numbers of cyst nematodes: in 1980, captafol applied at 60 kg/ha and rotavated or harrowed into the seed bed resulted in increased populations of *H. avenae* and *H. schachtii*. The experiment was repeated in 1981 applying the fungicide to the seedbed as before, and repeating applications as a soil drench at 6-wk and 4-wk intervals. The following general conclusions were drawn: a) for the second year, cyst nematode populations were generally greater in soil treated with captafol than in untreated soil; b) the effects of repeated captafol applications in 1981 were no greater than those observed in 1980 from a single application; c) *H. schachtii* multiplication on susceptible crops in untreated soil was low; d) estimates of fungal parasitism based on parasitised eggs and spore numbers in soil pre and post-cropping are not good estimates of the activity of nematophagous fungi through the growing season; e) nematophagous fungi other than *N. gynophila* and *V. chlamydosporium* may be important in reducing cyst nematode numbers; 4) Demonstration of methods used to study nematophagous fungi: semi-quantitative methods for the estimation of the number of propagules of predatory and endoparasitic fungi which parasitise active nematodes in soil were discussed; assays were described for estimating nematode attraction to traps of predatory fungi and the ability of these fungi to kill nematodes in soil; 5) Future work: the captafol experiment would continue for one more year with certain modifications; long-term experiments have been established to study population changes and fungal parasitism of *H. schachtii* under intensive sugarbeet cropping; population changes of *H. schachtii* will be monitored in 2 experiments set up to examine the effects of organic matter on pests and diseases of sugarbeet. The following general comments were made: the decline of the cereal cyst nematode on susceptible crops to levels which have little effect on yield has now been reported from Sweden, Denmark, Fed. Rep. Germany, Netherlands, UK and Bulgaria. Nematophagous fungi are considered the major factor limiting nematode multiplication. However, at Elsdorf in Germany, *H. schachtii* populations in sugarbeet grown continously for 17 years have stabilised at 20 eggs/g soil, which results in considerable yield losses.

Pathogens of Soil Pests Subgroup (H.F. Evans)

The final Danish results on persistence of granulosis virus (GV) in soil were presented. Virus concentration dropped from 5×10^6 to 1×10^5 capsules/ml after one year, but the virus was still capable of initiating high host mortality. This corroborated results obtained with the NPV of *Mamestra brassicae* (in Oxford) and *Pieris brassicae* (in Littlehampton). A survey of sugarbeet seedling pests for the presence of pathogens (based on submission to the Subgroup of samples of insects collected during field experiments of another Subgroup) has met with a poor response, largely because of the apparently healthy condition of the prime target species. The survey will continue, the emphasis being on *Atomaria*, with screening for viral, fungal, protozoan and bacterial pathogens. Pathogens of *Agrotis segetum* would be studied, with the objective of microbial control trials in 1983. Expansion of the Subgroup to develop a forum of European insect pathologists was envisaged.

Role of Organic Matter on Soil Pests and Diseases Subgroup (R. Lofty)

It was concluded that research should not be limited to the sugarbeet crop or pests and diseases alone, but include a wider range of soil-inhabiting animals. Results were presented on the use of sewage and animal slurries on grassland, where it was shown that species diversity and numbers of soil animals, particularly nematodes, can change drastically with application of high doses of such organic materials. The degree of aerobicity of cattle slurries was shown to affect the degree to which earthworms may be expelled from the soil when large doses are applied. With regard to the effect of naturally occurring organic matter, the biomass of animals was greatest beneath cut meadow, less under uncut meadow, and least under a periodic burning regime. Results obtained from long-term (150 years continuous cropping) and short-term investigations into the effects of organic and inorganic fertilisers on earthworm populations in a variety of crops (root, cereal, grass) were presented. In those sites under arable cropping, all earthworm species were more numerous in plots treated with organic fertilisers than in inorganically treated plots. There was a strong positive correlation between amounts of inorganic N applied and earthworm populations. The effects of both organic and inorganic N were much less on earthworms in grassland than on those in arable crops.

Seedling Pests of Sugarbeet Subgroup (C.A. Edwards)

The Subgroup reviewed a collaborative experiment begun in 1976 to compare the effects of rotations, insecticides (aldicarb and lindane), herbicides and, latterly, organic matter (especially spent mushroom compost) on the level of attack by seedling pests and diseases and on beneficial organisms. Two groups of workers, from the UK and Netherlands, had organised an experiment throughout the period up to 1981. Switzerland had set up 3 experiments, 2 of which ran for 3 years and 1 for 5 years. Belgium and Ireland had run experiments every year but the sites had not always been the same. There had been 3 experiments in FRG, each of which had a different design and had run for different periods. Most had investigated the effects of the 2 insecticides and 4 had grown continuous sugarbeet as well as a cereals/sugarbeet rotation. Most workers studied the effects of herbicides on pests and diseases until 1979 and then had substituted some form of organic matter application. The Danish and Austrian workers had joined the Subgroup recently and their work had involved only studies into the effects of insecticides. The individual reports on the 1981 work are given. It was decided that the long-term experiments would all be completed in 1982 and ancillary data obtained so as to allow a thorough review of progress towards integrated control to be made at the end of the year, and a completely new collaborative program designed for 1983. Collaborative work in 1982 would be in the following main areas: a) assessment of the effects of soil-applied insecticides; b) assessment of the effects of fungicides; c) completion of work on effects of organic matter and rotations on pests and beneficial organisms; d) effects of environmental factors and management practices on pests and diseases of sugarbeet; e) undersowing and intercropping; f) use of pathogens in pest control.

Next Meeting of the Working Group on Integrated Control of Soil Pests

This will be held at Trinity College, Cambridge, UK, from 20-22 September 1983. Student accommodation has been reserved in Trinity College, the cost of a room plus breakfast, lunch and dinner being approx. £27.00. Participants are expected to arrive on Monday 19 September, the meeting will begin on the morning of the 20th and end on the afternoon of the 21st. On the morning of the 22nd, there will be a visit to Brooms Barn Experimental Station. The meeting will include discussion on all Subgroup activities. Financial assistance for accommodation and/or travel may be available from IOBC funds. For further details, contact Dr C.A. Edwards, Rothamsted Experimental Station, Harpenden, Herts, UK.

IOBC / WPRS Working Group on Pesticides and Beneficial Arthropods, Copenhagen, September 1982

This is a summary of a report written by L. Samsøe-Petersen (Lyngby, DK) and S.A. Hassan (Darmstadt, DE). The meeting was attended by 27 research workers from 11 European countries, 5 of which represented the chemical industry. The development of standard laboratory, semi-field and field methods to test the side-effects of pesticides on beneficial arthropods, the initiation of a third joint pesticide testing programme, as well as extending the scope of the Working Group to include other beneficial organisms, were the main objectives of the meeting.

1) Improvement, standardization or rationalization of available guidelines

Suggestions for the rationalization of the *Chrysopa carnea* method were made by F. Bigler (Zurich-Reckenholz, CH), of *Syrphus corollae* by W. Rieckmann (Hannover, DE), of *Phygadeuon trichops* by E. Naton (Munich, DE), *Coccygomimus turionellae* by R. Albert (Stegen-Wittental, DE), *Phytoseiulus persimilis* by Samsøe-Petersen and by Hassan. The changes included evaluation methods, test procedures or analysis of results.

2) Development of new standardized laboratory and semi-field methods

New laboratory methods to test the initial toxicity of pesticides by exposing beneficials to fresh dry pesticide films applied on glass plates, soil or leaves were demonstrated by J.U. Brown (Chorley, UK) for *Cryptolaemus montrouzieri*, by P.J. Edwards (Bracknell, UK) for Carabidae, by E. Kirknel (Flakkebjerg) for *Aleochara bilineata*, by A.G. Vivas (Valencia, ES) for *Cales noacki*, by C. Inglesfield (Sittingbourne, UK) for spiders, by J. Brun (Valbonne, FR) for Coccinellids and by G. Vanwetswinkel (St. Truiden, BE), for *Amblyseius potentillae* (in a semi-field test). Several problems dealing with spraying, exposure surface, washing and re-using of glass, washing of sprayers, test procedures and evaluation were discussed. It is hoped that these test methods will be developed further and agreements to solve some of the general points discussed will be found soon.

3) Extending the scope of the Working Group

The members agreed to extend the scope of the Group and include other beneficial organisms. J.J. Tuset (Valencia) presented a method for the entomopathogenic fungus *Verticillium lecanii*, a potent agent for the biological control of scales.

4) Joint pesticide testing programmes

Results of the second joint pesticide testing programme were discussed and agreement to publish these data in *Z. ang. Ent.* was reached.

A third joint testing programme was initiated and pesticides were distributed by P. Blaisinger (Colmar, FR), Bigler and Hassan to 16 group members in 9 countries to be tested on about 16 beneficial organisms.

5) Field tests

A method to test the side-effects of pesticides on beneficial arthropods in citrus orchards was demonstrated by G. Viggiani (Napoli, IT), on field crops by Inglesfield, in apple orchards by B. Sechser (Basel, CH) and by A. Stäubli (Nyon, CH), in forests by P. Huang (Göttingen), in barley by P. Chiverton (Uppsala, SE). After intensive discussion, it was agreed that a special part at the next meeting should be devoted to the discussion of principles for field testing on predatory mites in apple, pear, citrus, vine and glasshouse crops.

6) Comparison of results from laboratory, semi-field and field test methods

Experiments carried out by Bigler, Naton and Hassan showed that there was agreement on results obtained from the three kinds of test methods when harmless pesticides are compared. Pesticides harmful in the laboratory were sometimes found to be less harmful in semi-field and field tests. R. Delorme (Versailles, FR) recommended including the host in additional tests when testing beneficials used in biological control, i.e. *Encarsia formosa*.

7) Integrated testing procedure

There was general agreement that pesticides should first be tested in the laboratory on several beneficials that are relevant to the crops on which the pesticide is to be used in practice. A "key" for the choice of species was proposed by Hassan; this will be discussed further at the next meeting.

Principles for the different methods were discussed and agreement on most points for the following tests was reached: 1) laboratory, initial toxicity test, 2) duration of harmful activity, persistence test and 3) semi-field test.

8) Research on natural enemies resistant to pesticides

Hassan presented results of semi-field tests with 3 different strains of *Phytoseiulus persimilis*, while Delorme reported on work in France to select *E. formosa* resistant to parathion and deltamethrin.

9) Information centre for the side-effects of pesticides on beneficial organisms

Blaisinger & Bigler reported on the EDB literature search but it appeared that people preferred to carry out their own searches. The problem of the lack of communication of unpublished results between Working Groups was raised. It was suggested that the list of Working Groups be supplemented with the fields of interest of the members to facilitate contacting relevent colleagues.

10) Legislation, labelling and information on selective pesticides

It was emphasised that the aim of the Working Group was to develop standard test methods which could be offered to European authorities for use in all countries; the Group should not take initiatives regarding labelling or registration procedures on side-effects of pesticides.

The meeting was closed by words of thanks to E. Kirknel, L. Samsøe-Petersen and other colleagues of the Plantevaernscentret in Lyngby and Flakkebjerg for their exceptional hospitality and the excellent facilities they provided the group with during the meeting.

Next Meeting of the Working Group on Pesticides and Beneficial Arthropods

The next full meeting would be held in France at the Station de Zoologie, INRA, 28, rue de Herrlisheim, FR-68021 Colmar, from 20-22 September 1983. An excursion is planned for 23 September, ending about 14.00 h. The following topics will be studied: 1) improvement, standardisation and rationalisation of existing guidelines; 2) development of new standardised laboratory (initial toxicity/persistence) and semi-field methods (type of cages, experimental conditions used in persistence and semi-field tests); 3) test methods for entomopathogenic fungi and other organisms; 4) results obtained within the third joint pesticide testing program; 5) principles for field testing (particularly methods for predatory mites in apple, pear, citrus, vines and glasshouse crops); 6) comparison of results obtained from laboratory and semi-field tests; 7) recommendations for an integrated testing procedure and a "key" for the selection of beneficial organisms for the tests; 8) information centre; 9) cooperation with industry and other WPRS Working Groups. Registration forms can be obtained from the Convenor, Dr S. A. Hassan, BBA, Institut für biologische Schädlingsbekämpfung, Heinrichstrasse 243, DE-6100 Darmstadt, FRG. A summary of contributions offered should be sent to Darmstadt before 30 July 1983. Hotel reservations can be made through Dr P. Blaisinger, Station de Zoologie, INRA, 28, rue de Herrlisheim, FR-68021 Colmar, France.

IOBC/WPRS Working Group on Pheromones: Special Meeting on Mating Disruption, Changins/Nyon, Switzerland, 28-29 Sept. 1982. Report by A.K. Minks

Following a request by colleagues working in this field, a Working Group meeting was held, especially devoted to the application of the mating disruption technique in fruit orchards and vineyards. Dr P.J. Charmillot and his co-workers deserve much credit for their perfect organization of the meeting. There were 28 participants from 8 countries (Switzerland 8, France 7, FRG 5, Italy 3, Netherlands 2, and 1 from Austria, the United Kingdom and the United States, respectively). Among the participants, were a number of representatives from industry. The programme was divided into four sessions:

I: *Mating disruption in fruit growing*

Most of the contributions were devoted to major fruit pests such as *Laspeyresia pomonella* and *Adoxophyes orana*, but attention was also given to other pests such as *Grapholitha molesta* and *G. funebrana*, to *Synanthedon myopaeformis* and *Prays oleae*. On the afternoon of the first day, an excursion was organized around Nyon to see the mating disruption experiments being carried out by Dr Charmillot and his colleagues.

II: *Mating disruption in vineyards*

All experiments in this particular field were directed towards the two major leaf-roller pests *Eupoecilia ambiguella* and *Lobesia botrana*.

III: *Applications techniques*

This session dealt with the methodological problems in mating disruption experiments. Questions of the composition of pheromone/attractant mixtures, formulation techniques, dispenser spacing, measuring of pheromone evaporation rates, etc., were discussed.

IV: *General discussion and recommendations*

In Europe, mating disruption experiments have been carried out for 7-8 years in order to investigate the practical applications of this method. Although many improvements have been introduced, the experimental results are variable. The summer of 1982 proved to be a good leaf-roller season with high populations and with mostly negative results, particularly in fruit-growing. Results from vine-growing experiments appeared more promising.

The following major constraints were identified:

a) A lack of knowledge on the behaviour of insects when they are treated with an excess of pheromone or attractant.

   It is *recommended* that much more attention be paid to basic studies on behaviour of the moths in, for instance, windtunnel experiments in the laboratory. Direct observations in the field are also extremely useful but difficult because most of the insect pests involved in these studies fly during the night.

b) A lack of knowledge on the actual quantities of pheromone in the field. Gravimetric and chromatographic analyses of the dispensers provide only partial and indirect information on this matter.

   It is *recommended* that a simple method of directly measuring the proportion of pheromone in the air be worked out. Cooperation with commercial industry with their great expertise in this field is also highly recommended.

c) The lack of a satisfactory means of assessing the effect caused by pheromone treatment in mating disruption experiments. All available methods (captures in sex pheromone traps and in lure pots, mating condition of tethered female moths, counting numbers of eggs or larvae of the next generation and estimating damage at harvest) give only partial and indirect information, often without much causal evidence. Direct information about disruption of mating activity itself is very difficult to obtain.

   It is strongly *recommended* that this problem be studied intensively and a solution found. In the meantime, it is essential to use as many independent assessment methods as possible in mating disruption experiments in order to collect a maximum of evidence.

The general conclusion of the meeting was that everyone working in this field should carefully consider the possibility of spending more time on the improvement of techniques. We have before us a difficult choice; to continue with a trial and error approach in field experimentation or first to turn extra attention to the solution of more fundamental questions and return later to the field.

IOBC (GLOBAL)

IOBC Global Working Group on Trichogramma and Other Egg Parasites

The need for an IOBC Global Working Group on *Trichogramma* and other egg parasites was repeatedly recommended by scientists working with these beneficial arthropods. 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 necessary mass production methods, quality control of parasites reared in the laboratory, the ecological and behavioural problems, as well as a lack of communication are some of the important points to be dealt with initially. The presence of Dr F. Bennett as an IOBC (Global) representative at the meeting in Antibes facilitated official recommendation and election of representatives for this Working Group.

Subgroups	Convenors	Assistant convenors
Systematic Genetic	Dr J. Voegelé, FR	Dr Nagarkati, India Dr A. Hung, USA, Dr F. Bin, IT
Mass production Utilization	Dr S.A. Hassan, FRG	Mrs Dr Li Li-Ying, China Mr R. Morrison, USA
Ecology Behaviour	Dr J. van Lenteren, NL	Dr Y. Hirose, Japan Dr S.M. Grinberg, USSR

All representatives elected were asked to initiate and coordinate research on the relevant subject. The three convenors were asked to arrange for a section on *Trichogramma* and other egg parasites within the 18th International Congress of Entomology to be held from August 20-26, 1984, in Hamburg (FRG), and a Symposium in China in 1986. To improve communication, a periodical Newsletter is to be issued, starting in 1983.

IOBC Global Working Group on Quality Control of Mass-Reared Insects. Summary Report of the First Meeting on Quality Control in Insects Reared for Genetic Control, Gainesville, Florida, USA, 23-27 August 1982. Convenor: D.L. Chambers

The participants included scientists, plant managers and data processing specialists from USA (39), Mexico (7), Guatemala (4), Taiwan (2), Japan (1), UK (1), FRG (1) and Switzerland (1). The objectives of the meeting were: 1) to review the state of the art of quality control with respect to fruit flies, Lepidoptera and insects of medical and veterinary importance; 2) to identify immediate needs in ongoing genetic control operations and to discuss possible solutions; 3) to identify and establish international programs of research and cooperation to be coordinated by the Working Group, and to develop organizational working structures and essential services.

The format developed for discussion topics was as follows: definition of objectives; definition of requirements; production evaluation and control; product evaluation and control; impact on target population; achievement of objectives; data management.

Session on Quality Control of Insects of Medical and Veterinary Importance Produced for Release

The species considered at length were screwworm flies, houseflies, mosquitoes, stable flies, tsetse flies and biting midges; numerous other species were also discussed, including parasites and predators of important species. Perhaps the most crucial quality control gap in the production of these insects is the absence of a sound method for correlating the findings in laboratory-observed parameters with actual behavioural competency in the field. Another major need is to initiate automatic data processing methods so that production control and product quality information can be immediately available to production managers. The areas requiring high priority attention in the production of insects of medical and veterinary importance were identified, as were the areas in which constructive cooperative research efforts could be initiated immediately. Finally, the panel recommended topics for future meetings.

Session on Quality Control of Fruit Flies (Tephritidae) Produced for Release

The Sterile Insect Technique (SIT) has been used against the following species of fruit flies: *Ceratitis capitata, Dacus tryoni, Dacus cucurbitae, Dacus dorsalis, Dacus oleae, Anastrepha ludens* and *Rhagoletis cerasi* with varying degrees of success. These programs and the role of quality control in them were discussed. The primary need expressed was to determine the relevance of laboratory tests to the effectiveness of field behaviour after release. Other recommendations included adoption of an automated data processing system, identification of the factors of rearing and handling that influence behaviour and vitality, intensive studies on the irradiation dose/sterility level effects upon the effectiveness of the sterile flies in the field, and development of strain improvement techniques.

Session on Quality Control of Lepidoptera Produced for Release

Again, the importance of linking laboratory quality control monitoring techniques to field performance so that insect effectiveness can be predicted was emphasised, as was the need for an automated data processing system for mass rearing and utilising Lepidoptera. Other areas requiring attention included the development of genetic markers or other ways of evaluating the interactions of released and wild-type moths; optimisation of production efficiency; the development of methods to monitor quality of dietary ingredients; and determination of the effects of sublethal pathogen infection and poor nutrition on subsequent behaviour of mass-produced Lepidoptera.

Each Session produced a generalised outline for SIT, which is presented in tabular form, and itemises the various functions, the characteristics being measured, and the statistics.

Recommendations

It was decided to establish an information service to be operated for the next 2 years by staff members of the Gainesville USDA Laboratory for Insect Attractants, Behaviour and Basic Biology Research. It will: 1) issue an updated address list of persons involved in quality control (QC) activities, 2) establish a newsletter, 3) establish a data bank for QC literature.

Documents addressing specific topics will be prepared in due course. A list of potential research activities was developed during the meeting; project outlines will be sent to potential participants in the specific activities. Exchange of data, acceptance of standards and specifications and transfer of biological material all would be facilitated through acceptance of at least a few standard assay procedures. It was decided that the standardised Rapid Quality Control System developed for *Ceratitis capitata* be adopted as a provisional standard procedure for fruit flies by this group.

It was suggested that the Second Meeting of the QC Group be held in conjunction with the International Congress of Entomology in 1984 in Hamburg, DE.

NORDIC RESEARCH PROJECT ON BIOLOGICAL CONTROL OF ROOT DISEASES OF GLASSHOUSE CROPS

By J. Hockenhull, DK. Chronica Horticulturae 22 (3): 48 (1982)

A project financed by the Nordic Council of Ministers and the National Agricultural Research Councils, involving Denmark, Finland, Iceland, Norway and Sweden, was initiated in 1981 to direct the efforts of co-operating researchers specifically towards root disease problems occurring in vegetable and ornamental glasshouse crops. The problems associated with modern growing techniques based on peat, synthetic fibre products and hydroponic systems are being studied. Current objectives include: 1) isolation and study of antagonists to the common root pathogens *Pythium, Phomopsis, Phytophthora, Rhizoctonia, Fusarium,* etc., 2) development of growth media able to suppress pathogenic organisms and thus decrease disease severity, 3) study of the mechanisms of biological control in selected plant pathogen/antagonist systems, 4) the practical application of research results to the control of specific diseases. Researchers from participating countries meet twice a year to review progress and plan for future coordinated effort. Contact with other regional or independent projects on biological control of root pathogens will be welcomed. Contact persons and research areas are as follows:

Denmark:

Kirsten Thinggaard: Control of black root rot of cucumber *(Phomopsis sclerotioides).*

John Hockenhull: Growth promoting and antagonistic rhizobacteria.

Royal Veterinary and Agricultural University, Department of Plant Pathology, Thorvaldsensvej 40, DK-1871 Copenhagen V.

Finland:

Risto Tahvonen & Marja-Leena Lahdenperä: *Streptomyces* in peat. Control of *Fusarium* wilts of carnation and tomato, root rot of cucumber and *Botrytis* and *Rhizoctonia* diseases of lettuce with *Streptomyces.*

Helsinki University, Institute of Plant Pathology, Viikki, SF-00710 Helsinki 71.

Iceland:

Halldór Sverrisson: Heat tolerant antagonistic microorganisms. Control of root rots in peat soil by heat treatment.

Agricultural Research Institute, Keldnaholt, IS-110 Reykjavik.

Norway:

Jan Solberg: Control of corky root of tomato *(Pyrenochaeta lycopersici).*

Leif Sundheim: Control of grey mould *(Botrytis cinerea)* and stem & fruit rot *(Didymella bryoniae)* of cucumber.

Control of cucumber powdery mildew by the hyperparasite *Ampelomyces quisqualis.*

Norwegian Plant Protection Institute, Division of Plant Pathology, NO-1432 As-NLH.

Sweden:

Birgitta Rämert: Diseases of cucumber and tomatoes.

Sadhna Alström: Growth promoting and antagonistic rhizobacteria.

Swedish University of Agricultural Science, Department of Plant- Forest Protection, Box 7044, SE-750 07 Uppsala.

FORTHCOMING MEETINGS

6th British Pest Control Conference, 7-10 September 1983, Cambridge, UK.

Meetings of the IOBC Executive Committee and Council

These meetings will be held during the 10th International Congress of Plant Protection (Brighton, GB, 20-25 November, 1983).

General Assembly

It is anticipated that the IOBC General Assembly will be held during the Entomology Congress (Hamburg, DE, 1984).

BOOKS

Biological Control of Weeds: a World Catalogue of Agents and their Target Weeds. Edited by M.H. Julien. CAB Biological Control Miscellaneous Publications No. 11, vi + 108 pp (1982). ISBN O 85198 4940

Annotated bibliographies, comprising series of abstracts, issued by the Commonwealth Institute of Entomology (56 Queen's Gate, London SW7 5JR, UK):

- E54 Biocontrol of termites 1973-1981, 75 references.
- E61 Integrated control of insect pests in Chile 1973-1981, 108 references.
- E62 *Beauveria bassiana:* culturing and applications 1973-1981, 331 references.
- E71 Biocontrol of waterhyacinth 1973-1981, 64 references.
- E74 Integrated pest management in Colombia 1973-1981, 85 references.

SELECTED ABSTRACTS

a) Plant Protection

1. INSECT AND MITE CONTROL

i) Entomopathogens

E.M. Dougherty et al. (1982). Biological control of the greater wax moth utilising in vivo and in vitro-propagated baculovirus. J. econ. Ent. 75 (4): 675-679

Galleria mellonella is a serious pest of the honey bee industry and causes millions of dollars damage annually in the United States. Currently, biological control methods are being investigated to replace chemical fumigants used to control wax moth populations. *In vivo* and *in vitro*-produced, multiple-embedded nuclear polyhedrosis virus of *G. mellonella* (MGmNPV) were used to control artificially induced wax moth populations. No significant differences in virulence (0.05 level) were noted between *in vitro* and *in vivo*-produced MGmNPV tested in an *in vivo* bioassay. MGmNPV virus produced *in vivo* and *in vitro* and applied at a dose of 1×10^9 polyhedral inclusion bodies per section (5 by 10 cm) of drawn honey comb proved efficacious under laboratory conditions. Similar results were

obtained under field conditions where economically important damage was prevented with similar dosages. A cost of 22 cents per 10-frame hive was calculated for *in vitro*-produced virus used in control studies.

F.M. Stephen et al. (1982). Preliminary evaluation of codling moth granulosis virus for suppression of Nantucket pine tip moth. J. Ga Ent. Soc. 17 (3): 398-404

A granulosis virus from codling moth, *Laspeyresia pomonella*, was tested against the Nantucket pine tip moth, *Rhyacionia frustrana*, in an effort to determine virus dosage parameters required for significant reduction of larval tip moth populations under field conditions. The results, although preliminary, suggest that *L. pomonella* granulosis virus will infect Nantucket pine tip moth in the field. Samples collected through time, from trees sprayed to runoff with virus dosages of 1×10^7, 10^8, and 10^9 capsules/ml generally yielded tip moth densities significantly lower than the control and 1×10^6 capsule/ml treatment.

C.J. Savanurmath & S.B. Mathad (1982). Competence of endosulfan integration with nuclear polyhedrosis virus in the management of armyworm Mythimna (Pseudaletia) separata. Z. ang. Ent. 93 (4): 413-420

Eight-day-old *Mythimna (Pseudaletia) separata* larvae were fed for 24 h on formulations containing simultaneous or sequential combinations of nuclear polyhedrosis virus and endosulfan incorporated into artificial diet at LC_{10}, LC_{25} and LC_{50}s. Prior and simultaneous endosulfan treatment or the virus treatment followed by endosulfan at 1 and 3-day lags almost restrained virus activity. Out of 51 combinations tried, only 8 produced significantly high mortality. While none from simultaneous and one from prior treatment endosulfan combinations yielded potentiating synergism, most of the postinfection treatments of endosulfan at 7-day lag, especially in combination with high concentration virus, produced significantly high mortality. The combinations of LC_{25} and LC_{50} virus followed by LC_{25} endosulfan yielded significantly high virus disease incidence. Further, the postinfection treatments of higher concentration endosulfan proved especially effective in affecting the sex ratio and male pupal weights of survivors. Remarkably, the higher concentrations of virus followed by endosulfan significantly reduced male pupal weights in the majority of combinations and female pupal weights in certain combinations with LC_{50} endosulfan. Among the 8 combinations that produced potentiating synergism, 2 were economically inviable and 2 others were deemed insufficient to stabilise virus in the ecosystem. The remaining four combinations could be tried in the field to control *M. (P.) separata*.

N.E. Crook & J.D. Brown (1982). Isolation and characterisation of a granulosis virus from the tomato moth, Lacanobia oleracea, and its potential as a control agent. J. Invert. Path. 40 (2): 221-227

A disease causing death in *Lacanobia oleracea* occurring in glasshouses in Scotland was shown to be caused by a granulosis virus (GV). Structural properties of the virus were examined by electron microscopy, immunodiffusion, polyacrylamide gel electrophoresis, and restriction endonuclease analysis and compared with an isolate of GV from *L. oleracea* obtained from France. The two isolates were structurally very similar but could be distinguished by analysis of *Eco*RI digests of their DNAs. Bioassays of the virus gave LD_{50} values from $10^{4.3}$ capsules for second-instar larvae to $10^{6.6}$ capsules for fifth-instar larvae. The French isolate was bioassayed in third-instar larvae and was not found to differ significantly from the Scottish isolate. Two small glasshouse trials using the virus to control artificial infestations of *L. oleracea* indicated that high-volume sprays of virus at 10^8 to 10^9 capsules/ml achieved good control. An alternative strategy using much smaller amounts of virus to control the insect is discussed.

R.H.S. Rajapakse & K. Jeevaratnam (1982). Use of a virus against the root and stem borer, Plocaederus ferrugineus, of the cashew. Insect Sci. Applic. 3 (1): 49-51

The virus *Rhabdionvirus oryctes* was tried against the root and stem borer of the cashew (*Anacardium occidentale*) in Sri Lanka by pouring a virus suspension into the galleries, releasing virus-infected adults and placing virus-mixed sawdust at the base of the infested stem. Results obtained after several surveys showed that the sawdust technique gave more positive results. The establishment of virus infection in the beetle population accounted for a reduction in beetle damage to trees in certain pockets of the cashew plantation.

D.W. Johnson et al. (1982). A temperature-dependent developmental model for a nucleopolyhedrosis virus of the velvetbean caterpillar, Anticarsia gemmatalis. J. Invert. Path. 40 (2): 292-298

Developmental times and rates of nucleopolyhedrosis virus infection in third-instar velvetbean caterpillar, *Anticarsia gemmatalis*, larvae were studied in the laboratory at a variety of constant and variable temperatures. Developmental time was considered to be time from inoculation until death. Viral infection exhibited a temperature optimum of *ca* 30°C and was inhibited at 10 and 40°C. Mean developmental time of the virus ranged from 18.1 days (15°C) to 5.5 days (30°C). Means and standard deviations of viral developmental rates (= development time^{-1}) were used as inputs into a previously derived absolute reaction rate model designed to generate a set of kinetic constants usable in predicting developmental times. Actual distributions of viral cohort developmental times were compared to distributions generated by the model. Reasonable agreement between predicted and actual distributions was found at three of four temperatures tested.

M.A. Mohamed et al. 1982). Persistence in soil and on foliage of nucleopolyhedrosis virus of the European pine sawfly, Neodiprion sertifer. Environ. Ent. 11 (5): 1116-1118

Six plots of pine trees harboring high densities of *N. sertifer* larvae were sprayed with the nucleopolyhedrosis virus (NPV) of this species. Half of these plots were resprayed in the second year of the study. Polyhedral inclusion bodies (PIB) were recovered in all plots from soil and foliage sampled at fixed time intervals within a 21-month period from the initial date of spraying. The concentration of PIB from both soil and foliage samples in the second year were generally lower in plots treated once than in those treated twice. NPV-induced larval mortality in plots sprayed once was 100% in the first season and 8% in

the second. Laboratory bioassays of soil samples at intervals within the 21-month period resulted in 11 to 80% NPV-induced larval mortality. This study suggests that the NPV of *N. sertifer* can persist and retain some activity for at least 21 months under field conditions.

M.J. Fraser & G.R. Stairs (1982). Susceptibility of Trichoplusia ni, Heliothis zea and Manduca sexta to a nuclear polyhedrosis virus from Galleria mellonella. J. Invert. Path. 40 (2): 255-259

Several alternate hosts were tested for their relative susceptibility to an isolate of *Galleria mellonella* nuclear polyhedrosis virus. Neonate *Trichoplusia ni, Heliothis zea,* and *Manduca sexta* were all susceptible to per oral administration of purified polyhedra. Of the three alternate species tested, *T. ni* was the most susceptible, and exhibited the most variable mortality response over the dose range tested, while *M. sexta* was the least susceptible. We believe this represents the first report of a lethal virus infection in a sphingid species, and useful parameters for the successful inoculation of alternate hosts are discussed.

H.D. Burges et al. (1982). Numbering the H-serotypes of Bacillus thuringiensis. J. Invert. Path. 40 (3): 419

Recently, new H-serotypes of *Bacillus thuringiensis* have been isolated by different laboratories at an increasing frequency. It has been difficult to avoid confusion in the numbering of the new serotypes. In order to avoid such confusion, we recommend the following general voluntary procedure which is normally used already, since there is an International Reference Centre for *B. thuringiensis* held by H. de Barjac at the Institut Pasteur, 25, rue du Docteur Roux, 75724 Paris Cedex, France. Before a manuscript on a new *B. thuringiensis* serotype is submitted to a scientific journal, it is suggested that a copy of this manuscript and a subculture of the new isolate be sent to the Reference Centre. If the *B. thuringiensis* isolate does not react with serotypes already numbered, the sender will receive from H. de Barjac information and subculture(s) of precedent new serotype(s) being considered for publication to allow further comparison with his isolate. Finally, the proposed number for the new serotype should be agreed upon by the Reference Centre before publication. Such a custom would help to avoid confusion in the numbering of new H-serotypes of *B. thuringiensis*.

A.-S. A. Ali & T.F. Watson (1982). Effects of Bacillus thuringiensis var. kurstaki on tobacco budworm adult and egg stages. J. econ. Ent. 75 (4): 596-598

Efficacy of *Bacillus thuringiensis* var. *kurstaki* against the adult and egg stages of *Heliothis virescens* was studied under laboratory conditions. The longevity and fecundity of adults were significantly reduced when a 5% sucrose solution containing 32,000 IUs of *B. thuringiensis* per ml was provided as a food source. Tobacco budworm eggs sprayed directly with *B. thuringiensis* hatched normally, but larval survival was significantly affected, indicating that some larvae had consumed a lethal dose during eclosion. Mortality was directly related to dosage level and age of egg.

A.-S. A. Ali & T.F. Watson (1982). Survival of tobacco budworm larvae after short-term feeding periods on cotton treated with Bacillus thuringiensis. J. econ. Ent. 75 (4): 630-632

Studies were conducted to determine if any adverse effects ensued when larvae of *Heliothis virescens* survived various feeding periods on cotton treated with *Bacillus thuringiensis*. Some of the 2nd instars that were fed *B. thuringiensis*-treated terminals for 6, 18, or 30 h and then transferred to an untreated diet survived. The ability of larvae to recover decreased with increases in dosage rate or exposure time. After feeding periods of 18 or 30 h, duration of the larval stage was significantly increased. Effects on pupae were similar. No effects on adult longevity, fecundity, egg viability or F_1 larval survival were detected.

W.H. McGaughey (1982). Evaluation of commercial formulations of Bacillus thuringiensis for control of the Indianmeal moth and almond moth in stored inshell peanuts. J. econ. Ent. 75 (4): 754-757

In laboratory tests, a dust formulation of *Bacillus thuringiensis* was superior to a WP formulation in protecting farmer's stock (inshell) peanuts from Indianmeal moth, *Plodia interpunctella,* and almond moth, *Ephestia cautella,* infestation. The WP did not completely eliminate moth emergence at rates as high as 625 mg/kg when applied as either a bulk or surface layer treatment. Efficacy of the WP was not improved by more uniform application. The dust nearly eliminated moth emergence when used as a surface layer or bulk treatment at 500 mg/kg. At equivalent dosages, the dust limited moth emergence and peanut damage to $\leqslant 5\%$, but the WP permitted *ca* 23% moth emergence and peanut damage.

A. Krieg (1982). The potential pathogenicity of spore-formers (genus Bacillus) for larvae of Galleria mellonella and its conditions. Z. ang. Ent. 93 (4): 355-365

In vivo and *in vitro* experiments demonstrated that the reaction of larvae of the greater wax moth following an injection of spore-formers is dependent not only on the production of exoenzymes and toxins but also on the sensitivity of the bacilli to lysozyme. Potential pathogenicity was typical for strains of the *B. cereus/B. thuringiensis* group (including *B. finitimus,* Fowler's bacillus and *B. mycoides*) which showed resistance to lysozyme. However, in the case of *B. megaterium,* all apathogenic strains were lysozyme-sensitive.

R.A. Samson & C.W. McCoy (1982). A new fungal pathogen of the scavenger mite, Tydeus gloveri. J. Invert. Path. 40 (2): 216-220

A new fungal pathogen, *Hirsutella tydeicola,* was found causing epizootics in populations of the scavenger mite, *Tydeus gloveri,* during the summer of 1979 and 1980 on citrus in Florida. The fungus is described in association with its host using light and scanning electron microscopy. *H. tydeicola* is compared with a closely related species, *H. thompsonii,* a coexisting pathogen of the citrus rust mite. All attemps to isolate the fungus on various agar media failed.

P.V. Gopinathan et al. (1982). Occurrence of Fusarium equiseti as a fungal parasite of Brinjal mealy bug, Coccidohystrix insolita. Entomon 7 (1): 120-121

This is the first report of *F. equiseti* as a parasite of the Brinjal mealy bug. About 30% of the population was found

to be mummified by the pathogen. It was isolated in pure culture on Czapek's medium.

A.K.A. Mohamed (1982). Pathogenicity of Nomuraea rileyi and its effect on food consumption and utilisation by Heliothis virescens larvae. J. Ga Ent. Soc. 17 (3): 377-382

Instars 2-5 of *Heliothis virescens* larvae were equally susceptible to *Nomuraea rileyi* conidia. The highest mortality was 77% among the 5th instar larvae. The consumption of cotton squares by untreated larvae for days 5 and 6 was significantly lower ($P = 0.05$) than larvae infected with *N. rileyi*. There was no significant difference in the approximate digestibility of the treated and untreated larvae. The efficiency of conversion of ingested and digested food to body substance was significantly higher ($P = 0.05$) in the control than the *N. rileyi* treated larvae for days 4-6.

G. Zimmermann (1982). Investigations on the efficacy of Metarhizium anisopliae on eggs and hatching first-instar larvae of Otiorhynchus sulcatus. Z. ang. Ent. 93 (5): 476-482

In several infection experiments, it could be proved that the entomopathogenic fungus *Metarhizium anisopliae* is able to infect young eggs of the black vine weevil, *Otiorhynchus sulcatus*. Increasing age of eggs is correlated with increasing resistance to the fungus. Using a concentration of 1.0×10^8 conidia/ml, the mean lethal infection rate of 1-day-old white eggs was 84% after an incubation period of 3 weeks at 20°C; in contrast, 6 and 8-day-old brown-coloured eggs were destroyed by the fungus at rates of only 12% and 4%, respectively. First-instar larvae hatching from treated eggs were also infected by *M. anisopliae* up to nearly 25%. Further tests with 1-day-old white eggs revealed a good concentration-mortality correlation, with an LC_{50} of 1.21×10^7 conidia/ml. The possibility of using the egg stage of *O. sulcatus* for biotests is discussed.

R.L. Brandenburg & G.G. Kennedy (1982). Relationship of Neozygites floridana to twospotted spider mite populations in field corn. J. econ. Ent. 75 (4): 691-694

Abrupt declines in populations of *Tetranychus urticae* are frequently associated with epizootics of the pathogen *Neozygites floridana*. Use of benomyl and chlorothalonil to exclude the fungal pathogen from twospotted spider mite populations in field corn plots did not prevent this population decline. Environmental monitoring revealed that periods of cooler temperatures and high relative humidity ($\geq 90\%$) prevailed for *ca* 40 h before a noticeable increase in the incidence of the pathogen. A small percentage (2.7) of the spider mites that dispersed from the corn on wind currents were infected with the pathogen and transported it to new host sites.

N. Claydon & J.F. Grove (1982). Insecticidal secondary metabolic products from the entomogenous fungus Verticillium lecanii. J. Invert. Path. 40 (3): 413-418

Seven strains of the insect pathogenic fungus *Verticillium lecanii* have been examined in the *Calliphora erythrocephala* bioassay for the production, in surface culture on Czapek Dox medium, of insecticidal secondary metabolites. One strain which had lost its pathogenicity on storage yielded no active compounds. The remainder yielded dipicolinic acid (pyridine-2,6-dicarboxylic acid) which was responsible for the insecticidal activity of acidic extracts. Neutral extracts from two strains contained novel insecticidal C_{23} compounds.

R.E. Hillman et al. (1982). Effects of a haplosporidian parasite, Haplosporidium sp., on species of the molluscan woodborer, Teredo, in Barnegat Bay, New Jersey. J. Invert. Path. 40 (3): 307-319

Abundance of the molluscan woodborer, *Teredo navalis*, in Barnegat Bay, New Jersey, was reduced in breeding seasons following levels of infection of 40% or more by a haplosporidian parasite of the genus *Haplosporidium*. Infections also occurred in *T. bartschi* and *T. furcifera*, subtropical species which have been introduced into Barnegat Bay, and which may have originally introduced the parasite. Infections were not observed in *Bankia gouldi*, the most common molluscan woodborer in the bay.

L.C. Lewis (1982). Persistence of Nosema pyrausta and Vairimorpha necatrix measured by microsporidiosis in the European corn borer. J. econ. Ent. 75 (4): 670-674

Aqueous suspensions of spores of *Nosema pyrausta* were applied to corn foliage with and without shade during the whorl and pollen-shedding stages of plant development. Larvae of *Ostrinia nubilalis* were placed on the plants at certain times after application of the microsporidium. Shade did not affect the persistence of *N. pyrausta* as determined by the prevalence of a microsporidiosis in the European corn borer. Evidently, the structure of the corn plant protects *N. pyrausta* spores from the detrimental effects of ultraviolet radiation. Aqueous suspensions of spores of *N. pyrausta* and *Vairimorpha necatrix* were applied separately to corn foliage in both the whorl and pollen-shedding stages of plant development. European corn borer larvae exposed to *N. pyrausta* had an equal or greater prevalence of microsporidiosis than those exposed to *V. necatrix* during both stages of plant development. During the whorl stage of plant development, insects exposed to *V. necatrix* had a greater intensity of microsporidiosis, measured as spores per mg of infected tissue. During the pollen-shedding stage of plant development, there were no differences in intensity between microsporidia. Both microsporidia caused an infection in corn borer larvae 12 days after application.

J.J. Hamm & R.E. Lynch (1982). Comparative susceptibility of the granulate cutworm, fall armyworm and corn earworm to some entomopathogens. J. Ga Ent. Soc. 17 (3): 363-369

In laboratory tests, newly-hatched larvae of the granulate cutworm, *Feltia subterranea*, the fall armyworm, *Spodoptera frugiperda*, and the corn earworm, *Heliothis zea*, were treated with four concentrations of three species of microsporidia, *Vairimorpha necatrix*, *V. heterosporum*, *V.* sp. from *Alabama argillacea* from Bolivia, a nuclear polyhedrosis virus from *Heliothis armigera* from the USSR, and a granulosis virus of *H. armigera* from South Africa. The nuclear polyhedrosis virus resulted in the shortest time to death but the granulate cutworm and fall armyworm were much less susceptible than the corn earworm. All three species were highly susceptible to *V. necatrix*, even at a concentration of 7.6×10^3 spores per ml diet.

ii) Parasites and Predators

B. Puttler (1982). Studies on a potential parasite (Edovum puttleri Grissell) for the biological control of the Colorado potato beetle. USDA, SE, ARS, Biological Control of Insects Research Laboratory, Columbia, Missouri (USA)

In host specificity tests conducted in the laboratory with the recently introduced eulophid egg parasite *Edovum puttleri* n.g., n.sp. reared from *Leptinotarsa undecimlineata* (Chrysomelidae) in Colombia (S.A.), the parasite was readily attracted to and successfully parasitized eggs of the Colorado potato beetle, *L. decemlineata*, and the false Colorado potato beetle, *L. juncta*. *Labidomera clivicollis* (which feeds on climbing milk weed) served as an occasional host. Eggs of 8 other species of chrysomelid beetles and 10 species of Coccinellidae were not acceptable as hosts. The results of these tests clearly indicate that the parasite has a restricted host range, with high specificity to chrysomelids of the genus *Leptinotarsa* or perhaps some other species of genera in the tribe Doryphorini, to which the aforementioned hosts belong.

Edovum puttleri is a solitary endoparasite. It prefers to oviposit in eggs ⩽72 h old and completes its life-cycle (egg-adult) in 14 to 15 days at 78°F. Mating takes place shortly after emergence, with the females undergoing a preoviposi-tional period of *ca.* 24 h. Host feeding is common and contributes substantially to egg mortality.

Trial field releases in 1980 and 1981 in Missouri have shown that the parasite can find and parasitize natural populations of Colorado potato beetle eggs on potato, eggplant, and tomato plants. One release of 1,000 to 3,000 parasites usually allows for parasite recoveries throughout the season when host stages are available on the particular crop. Similar results were obtained with parasites reared in Missouri and shipped for release in Maryland and Delaware in co-operation with Schroder and Schaefer of the USDA Biological control laboratories in the respective states.

T.G. Andreadis (1982). Current status of imported and native parasites of the European corn borer in Connecticut. J. econ. Ent. 75 (4): 626-629

Of the four imported insect parasites of *Ostrinia nubilalis* which were established in Connecticut in 1954, only an ichneumonid, *Eriborus terebrans*, and a braconid, *Macrocentrus grandii*, were recovered in fall and spring surveys conducted from 1978-1981. *E. terebrans* was collected from one location only and occurs at a very low level. *M. grandii* is widespread and sufficiently abundant in some areas to possibly aid in the natural suppression of the European corn borer (ECB). *M. grandii* emergence from ECB larvae in the spring is well synchronized with emergence of ECB adults, and this parasite appears well adapted to the seasonal occurrence of the ECB in this region. Native parasites found include two tachinid flies, *Aplomya caesar* and *Lixophaga* sp. Both are widespread but account for less than 6% of total parasitism, and neither parasite appears to have a significant controlling effect on ECB populations.

L.B. Huebner & H.C. Chiang (1982). Effects of parasitism by Lixophaga diatraeae on food consumption and utilisation of European corn borer larvae. Environ. Ent. 11 (5): 1053-1057

Parasitism of European corn borer, *Ostrinia nubilalis*, larvae by *Lixophaga diatraeae* in the early 3rd, 4th and 5th instars resulted in a significant reduction in the amount of food consumed, frass weight, weight gained and length of feeding period. The approximate digestibility was significantly greater for parasitized larvae of all three instars fed on artificial diet. Efficiency of conversion of ingested food to body substance was higher in unparasitized than parasitized larvae of the 4th and 5th instars. Efficiency of conversion of digested food to body substance was higher in unparasitized larvae of all three instars. The effects of *L. diatraeae* on *O. nubilalis*, an unnatural host, are very similar to the effects of this parasite on its natural host, *Diatraea saccharalis*.

H. Kajita & J.C. van Lenteren (1982). The parasite-host relationship between Encarsia formosa and Trialeurodes vaporariorum. XIII. Effect of low temperature on egg maturation of Encarsia formosa. Z. ang. Ent. 93 (5): 430-439

To develop programs for the biological control of the greenhouse whitefly, *Trialeurodes vaporariorum*, in tomatoes at the new temperature regimes, information is required about the reproduction capacity of *Encarsia formosa* at these low temperatures. Egg maturation, oviposition behaviour and oviposition frequency were tested using females kept at temperatures of 5, 10, 15, 20 and 25°C. All females were put at 25°C for 2 days immediately after emergence and prior to the experiments; they were allowed to feed and oviposit. During the following period of 4 days, females kept at 5 and 10°C laid (almost) no eggs. Egg maturation did not occur at 5°C and is also absent or very slow at 10°C. At temperatures of 15°C or higher, the rate of egg maturation and the number of eggs laid increased with increasing temperature. All females kept at the 5 different temperatures for 4 days, laid eggs when they were placed at 25°C for a 16- h period. The intended future rearing temperatures at night, which will be below 15°C, greatly reduce egg maturation of *E. formosa*. With the data reported in this paper, we can estimate the reproduction capacity of *E. formosa* as soon as the final details of the new temperature regimes for tomato growing will be available.

B.S. Ekbom (1982). Diurnal activity patterns of the greenhouse whitefly, Trialeurodes vaporariorum, and its parasitoid, Encarsia formosa. Protection Ecology 4 (2): 141-150

Diurnal activity patterns of the greenhouse whitefly *(Trialeurodes vaporariorum)* and its parasitoid, *Encarsia formosa*, were studied in greenhouse and laboratory trials. In greenhouse studies, whiteflies were most active in the middle of the day, both in autumn and spring. There were no differences in hourly activity under short-day conditions. A peak in hourly activity under long-day conditions occurred in the middle of the day (10.00 – 13.00 h) for whiteflies. In autumn, *Encarsia formosa* was most active between 14.00 and 16.00 h. This peak was not observed in the spring. Long-day laboratory trials showed significantly lower activity during the first morning hour (08.00 h) for *E. formosa* and short-day trials showed lower activity during the first three morning hours (08.00 – 10.00 h). The apparent time lag between sunrise (or switching on of lights) and the most active periods for *E. formosa* may be a factor affecting the parasitoid's efficiency when day length is short, for example in the early spring.

W. Olkowski et al. (1982). Linden aphid parasite establishment. Environ. Ent. 11 (5): 1023-1025

The linden aphid, *Eucallipterus tiliae*, is a pest on linden trees, *Tilia* spp., which are common as urban shade trees thoughout North America. The aphidiid *Trioxys curvicaudus*, which is monophagous on *E. tilia*, was imported from Europe and released in Berkeley, Calif., where it became established. Subsequent observations showed that the parasite had effectively reduced linden aphid populations below an aesthetic injury level.

R.M. McPherson et al. (1982). Incidence of tachinid parasitism of several stink bug species associated with soybean. J. econ. Ent. 75 (5): 783-786

Parasitism by tachinids of 13 species of pentatomids collected primarily in soybean fields from four locations in Louisiana was evaluated during a 3-year study. Parasitism was determined by examining the hosts externally for the presence of parasite eggs plus holding them in the laboratory and observing for parasite emergence. Parasite species composition was determined for each pentatomid. Seasonal rates of parasitism were evaluated for the pest species, *Nezara viridula*, *Acrosternum hilare* and *Euschistus* spp. Seven tachinid species were recovered. Only *Trichopoda pennipes* was observed developing on *N. viridula*. Supernumerary oviposition, with up to 19 and 25 eggs observed on single *N. viridula* and *A. hilare* males, was common by this parasite. *N. viridula* were dissected in the laboratory to determine the incidence of parasite larvae, the gonadal developmental stages of males and females most commonly parasitized, and the effects of parasitism on the fecundity of parasitized female hosts. Although significantly more parasite eggs were deposited on males than on females, the percent with parasite larvae and number of larvae per host were not statistically different between sexes. Significantly more of the *N. viridula* bearing larvae were in the later compared with the earlier gonadal developmental categories. The mean number of eggs per reproductively active female was significantly reduced in parasitized *N. viridula*. Parasitism of *N. viridula* was higher in collections made from cowpea than from soybean.

J.A. Odebiyi (1982). Parasites of the cotton leafroller, Sylepta derogata, in southwestern Nigeria. Bull. ent. Res. 72 (2): 329-333

Surveys of parasites of *Sylepta derogata* on cotton at Ibadan, Nigeria, in 1979-1980 showed that there were three larval parasites: *Apanteles syleptae*, *A. sagax* and *Charops* sp. An average of 17.7% parasitism was recorded, and *A. syleptae* accounted for 98.6% of this. There were three pupal parasites: the chalcidid *Brachymeria feae*, the ichneumonid *Xanthopimpla* sp. and the tachinid *Cadurcia auratocauda*. Together, they caused an average of 31.7% parasitism. *Xanthopimpla* was the most abundant, while *B. feae* was of secondary importance.

R. Singh & T.B. Sinha (1982). Bionomics of Trioxys indicus, an aphidiid parasitoid of Aphis craccivora. X. Superparasitism caused by confinement with the host. Ent. exp. appl. 32 (3): 227-231

Superparasitism in *Aphis craccivora* by *Trioxys indicus* was observed in the field and in the laboratory. A parasitoid which is ready to oviposit will not so readily lay eggs in parasitized hosts, and search-deterring substances may reduce superparasitism. As the number of parasitized hosts in a container increases, the "escape" attempts of the parasitoid are more frequent. After a period of preening and standing-still, the parasitoid returns to the leaf, begins to encounter, prick and probe the hosts again; the escape tendency apparently decreases. These activities either lower the oviposition threshold or overcome it, resulting in superparasitism.

E.E. Grafton-Cardwell (1982). Ovipositional response of Meteorus leviventris to various densities of Agrotis ipsilon. Environ. Ent. 11 (5): 1026-1028

The ovipositional response of the parasitoid *Meteorus leviventris* was examined over five host densities. Fecundity was the same for all host densities tested. Daily oviposition peaked *ca* 48 h after emergence, then decreased as parasitoids aged. Both the total number of eggs deposited and the number of hosts parasitized per 12 h were significantly higher during the dark phase of the LD 12:12 cycle. The maximum number of hosts parasitized during a 12-h period for any parasitoid was 8, with an average of 3.5 hosts for parasitoids exposed to 12 hosts per 12 h. With increasing host density, more total hosts were parasitized, resulting in lower numbers of eggs per host and fewer incidences of superparasitism.

J.H. Lashomb & A.L. Steinhauer (1982). Association of three Nantucket pine tip moth parasitoids within the crown of loblolly pine. J. Ga Ent. Soc. 17 (3): 287-292

The association between two primary parasitoids of the Nantucket pine tip moth, *Lixophaga mediocris* and *Campoplex frustranae*, and a facultative ecleptoparasitoid, *Eurytoma pini*, within loblolly pine crowns was tested by chi square analysis. Results of the analysis show that numerical superiority and earlier emergence by *Lixophaga mediocris* does not result in competitive exclusion of *C. frustrana*. The facultative nature of *E. pini* is corroborated by field data.

J.I. Olaifa & A.E. Akingbohungbe (1982). Bionomics of Bracon? hancocki, a larval parasite of Cydia ptychora in Nigeria. Bull. ent. Res. 72 (4): 567-572

Bracon? hancocki is a larval ectoparasite of *Cydia ptychora*, a major pest of cowpea at Ile-Ife, Nigeria. Parasitism occurred in the field all the year round, varying from 0 to 65.9% and with the highest incidence from September to February. In the laboratory, the fecundity of the parasite was low, averaging about six eggs per female. The life-cycle was completed in ten days. Mating occurred soon after emergence, and the preoviposition period lasted about 2-3 days. Unmated females rarely laid eggs, and their life-span averaged six days, as compared to 14 days for mated females. The female: male ratio was 2:1. The parasite rarely attacked previously paralysed hosts, and the preferred hosts were the older, larger larvae. A description of the egg and larvae is given.

R.C. Berberet (1982). Effects of host age on embryogenesis and encapsulation of the parasite Bathyplectes curculionis in the alfalfa weevil. J. Invert. Path. 40 (3): 359-366

First through fourth-instar larvae of *Hypera postica* were fixed at 12 to 24-h intervals after parasitization by

Bathyplectes curculionis and sectioned histologically. Sections revealed that host age had little effect on time required for embryogenesis and hatching of parasites. *B. curculionis* completed larval development and emerged from all host instars ca. 11 days after parasitization at 22.2°C. Parasite eggs were fully encapsulated in just 3.3% of the first-instar *H. postica* compared with 50.0% in the third instar. Much larger hemocyte capsules were formed in later instars as well.

F. Kozar et al. (1982). Comparative evaluation of the distribution of scale insects and their parasites in Georgia (USSR) and in Turkey. Survey of scale insect infestations in European orchards, No. VI. Z. ang. Ent. 93 (4): 333-338

Quadraspidiotus perniciosus, Epidiaspis leperii and *Lopholeucaspis japonica* are the main scale insect species on deciduous fruit trees in Georgia. A new pest is *Parlatoria theae* on apple. Samples of Q. *perniciosus* collected from old infestation foci were parasitized to 87.9%, while those from the new distribution area of this species in Turkey, to only 34.5%. The parasites *Aphytis maculicornis, A. mytilaspidis, A. proclia, Aspidiotiphagus citrinus, Discodes coccophagus, Prospaltella berlesei* and *P. perniciosi* were detected. *L. japonica* and *Ceroplastes japonicus* were only slightly attacked by parasites in Georgia.

E.J. Stark & J.D. Harper (1982). Pupal mortality in forest tent caterpillar: causes and impact on populations in southwestern Alabama. Environ. Ent. 11 (5): 1071-1077

Analyses of pupal mortality factors were made in six subpopulations of forest tent caterpillar (FTC), *Malacosoma disstria*, in Baldwin and Mobile countries in southwestern Alabama in 1977, 1978, and 1979. Infestations were confined to a cypress-tupelo deltoid swamp with water tupelo, *Nyssa aquatica*, as the predominant host species. Major identifiable mortality factors included predation, disease and parasitism. Pupal predation was attributable predominantly to birds and ants, whereas the entomogenous fungus *Beauveria bassiana* caused all observed mortality attributable to disease. Fifteen parasitic insects were reared from FTC pupae; nine were considered primary parasites and six were hyperparasites. Rate of pupal parasitization was less than 60% in 17 of 18 temporally or spatially distinct samples during the 3-year study. Although parasitism was the most important cause of pupal mortality, it did not appear to be a dominant regulatory factor for FTC in this ecosystem. Neither host population quality nor density was highly correlated with degree of parasitism. The aquatic habitat places severe restrictions on the species of parasites which can effectively utilize FTC as a host, which in turn limits total parasite impact.

D.N. Raychaudhuri et al. (1982). Study of the genus Aphidius of India. Entomon 7 (1): 11-22

Eight species of *Aphidius* are described, and a distribution map given.

R.C. Bhagat (1982). Aphid galls and their parasitoids from Kashmir, India. Entomon 7 (1): 103-105

Brief descriptions with illustrations are given of various aphid galls from Kashmir, together with records of the aphid species causing these galls and the hymenopterous parasitoids attacking the gall-producing aphids.

K. Furuta (1982). Natural control of a Lymantria dispar population at low density levels in Hokkaido (Japan). Z. ang. Ent. 93 (5): 513-522

The *Lymantria dispar* population in a broad-leaved natural forest suffered high and density-dependent mortality from bird predation. On the other hand, the same insect population in a young artificial plantation was not always heavily preyed upon by birds. Predation by birds was the most important factor determining density of the *L. dispar* population at low levels. Some parasitoids caused density-dependent mortalities, but their distribution seemed to be restricted.

J.C. Gupta (1982). Evaluation of Agama agama as a natural control agent of insect pests. Z. ang. Ent. 93 (4): 397-402

Agama agama is a lizard native to tropical Africa and is found in every conceivable habitat, i.e. agricultural, forest and human residential areas. The food of this animal is 100% insects, ants alone comprising 70%. The major insect orders represented in the diet were Hymenoptera, Isoptera, Orthoptera, Diptera, Hemiptera, Lepidoptera and Coleoptera. Rainbow lizard consumed 9 major pests of 21 plant species of economic importance. The population of this lizard was quite high in the agroecosystem and ranged between 67 ± 8.2 in January to 115 ± 4.4 per acre in June. Both males and females showed a definite preference for tailor ants *(Oecophylla smaragdina)* as compared to termites (*Macrotermes* sp.), mosquitoes *(Culex pipiens)* and house fly *(Musca domestica)*.

A. el-T. A. Yousef et al. (1982). Effect of prey on the biology of Amblyseius gossypii and Agistemus exsertus. Z. ang. Ent. 93 (5): 453-456

The effect of prey species and stage on the duration, feeding capacity and fecundity of the predators *A. gossypii* and *A. exsertus* were investigated under laboratory conditions. It was noticed that both species fed on eggs of *Tenuipalpus granati*, but the former developed more quickly. *Amblyseius gossypii* showed greater predacious efficiency in attacking *T. granati* eggs than did *A. exsertus*. The former predator attacked a smaller number of prey eggs than the latter, yet showed an obviously greater daily mean. *Amblyseius gossypii* proved to be more efficient than *A. exsertus*. Both predators preferred attacking immature stages of *T. granati* than those of *Tetranychus urticae*. Eggs of *T. granati* increased the fecundity of the two predators more than the immature stages of this prey and more than both eggs and immature stages of *T. urticae*.

M. Gaudchau (1982). Studies on the feeding capacity of syrphid larvae predaceous on aphids in greenhouses. Z. ang. Ent. 93 (5): 425-429

Investigations were carried out in separate greenhouse areas (1.4 m²) to observe the influence of second larval instars of *Syrphus corollae* on populations of the pea aphid, *Acyrthosiphon pisum*. The predator: prey ratios were 1:10, 1:5, and 1:2.5 respectively. The closer the ratio, the more aphids were killed by predators, but there were great differences between particular results. An increased number of aphids/area didn't lead to increased feeding capacity of syrphid larvae. The results of the trials are discussed, considering the problems which may arise if biological

control is intended in greenhouses by releasing aphid predators.

R.H. Turnbow & R.T. Franklin (1982). Behaviour and development of an overwintering population of the southern pine beetle predator Thanasimus dubius. J. Ga Ent. Soc. 17 (3): 292-297

Both adults and larvae of *Thanasimus dubius* were found to overwinter on infested southern pine beetle trees. Clerid larval development was largely arrested with the onset of winter and was not resumed until the following spring. Associated southern pine beetle broods completed development during the winter months. The prepupal period for clerids following resumption of development varied from 30-131 days. Clerid flight activity occurred whenever daily temperature maxima exceeded 20 °C. Feeding and oviposition levels resuming in the spring were comparable to those of summer adults reported in other studies.

K.V. Miller & R.N. Williams (1982). Expansion of the Holling disc equation to include changing prey densities. J. Ga Ent. Soc. 17 (3): 404-410

A model is presented of the functional responses of larval instars and adult *Atheta coriaria* in relation to predator-induced decreases in the density of *Stelidota geminata* eggs. The model closely estimated the number consumed at all initial densities. Increases in temperature resulted in an increase in the number of prey eggs consumed by adults at all densities.

C.S. Hollingsworth & G.W. Bishop (1982). Orius tristicolor as a predator of Myzus persicae on potatoes. Environ. Ent. 11 (5): 1046-1048

Laboratory and field studies were conducted to investigate the relationship between *Orius tristicolor* and the green peach aphid, *Myzus persicae*, in potato fields. *O. tristicolor* provided with 1, 5 and 10 aphids per day killed 11.4 ± 1.2, 37.2 ± 1.1 and 53.7 ± 1.2 aphids, respectively, during development. Adults killed an average of 0.9 ± 0.6, 1.9 ± 0.5, and 2.7 ± 0.6 aphids per day when supplied with 1,5 and 10 aphids per day, respectively. Development time was not affected by prey density; the mean time required for development (at 24.4°C) was 14.6 days. At low aphid densities, predation rates among nymphal instars were not significantly different. When *O. tristicolor* were supplied with 10 aphids per day, 3rd instars killed more aphids than either the 5th instars or adults. *O. tristicolor* populations did not appear to be a significant cause of decline of green peach aphid populations in potatoes. Where the thrips, *Frankliniella tritici*, occurred, its occurrence was strongly correlated with *O. tristicolor*.

T.B. Sinha et al. (1982). The functional response of Coccinella septempunctata, a coccinellid predator of mustard aphid, Lipaphis erysimi. Entomon 7 (1): 7-10.

The present work elucidates the functional response of the grub of *Coccinella septempunctata*, showing a non-linear relationship between consumption and density of *Lipaphis erysimi*. *C. septempunctata* consumed 20 aphids/predator at the prey population of 20 aphids, but consumed more aphids (349 ± 26.8 aphids/predator) at a density of 1600, during the same period (24 hours). Such a response of *C. septempunctata* indicates its searching capacity which increases with the prey population, reflecting its utility as a bioagent of mustard *(Brassica campestris)* aphids.

J.P. McCaffrey & R.L. Horsburgh (1982). Interspecific interactions between Orius insidiosus and Leptothrips mali. Environ. Ent. 11 (5): 1104-1107

The interspecific interactions of 5th-instar *Orius insidiosus* and 2nd-instar larvae of another mite predator, *Leptothrips mali*, were studied in the laboratory. *L. mali* is a potential prey for *O. insidiosus*, but has a defensive anal secretion which repels predator attacks. Most contacts between well-fed *O. insidiosus* and *L. mali* resulted in mutual avoidance. Most attacks by *O. insidiosus* were unsuccessful, especially if the approach was from the rear. Contact with the thrips' anal secretion resulted in immediate repelling of *O. insidiosus*, with subsequent cleaning activity lasting 1 to 3 min. This study indicates that these two predators are compatible, especially in the presence of another food source such as the European red mite.

P. Neuenschwander (1982). Beneficial insects caught by yellow traps used in mass-trapping of the olive fly, Dacus oleae. Ent. exp. appl. 32 (3): 286-296

Under the conditions of a mass-trapping experiment with 2 yellow sticky traps (YT)/small tree, 16 times as many parasitoids and predators as *Dacus oleae* were caught. If only the known parasitoids and predators of the main olive pest insects *D. oleae*, *Saissetia oleae*, *Prays oleae* and *Aspidiotus nerii* were considered, this ratio was reduced to 4. Olive flies (especially the males) were more abundant on the inner side of the YT, parasitoids and predators on the outer side and on traps in the eastern part of the canopy. This is interpreted as higher flight activity of the beneficial insects compared to *D. oleae*, particularly in the morning. Catches by traps on which half of each surface was painted either white, grey or black, the other half being yellow, showed that – except for the night-active chrysopids and coniopterygids – all parasitoids and predators were equally or better attracted to yellow than *D. oleae*. Other yellow or orange colours did not confer higher specificity of the traps for the fruit fly. From absolute population estimates, it is concluded that 3 – 5 YT/tree can virtually eliminate the beneficial fauna.

J.C. Ball (1982). Impact of fungicides and miticides on predatory and phytophagous mites associated with pecan foliage. Environ. Ent. 11 (5): 1001-1004

Sulfur, the acaricide cyhexatin (Plictran 50W), and the fungicides benomyl (Benlate 50W) and fentin hydroxide (Duter 50W) were field tested against the pecan leaf scorch mite (PLSM), *Eotetranychus hicoriae*, and other mites found on pecan foliage. All materials were toxic to the tydeid, tenuipalpid, phytoseiid and eriophyoid mites present. Sulfur and cyhexatin acted rapidly and were the most toxic. Depending on species, benomyl and fentin hydroxide caused 40 to 90% reduction within 14 days. Pesticide effects on PLSM were inconclusive because of large variance associated with the populations. Benomyl and fentin hydroxide treatments resulted in change of relative abundance of phytoseiid species.

M.E. Whalon et al. (1982). Introduction and survival of susceptible and pyrethroid-resistant strains of Amblyseius fallacis in a Michigan apple orchard. Environ. Ent. 11 (5): 1096-1099.

The survival of a susceptible and two synthetic pyrethroid-resistant strains of the predatory mite, *Amblyseius fallacis*, were compared with an indigenous predatory mite population after the applications of two synthetic pyrethroids, permethrin and fenvalerate. Susceptible and indigenous predatory mites were reduced to almost undetectable numbers after two permethrin and one fenvalerate applications. The two resistant strains survived permethrin applications equally well, but only one strain survived the fenvalerate spray at measurable levels. Overwintering survival of resistant strains was confirmed by using microelectrophoresis and LC_{50} studies.

S.V. Rajakulendran & F.W. Plapp, Jr (1982). Comparative toxicities of five synthetic pyrethroids to the tobacco budworm, an ichneumonid parasite, Campoletis sonorensis, and a predator, Chrysopa carnea. J. econ. Ent. 75 (5): 769-772

Five synthetic pyrethroids, phenothrin, cypermethrin, tralomethrin, fluvalinate and Pay-off [(±)-cyano (3-phenoxyphenyl) methyl (+)-4-(difluoromethoxy)-α-(1-methylethyl) benzeneacetate] were tested for toxicity to larvae of the tobacco budworm, *Heliothis virescens*, larvae of a predator, *Chrysopa carnea*, and adult males of a parasite, *Campoletis sonorensis*. Tralomethrin was the most toxic to the pest and the parasite, but one of the least toxic to the predator. All these synthetic pyrethroids were less toxic to the predator than to the parasite and, except for phenothrin, were less toxic to the predator than to the pest. Based on their selectivity ratios, tralomethrin seems to be the most promising candidate of the pyrethroids tested for use in integrated pest management programs, provided *C. carnea* is the major natural enemy component in the ecosystem. Pay-off, tralomethrin, and fluvalinate were nearly equal in toxicity to the pest and the parasite and, therefore, if applied at low doses, these insecticides could allow survival of enough parasites to provide additional control of the pest.

R.W. Weires et al. (1982). Toxicity of several insecticides to the spotted tentiform leafminer and its parasite, Apanteles ornigis. J. econ. Ent. 75 (4): 680-684

Spotted tentiform leafminer, *Phyllonorycter blancardella*, moths collected from Western New York commercial apple orchards were highly resistant to azinphosmethyl and carbaryl but susceptible to demeton, endosulfan, methomyl and oxamyl. *Apanteles ornigis*, a parasite of the leafminer, was highly susceptible to all of the aforementioned insecticides. The susceptibility of leafminer larval populations to systemic organophosphates was low, and about twice the recommended field rates were required to obtain control. Control is recommended by using the systemic carbamates methomyl or oxamyl when larval populations exceed action threshold levels of one mine per leaf during the first brood or two mines per leaf during the second brood.

M. Ticehurst et al. (1982). Effects of reduced rates of Dipel 4L, Dylox 1.5 Oil and Dimilin W-25 on Lymantria dispar parasitism and defoliation. Environ. Ent. 11 (5): 1058-1062

Reduced rates of Dipel 4L, Dylox 1.5 Oil and Dimilin W-25 were applied to an outbreak infestation of *Lymantria dispar* in 1980. Treatment effects were investigated on larvae, pupae, adult males and egg masses as well as on parasitism and defoliation in 1980 and partially in 1981. Treatment effects for Dimilin were not reported because of improper aerial application. Dipel and Dylox provided excellent foliage protection in 1980 and reduced populations of stages I to III by 87 and 38%, respectively. Enhancement of parasitism by *Apanteles melanoscelus* was most apparent in blocks treated with Dipel. Other positive and negative effects on parasitism were detected by both insecticides. Cost was reduced over standard application.

M.A. Hoy (1982). Aerial dispersion and field efficacy of a genetically improved strain of the spider mite predator Metaseiulus occidentalis. Ent. exp. appl. 32 (3): 205-212

In August 1979, a strain of *Metaseiulus occidentalis* resistant to carbaryl and organophosphorus (OP) insecticides was released into a few trees at one edge of a 32-hectare commercial almond orchard near Bakersfield, California. In August 1980, predators collected from 7 widely separated sites in the orchard had moderate to high levels carbaryl resistance, indicating the resistant strain had established, multiplied, overwintered and dispersed from the release site. During 1980, the resistant predators had a substantial impact on spider mite populations. Aerial dispersal of *M. occidentalis* was suspected in this orchard because the predators had moved so far so quickly. Predators sampled in April and September 1981 were still carbaryl resistant, indicating that this strain had survived a 2nd year in this commercial almond orchard. The carbaryl-OP-resistant strain also was released into every 3rd tree in every 3rd row in a commercial almond orchard near Livingston, California in June 1981 and inter-tree dispersal occurred within one month. The predators exerted considerable control over the spider mites in this orchard, as well. Aerial dispersal occurred and was monitored by trapping large numbers of *M. occidentalis* females on sticky panels located outside the orchard. This is the first documentation that *M. occidentalis* disperses aerially in the field, and suggests that this carbaryl-OP-resistant strain may be capable of substantial dispersal from release orchards. It is also the first time that this laboratory-selected strain has been shown to be effective in large commercial almond orchards, as previous trials used only 10 – 30 tree plots.

C.I. Keerthisinghe (1982). Economic thresholds for cotton pest management in Sri Lanka. Bull. ent. Res. 72 (2): 239-246

Field experiments conducted on cotton in southern Sri Lanka, where the main pests were *Heliothis armigera*, *Earias vittella* and *Pectinophora gossypiella*, indicated that a damage action threshold of five squares and six bolls per 30 plants could be used for forecasting and early warning in pest management. A parallel sampling study indicated that a sample size of 30 plants would reduce the sampling error to acceptable levels as well as being a more convenient number

in the field. An expression that corrects experimentally established thresholds for changes in the cost of control and the market price of the yield is given.

iii) Behavioural Means

S.W. Robinson et al. (1982). Field evaluation of methyl 4-methylpyrrole-2-carboxylate, an ant trail pheromone, as a component of baits for leaf-cutting ant control. Bull. ent. Res. 72 (3): 345-356

In the laboratory, the trail pheromone methyl 4-methylpyrrole-2-carboxylate (M4MP2C), when added to bait particles, acts as an attractant to leaf-cutting ants, increasing the pick-up of pheromone-impregnated bait compared with plain bait. However, field trials in Trinidad, Brazil and Paraguay were disappointing. Bait with and without pheromone was scattered in the foraging area, and the proportion of each taken to the nest by *Atta sexdens rubropilosa*, *A. cephalotes* and *Acromyrmex octospinosus* was assessed. In only one of the experiments (*A. octospinosus* foraging bait with 50 ppm of M4MP2C), was increased pick-up detected. Four reasons for this are suggested: (1) small pheromone effects are difficult to measure, as scattering bait produced a patchy distribution and heterogeneous replicates, whilst choice trials on plain and pheromone-impregnated bait placed close together were difficult to interpret, as the pheromone probably excited the ants, increasing pick-up of plain bait; (2) *A. octospinosus* workers, the subject of detailed studies, were less sensitive to M4MP2C in the field than in the laboratory; (3) as the pheromone only attracts, it does not produce a comparable increase in the number of pieces picked up, contact/pick-up ratios of sucrose-impregnated discs increasing from 2.26 at 5 pg pheromone to 16.39 at 50 ng; and (4) soyabean oil, citrus-pulp extract and orange juice were found to be attractive, and when pheromone was added, its effects were not additive. Early studies used sucrose-impregnated paper discs, and as these have no attractants of their own, the addition of M4MP2C had a more marked effect. It is concluded that M4MP2C is not a cost-effective addition to current leaf-cutting ant baits which possess food odours, a much cheaper source of attractiveness.

J.L. Robertson & M.I. Haverty (1982). Estimation of rates and times of application for selected insect growth regulator formulations applied to western spruce budworm. J. Ga Ent. Soc. 17 (3): 297-308

Four insect growth regulator formulations – BAY SIR 8514, UC 62644, methoprene: permethrin (9:1) and TH 6040: methoprene (9:1) – were tested in a series of bioassays designed to estimate their optimal time of application relative to a theoretical instar distribution of a population of western spruce budworm, *Choristoneura occidentalis*. Field application rates dependent on each formulation's rainfastness were calculated based on laboratory ED_{90} values. The 6th instar was the most susceptible stage to all formulations. The formulation with the greatest activity and broadest predicted optimal time of application was UC 62644. The TH 6040: methoprene mixture cannot be considered a viable candidate for field testing because of solubility problems around the ED_{90}.

J.E. Leggett (1982). Influence of trap spacing and Grandlure concentration on detection of interfield boll weevil movement. Environ. Ent. 11 (5): 1114-1115

The response of boll weevils, *Anthonomus grandis grandis*, to trap density (number per ha) and Grandlure concentration (wicks per trap) was determined in a non-cotton area. Trap density in this area was not a factor in weevil capture. Traps with four wicks were significantly more effective than traps containing one or two wicks per trap. Results in a cotton field may differ, depending on competition between male weevils and traps and the maturity of the cotton plants.

E.J. Villavaso (1982). Boll weevil: isolated field plot studies of disruption of pheromonal communication. J. Ga Ent. Soc. 17 (3): 347-350

Pheromone wicks, each containing 24 mg of Grandlure, the boll weevil sex pheromone, were put into isolated 1/2-acre plots of cotton at the rate of 100 wicks per plot. There were significant differences in the percentage of squares containing oviposition punctures in the Grandlure-treated vs the untreated plots indicating that disruption of pheromonal communication was achieved.

J.J. Lam, Jr & A.H. Baumhover (1982). Nocturnal response of Heliothis virescens to artificial light and sex pheromones. Environ. Ent. 11 (5): 1032-1035

Virgin females (VF), *Heliothis virescens*, attracted 68 to 75% fewer males to grid traps when exposed to 7-W BLB or incandescent lamp radiation. Exposure of VF in sticky-type traps to a 15-W blacklight located 3.0, 9.1, 18.3, 36.6 and 73.2 m away reduced the male catch by 84, 85, 57, 6 and 0%, respectively. Sexual response of males appeared unaffected by the radiation. The time of sexual activity for either sex was shifted by exposing adults to darkness before or after ambient darkness.

J.A. Klun et al. (1982). Female Heliothis subflexa sex pheromone: chemistry and congeneric comparisons. Environ. Ent. 11 (5): 1084-1090

Chemical, chromatographic and mass spectral analyses of that are analogous to known *Heliothis* spp. sex pheromones. ovipositors showed that the females produce 11 compounds that are analigous to known *Heliothis* spp. sex pheromones. Seven of these compounds have been previously identified from female *H. virescens*. In addition to these seven, female *H. subflexa* produce the (Z)-isomers of 7, 9 and 11-hexadecen-1-ol acetate and 1-hexadecanol acetate. The ratio of (Z)-11-hexadecenal to (Z)-9-hexadecenal found in *H. subflexa* was significantly different from ratios found in other female *Heliothis* spp. Chromatographic analyses of the heptane extracts of the ovipositors of F_1 females resulting from the *H. subflexa* (female) × *H. virescens* (male) cross and female progeny from F_1 hybrid females backcrossed 34 times to *H. virescens* showed that they both produce a blend of pheromonal compounds that is qualitatively and quantitatively similar to compounds produced by *H. virescens* females. Field and laboratory behavioral studies indicated that the C_{16} acetates and the ratio of (Z)-11-hexadecenal: (Z)-9-hexadecenal secreted by female *H. subflexa* play significant roles in the maintenance of the specificity of the female *H. subflexa* pheromonal signal.

W.F. Steck et al. (1982). (Z)-7-tetradecenal, a seasonally dependent sex pheromone of the w-marked cutworm, Spaelotis clandestina. Environ. Ent. 11 (5): 1119-1122

(Z)-7-tetradecenal appears to be the sole attractive component of the sex pheromone of *Spaelotis clandestina*, from which it was identified by gas chromatography, mass spectroscopy, electrophysiological analyses, synthesis and field trapping tests. Synthetic material was unattractive during June and July (before and during the aestivation period of the moths) but became attractive during August and September, at which time is was a potent and specific lure. None of thirty analogs tested enhanced attraction; the (Z)-9-isomer was a powerful trapping inhibitor.

A. Ram et al. (1982). Evidence for the presence of a kairomone in Corcyra cephalonica larvae for Bracon brevicornis. Z. ang. Ent. 93 (4): 338-341

Hexane extract of the cuticle of larvae of *Corcyra cephalonica* elicited a host seeking response by females of *Bracon brevicornis*. The response of the female parasitoid varied with age, and optimum response was obtained in 7-12-day-old females. The kairomone loses its activity with time, a 50% loss in biological activity took place in 66 h. The loss of biological activity of the extract diluted serially was found to be linear, and the extract lost 50% of its biological activity when diluted 18-fold.

A.L. Averill & R.J. Prokopy (1982). Oviposition-deterring fruit marking pheromone in Rhagoletis zephyria. J. Ga Ent. Soc. 17 (3): 315-319

Following egg laying in snowberries, females of *Rhagoletis zephyria* were found to deposit a marking pheromone on the fruit surface which deters repeated oviposition attempts by other females into that fruit. *R. zephyria* partially recognized the marking pheromone of its sibling species, *R. pomonella*, while *R. pomonella* exhibited complete recognition of *R. zephyria*'s marking pheromone.

J.W. Haynes & J.E. Wright (1982). Laboratory competitiveness of sterilized boll weevils. J. Ga Ent. Soc. 17 (3): 382-388

Male boll weevils *(Anthonomus grandis)* were sterilized by feeding adult diet pellets, containing 100 ppm of diflubenzuron for five days, and then given a 10-krad acute dose of gamma irradiation on the 6th day. In tests where 1, 5, 10, 20 or 40 sterile males were allowed to compete with one normal male for one normal virgin female, we found that 40 sterile males were needed to reduce egg hatch to 2% and, according to Fried's formula, the competitiveness value for laboratory tested weevils was 73%.

M.S. El-Garhy (1980). Preliminary results with sex pheromones to trap potato tuber worm moths in Saudi Arabia. Potato Res. 23 (1980): 361-363

The tuber moth *Phthorimaea operculella* is the most serious pest of potato crops in Saudi Arabia. A knowledge of its population dynamics is a prerequisite for developing efficient pest management programmes. A mixture of sex pheromone PTM_1 and PTM_2 on rubber cap dispensers was used to attract adult males to water pan traps. The experiments were designed to investigate: 1) the effectiveness and persistence of pheromones for monitoring populations and possibly controlling potato tuber moth; 2) the correlation between daily catch, temperature and relative humidity. The results obtained look promising but call for further experiments.

iv) Techniques

A.M. Dewar & G.J. Dean (1982). Assessment of methods for estimating the numbers of aphids in cereals. Bull. ent. Res. 72 (4): 675-685

Visual counting was found to be the most accurate method of estimating cereal aphid numbers in field studies in England. Vacuum sampling decreased in efficiency as aphid density increased, but could be a useful alternative to visual counts at very low aphid densities when the latter became too time-consuming. Cutting tillers for later washing in the laboratory was less efficient than visual counting as aphids, especially *Metopolophium dirhodum*, fell off the plants during sampling, but this method was useful in determining the proportion of different morphs of *Sitobion avenae* present at very high densities.

L.E. Volkman & P.A. Goldsmith (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.

L.E. Volkman & L.A. Falcon (1982). Use of monoclonal antibody in an enzyme-linked immunosorbent assay to detect the presence of Trichoplusia ni S nuclear polyhedrosis virus polyhedrin in T. ni larvae. J. econ. Ent. 75 (5): 868-871

A sandwich type of enzyme-linked immunosorbent assay (ELISA) incorporating monoclonal antibody and rabbit immune serum was used to detect polyhedrin in *Trichoplusia ni* S nuclear polyhedrosis virus (TSN)-infected *T. ni* larvae. Polyhedrin, the major component of nuclear polyhedrosis virus (NPV) polyhedra, is coded for by the virus, and its presence in larvae indicates the presence of NPV or an NPV infection. The ELISA and the judgment of a trained observer were compared with regard to detecting

NPV or NPV disease in larvae exposed to high, medium and low doses of TSN. The ELISA was the more sensitive diagnostic technique of the two, and detected the presence of NPV 2 to 3 days in advance of the observer. At the medium and high dosages, the ELISA detected polyhedrin in or on larvae 2 h after exposure to the virus, before any protein amplification could have taken place, indicating a high degree of assay sensitivity.

P.L. Roberts & W. Naser (1982). Characterisation of monoclonal antibodies to the Autographa californica nuclear polyhedrosis virus. Virology 122 (2): 424-430

Mouse hybridomas which produce monoclonal antibodies to the *Autographa californica* nuclear polyhedrosis virus (AcNPV) have been prepared and the protein to which each is directed has been determined. The antibody produced by clones 3F3 and 5E9 specifically bound polyhedron protein of MW 32,000 when used in immunoadsorption chromatography. When used in ELISA, they could not distinguish between insect- and cell culture-derived polyhedron protein and also reacted with a wide range of baculoviruses. The antibody produced by clone 3D10 specifically immunoprecipitated a polypeptide of MW 42,000 from tissue culture-derived extracellular virus which was a prominent product synthesized in infected cells. This polypeptide was a major component of enveloped virus, released from insect-derived polyhedra, and nucleocapsids. In contrast to 3F3 and 5E9, this antibody was specific for AcNPV.

R. Rubinstein et al. (1982). Use of primary fat body cultures for the study of baculovirus replication. J. Invert. Path. 40 (2): 266-273

Fat body cultures of *Trichoplusia ni* and *Estigmene acrea* were established for use in the study of the two baculoviruses *Autographa californica* nuclear polyhedrosis virus (AcNPV) and *Estigmene acrea* granulosis virus (EaGV), respectively. Multiplication of AcNPV observed by phase and electron microscopy was correlated with an increase in viral specific proteins as determined by indirect enzyme-linked immunosorbent assay (ELISA). Although EaGV morphogenesis was not observed in fat body cultures, an increase in specific proteins of this virus could be detected with the ELISA.

G.R. Rohrmann et al. (1982). Identification, cloning and R-loop mapping of the polyhedrin gene from the multicapsid nuclear polyhedrosis virus of Orgyia pseudotsugata. Virology 121 (1): 51-60

Polyadenylated RNA was isolated from *Orgyia pseudotsugata* larvae 8-10 days postinfection with the multicapsid nuclear polyhedrosis virus. This RNA was centrifuged through a sucrose gradient and fractions enriched for polyhedrin mRNA were identified by *in vitro* translation. Complementary DNA made to this RNA hybridized predominantly to a 5-kb fragment of *Xho*I-digested viral DNA. This fragment was cloned into the plasmid pACYC177 and mapped with restriction endonucleases. A *Sal*I subclone with a 2.5-kb insert derived from the cloned *Xho*I fragment was found to select by hybridization only polyhedrin mRNA as determined by the size of the *in vitro* translation product and its precipitation by anti-polyhedrin antibodies. The orientation of the polyhedrin gene and the region of the insert encoding the N terminus of the polyhedrin protein were determined by DNA sequencing. R-Loop mapping indicated polyhedrin mRNA is 980 ± 75 bases long and contains about 250 nucleotides not represented in the final protein. The polyhedrin gene had no observable intervening sequences.

G.E. Cantwell et al. (1982). Activity of a 'thermostable exotoxin' of Bacillus thuringiensis subsp. morrisoni in the Salmonella/microsomal assay for bacterial mutagenicity. J. Invert. Path. 40 (3): 350-358

The purpose of this study was to employ the *Salmonella*/microsomal assay (Ames test) to investigate the mutagenic potential of a thermostable exotoxin of *Bacillus thuringiensis* subsp. *morrisoni*. Bacteria are ideal for the detection of infrequently occurring point mutations because the large number of organisms (200 to 400 million bacteria per plate) exposed to the mutagen at any one time increases the possibility of observing a random mutational event. The exotoxin used in this study was produced using the shaker flask fermentation procedure with mineral casein broth. A Petri dish method of bioassay using fresh bovine feces was used to determine the efficacy of the exotoxin against horn flies. The LD_{50} was found to be 5.35 µl/g of feces. Five bacterial tester strains were identified and characterized for the genetic markers described by Ames et al. (B. N. Ames et al., 1975, *Mutat. Res.*, **31**, 347-364). Appropriate doses of the *B. thuringiensis* supernatant, solvent or positive control were added to agar plates. The supernatant was tested at five dose levels against all five strains of bacteria. Controls of bacteria only were included for spontaneous reversions. All treatments were performed in triplicate. The numbers of revertant colonies from each set of triplicate plates were averaged and the standard deviation calculated and compared to that found with the solvent control. The negative controls, positive controls and sterility controls all fulfilled requirements for determination of a valid test. No detectable mutagenic activity was found for the thermostable exotoxin of *B. thuringiensis morrisoni*.

D.A. Streett & J.D. Briggs (1982). An evaluation of sodium dodecyl sulfate-polyacrylamide gel electrophoresis for the identification of microsporidia. J. Invert. Path. 40 (2): 159-165

Microsporidian spore polypeptides separated with sodium dodecyl sulfate (SDS) – polyacrylamide gel electrophoresis (PAGE) – can be used to identify isolates of microsporidia. The spore polypeptides separated with SDS/PAGE provided unique, reproducible electrophoretic profiles which were not influenced by host species or the temperature at which the host larvae were maintained for development. Furthermore, host proteins were not detected in electrophoretic profiles of the spore polypeptides. Spore mixtures of two microsporidian species can be detected when the spore polypeptides of either or both species have been previously separated with SDS/PAGE.

C.S. Creighton & G. Fassuliotis (1982). Mass rearing a mermithid nematode, Filipjevimermis leipsandra on the banded cucumber beetle. J. econ. Ent. 75 (4): 701-703

About 5 million eggs of a parasitic mermithid nematode, *Filipjevimermis leipsandra*, were produced each week during a 6-month period for laboratory and field experimentation by modification of existing techniques and develop-

ment of new ones for culturing the parasite *in vivo*. The current procedures for mass rearing *F. leipsandra* are described.

R. Kfir (1982). Reproduction characteristics of Trichogramma brasiliensis and T. lutea, parasitising eggs of Heliothis armigera. Ent. exp. appl. 32 (3): 249-255

The search rate, the number of female progeny per female parent and the sex ratio of the progeny of *Trichogrammatoidea lutea* were severely affected by increasing the parasite density from 1/150 hosts to 8/150. *Trichogramma brasiliensis* was very little affected. Females of *T. lutea* were more susceptible than females of *T. brasiliensis* to interference from other searching females or by encountering hosts that had been previously parasitised. *T. lutea* females tended to leave the area they searched following interference. *T. lutea* was found to be arrhenotokous and *T. brasiliensis* deuterotokous. *T. lutea* clustered its progeny in the hosts more than *T. brasiliensis*. The average number of *T. lutea* progeny that developed in a host was 2.02 as compared with 1.28 for *T. brasiliensis*. The clustering of female progeny in the parasitised hosts by the 2 species did not differ. The average number of *T. lutea* females per host was 1.32. When more than one progeny of a mated *T. lutea* female developed in a host, usually only one male emerged, the rest being females. *T. lutea* produced more female progeny per female parent than *T. brasiliensis* and its developmental time was shorter.

A. Krishnamoorthy (1982). Mass rearing technique for an indigenous predatory mite, Amblyseius (Typhlodromids) tetranychivorus in the laboratory. Entomon 7 (1): 47-49

The indigenous predatory mite, *Amblyseius (Typhlodromids) tetranychivorus* is confined on a suitably prepared glass substrate which has obviated the need for using host plant material. Castor pollen is used as food material for the predatory mites instead of host spider mites.

D.E. Hendricks (1982). Polyvinyl chloride capsules: a new substrate for dispensing tobacco budworm sex pheromone bait formulations. Environ. Ent. 11 (5): 1005-1010

A new plastic (polyvinyl chloride [PVC]) capsule was introduced as a substrate for use as a dispenser of tobacco budworm (TBW) sex pheromone components. Infield bioassays, where the numbers and frequency in TBW trap catches were compared, showed that the capsule was more effective as a bait loaded with 10-mg doses of V-2 rather than for the same dosage of V-7. V-2 was (Z)-11-hexadecenal and (Z)-9-tetradecenal in a 16:1 ratio. V-7 was a mixture (with proportions) as follows: (Z)-11-hexadecenal (16); (Z)-9-tetradecenal (1); (Z)-11-hexadecen-1-ol (1.3); (Z)-9-hexadecenal (0.65); (Z)-7-hexadecenal (0.38); hexadecanal (1.6); and tetradecanal (0.33). A laminated PVC (Hercon) dispenser also was more effective as trap bait with 20-mg doses of V-2 when compared with the same dosage of V-7. When loaded with 10 mg of V-2, performance of both the new capsular and the laminated PVC dispensers as bait in traps was nearly equal for 2-week test periods.

2. CONTROL OF PLANT PATHOGENIC BACTERIA, FUNGI AND NEMATODES

D.A. Cooksey & L.W. Moore (1982). Biological control of crown gall with an agrocin mutant of Agrobacterium radiobacter. Phytopathology 72 (7): 919-921

A mutant of *Agrobacterium radiobacter* K84 that no longer produced agrocin 84 was obtained by mitomycin C curing of the 30 Mdalton bacteriocinogenic plasmid in K84. This mutant (designated K84Agr$^-$) no longer prevented crown gall of tomato stems when coinoculated with an agrocin-sensitive pathogen *A. tumefaciens* K24. However, it effectively reduced infection when it was placed on the host plant 24 h before the pathogen. In addition, either K84 or K84Agr$^-$ reduced infection by agrocin-resistant *A. tumefaciens* B6 when the antagonists were applied 24 h before the pathogen. Tumor weights were reduced when K84Agr$^-$ was coinoculated with K24 or B6, or when it was applied 24 h before the pathogens. The data suggest that other mechanisms, such as physical blockage of infection sites, are involved in biological control by K84 in addition to production of agrocin 84.

Y. Elad et al. (1982). Degradation of plant pathogenic fungi by Trichoderma harzianum. Can. J. Microbiol. 28 (7): 719-725

Trichoderma harzianum excreted ß-1,3-glucanase and chitinase into the medium when grown on laminarin and chitin, respectively, or on cell walls of the pathogen *Sclerotium rolfsii*, as sole carbon source. *Trichoderma harzianum* also showed high activity of both enzymes when grown on homogenized *S. rolfsii* sclerotia. Glucanase activity increased by 67% when the fungus was grown on a mixture of laminarin and glucose (3:1, v/v). Similarly, high lytic activity was detected in wheat bran culture of the fungus and in soil inoculated with this culture. Protease and lipase activity were detected in the medium when the antagonist attacked mycelium of *S. rolfsii*. Isolates of *T. harzianum* were found to differ in the levels of hydrolytic enzymes produced when mycelium of *S. rolfsii*, *Rhizoctonia solani* and *Pythium aphanidermatum* in soil was attacked. This phenomenon was correlated with the ability of each of the *Trichoderma* isolates to control the respective soilborne pathogens.

L. Sundheim (1982). Control of cucumber powdery mildew by the hyperparasite Ampelomyces quisqualis and fungicides. Pl. Path. 31 (3): 209-214

Application of conidial suspensions of the hyperparasite *Ampelomyces quisqualis* to greenhouse cucumbers inoculated with *Sphaerotheca fuliginea* increased cucumber yield compared with an untreated control. Similar yield increases were obtained with triforine and also when a reduced rate of triforine and the hyperparasite were combined. *A. quisqualis* extensively parasitized *S. fuliginea* and also, in experiments with commercial cucumber crops, *Erysiphe cichoracearum*.

B.A Jaffee & E.I. Zehr (1982). Parasitism of the nematode Criconemella xenoplax by the fungus Hirsutella rhossiliensis. Phytopathology 72 (10): 1378-1381

Hirsutella rhossiliensis was commonly isolated from dead, surface-disinfested *Criconemella xenoplax* extracted from

peach orchard soils. Invasion of living nematodes followed attachment of spores to the nematode's cuticle. After penetration of the cuticle directly beneath the adhering spore, a bulbous infection hypha formed from which secondary hyphae developed. Approximately 25% of inoculated juveniles were penetrated and killed by the fungus under laboratory conditions; adult *C. xenoplax* were penetrated less often. Approximately 50% of stressed adults (120 min incubation at 40°C prior to inoculation) were invaded and killed by the fungus. *H. rhossiliensis* rapidly penetrated and colonized all adults killed by 30 min of incubation at 60°C prior to inoculation.

3. CONTROL OF WEEDS

M.J.W. Cock (1982). The biology and host specificity of Liothrips mikaniae, a potential biological control agent of Mikania micrantha. Bull. ent. Res. 72 (3): 523-533

Liothrips mikaniae comb. n. is one of the most promising biological control agents for *Mikania micrantha*, a sprawling composite vine native to the Neotropics, which is a serious weed of plantations in South-East Asia. A description and illustrations of the adult and larvae of this thrips is followed by details of the life-history, culture technique, host specificity (including laboratory studies demonstrating oligophagy) and natural enemies. It is recommended for introduction to South-East Asia.

S.H. Sharrow & W.D. Mosher (1982). Sheep as a biological control agent for tansy ragwort. J. Range Management 35 (4): 480-482

Tansy ragwort *(Senecio jacobaea)* is a biennial weed commonly found on forest and pasture lands in the maritime regions of the Pacific Northwest. Pyrrolizidine alkaloids in tansy ragwort, when consumed by most types of livestock, produce progressive and irreversible liver damage. Sheep, however, appear immune to these alkaloids. To evaluate the possibility of using sheep to suppress tansy ragwort in cattle pastures, 100 plants were marked and their status followed during 1977 and 1978 in pastures grazed by cattle alone and in pastures grazed by both cattle and sheep. Total tansy ragwort mortality did not differ between pastures. However, the cause of mortality did differ. Mortality on the cattle-grazed pasture was predominantly due to completion of the plant's biennial life cycle (blooming and seed set), while most plant mortality on the sheep plus cattle pasture appeared to be the result of grazing. The data suggest that sheep may be used as a biological control agent to suppress tansy ragwort populations by reducing their ability to produce seed.

M.J.W. Cock & J.D. Holloway (1982). The history of, and prospects for, the biological control of Chromolaena odorata by Pareuchaetes pseudoinsulata. Bull. ent. Res. 72 (2): 193-205

Chromolaena odorata is a tropical American species of the Compositae that has become a serious problem in plantations in the tropics of Asia and Africa. The history of attempts to control it using the arctiid moth *Pareuchaetes pseudoinsulata* (misidentified in previous literature as *Ammalo insulata*) is summarised. The taxonomy and distributions of the five species in *Pareuchaetes* are presented, together with keys based on genitalic characters, three new synonyms and one new combination. Information on the biogeography and ecology of the *Pareuchaetes* species is used to assess their potential as biological control agents.

J.A. Winder & K.L.S. Harley (1982). The effects of natural enemies on the growth of Lantana in Brazil. Bull. ent. Res. 27 (4): 599-616

Observations were made over a two-year period on the growth and natural enemies of *Lantana tiliaefolia* and *L. glutinosa* growing naturally at nine sites covering different climatic areas of Paraná State, south Brazil. Lantana was found to be subjected to continuous attack by insects and/or fungi throughout the year, with different species causing damage at different times. Temperate-climate sites had a more diverse complex of insects and a greater intensity of attack than warmer-climate sites. Shrubs in sites which suffered severe insect attack, especially during the previous season, flowered and fruited significantly less than those which had suffered only light attack. Differential weighting of the principal phytophagous insects demonstrated that feeding by insects of some groups may be more damaging than that by others. The relevance of the results to the search for biological agents for control of lantana in Australia is discussed.

H.L. Walker & J.A. Riley (1982). Evaluation of Alternaria cassiae for the biocontrol of sicklepod (Cassia obtusifolia). Weed Sci. 30 (6): 651-654

A method is described to produce inoculum of *Alternaria cassiae* for biocontrol studies. Approximately 8 g of a conidial preparation containing 1×10^8 conidia/g were produced per litre of growth medium. In greenhouse studies, the effectiveness of *A. cassiae* as a biocontrol agent for sicklepod *(Cassia obtusifolia)* was affected by dew-period temperature, dew-period duration, inoculum concentration and the stage of growth of sicklepod seedlings at the time of inoculation. Optimum environmental conditions included at least 8 h of free moisture at 20 to 30°C. Spray mixtures containing approximately 5×10^4 or more conidia/ml gave maximum control when sicklepod seedlings were sprayed to runoff. Sicklepod seedlings in the cotyledon to first-leaf stage were most susceptible to the pathogen.

T.D. Center et al. (1982). Control of waterhyacinth (Eichhornia crassipes) with Neochetina eichhorniae and a growth retardant. Weed Sci. 30 (5): 453-457

Waterhyacinths *(Eichhornia crassipes)* grown in screen-enclosed, outdoor aquaria were treated with factorial combinations of 0, 0.75, 1.5 or 3 kg/ha of the experimental growth retardant EL-509 [α-(4-chloro-phenyl)-α-(1-methyl-ethyl)-5-pyrimidine-methanol] and zero, one, two or three pairs of waterhyacinth weevils *(Neochetina eichhorniae)*/plant, with three replicates of each weevil number by retardant level combination. When plant growth was evaluated over a time course, significant effects of weevils and retardant were observed. After 127 days, however, waterhyacinth was reduced as weevil numbers increased, but the growth retardant was ineffective without weevils.

Weevils appeared to be more effective when used in combination with the retardant, and the combined effects were additive.

R.G. Baer & P.C. Quimby, Jr (1982). Some natural enemies of the native moth Arzama densa on waterhyacinth. J. Ga Ent. Soc. 17 (3): 327-333

Populations of *Arzama densa* on waterhyacinth were surveyed for natural enemies. Mortality was mainly due to larval parasites – *Lydella radicis* and *Campoletis oxylus*. Predators and pathogens also played roles in reducing *A. densa* populations. The effects of augmenting this native biological control agent against waterhyacinth could be enhanced by use of information from a survey of its natural enemies in a given locality.

b) Public Health

R.A. Smith (1982). Effect of strain and medium variation on mosquito toxin production by Bacillus thuringiensis var. israelensis. Can. J. Microbiol. 28 (9): 1089-1092

The effect of strain variation and culture medium on production of toxin lethal to mosquito larvae by *Bacillus thuringiensis* var. *israelensis* serotype H-14 was investigated. Shake flask culture of *B. thuringiensis* H-14 strains showed varied ability to produce toxins lethal to mosquito larvae dependent upon the particular strain and growth medium used. Buffered media demonstrated no better mosquito toxicity than did unbuffered media that ranged in pH from 5.7 to 8.1 at harvest. Although toxin production is associated with sporulation, spore count was generally not proportional to toxin produced for those strains and media evaluated.

R.A. Daoust et al. (1982). Effect of formulation on the virulence of Metarhizium anisopliae conidia against mosquito larvae. J. Invert. Path. 40 (2): 228-236

Metarhizium anisopliae conidia were formulated with three granular carriers and nine dust diluents and stored over an 8 to 12-month period at 4 or 20°C. The virulence of formulations, with the exception of two dust preparations, was reduced significantly compared to unformulated conidia against *Culex pipiens pipiens* larvae. The formulation components most detrimental to conidial virulence were corn cob granules, diatomaceous earth, and two Kaolinite diluents. This was exampled by a decline in virulence from ca. 100% for unformulated conidia to 36% or below for these formulations. LT_{50} values also increased from 2.4 – 2.6 days for unformulated conidia to above 6 days. In contrast, a diluent derived from dried castor oil (Thixcin R) significantly enhanced conidial virulence at several doses above that of unformulated conidia against *C. pipiens* larvae. Enhancement occurred whether conidia were formulated prior to storage or stored separated from the diluent and mixed prior to application. The Thixcin R formulation was more effective against *Anopheles stephensi* larvae, but virulence was reduced against *Aedes aegypti* larvae. A bentonite formulation (Bentone-38) also maintained conidial virulence effectively, but Thixcin R was a superior diluent. It was shown that conidial virulence of formulations was not correlated with differences in conidial viability. The preparations that were applied dry by a surface method were more virulent than when an aqueous suspension containing a surfactant was used. The results demonstrate the need to assess efficacy of mycoinsecticidal formulations in a virulence bioassay prior to field testing.

R. Cooper & A.W. Sweeney (1982). The comparative activity of the Australian and United States strains of Culicinomyces clavosporus bioassayed in mosquito larvae of three different genera. J. Invert. Path. 40 (3): 383-387

Anopheles hilli, Culex quinquefasciatus and *Aedes aegypti* were used as test insects to compare the activity of the Australian and United States strains of *Culicinomyces clavosporus*. To minimize the variability incurred by using different larval batches, both strains were bioassayed at the same time using one batch of larvae. Six pairs of assays for each of the three test species were conducted in this manner. It was found that there was no difference in potency of the two strains in any one of the three species. A between species comparison, with the data pooled for both strains, showed that *A. aegypti* was more susceptible to the fungus than *A. hilli*. The susceptibility of *C. quinquefasciatus* appeared to be intermediate but the fiducial limits of the weighted mean LC_{50} overlapped with those of the other two species. From the results of these experiments, it would seem that, with regard to potency, both strains of *Culicinomyces* may be equally promising for the biological control of mosquitoes.

M.K. Toohey et al. (1982). Elaphoidella taroi: the intermediate copepod host in Fiji for the mosquito pathogenic fungus Coelomomyces. J. Invert. Path. 40 (3): 378-382

Five species of copepods were screened for their ability to transmit *Coelomomyces* sp. in Fiji. Only one, a common treehole copepod, *Elaphoidella taroi*, was found to be the intermediate host. When *E. taroi* was used, the mosquitoes *Aedes aegypti, A. pseudoscutellaris* and *A. polynesiensis* were susceptible to *Coelomomyces* sp. infection.

C. Womersley & E.G. Platzer (1982). The effect of parasitism by the mermithid Romanomermis culicivorax on the dry weight and haemolymph soluble protein content of three species of mosquitoes. J. Invert. Path 40 (3): 406-412

The dry weight, haemolymph soluble protein composition and content of three species of mosquitoes, *Culex pipiens, Aedes taeniorhynchus* and *Anopheles quadrimaculatus*, were examined to determine the effects of parasitism by the mermithid nematode *Romanomermis culicivorax*. The dry weights of infected fourth-stage larvae of all three species were significantly lower than controls. The differences in weight found between infected early and late *C. pipiens* and *A. quadrimaculatus* larvae were attributed to the weight of the parasite itself. This difference was not noticeable in *A. taeniorhynchus* larvae. Haemolymph proteins were severely depleted in all three mosquito species during parasitism by *R. culicivorax*. Analysis of protein

composition by PAGE showed that these depletions were accompanied by a reduction in the number of proteins. Differences between protein composition concentrations were evident between early and late fourth-stage control larvae of *C. pipiens* and *A. quadrimaculatus*. The concentration of some low-molecular-weight proteins (below 68,000) remained constant between infected and control samples of all three mosquito species.

G.K. Sharma & L.N. Gupta (1982). Role of pH factor in biological control of Culex fatigans by a mermithid nematode Romanomermis culicivorax. Z. ang. Ent. 93 (4): 326-328

The late first-instar larvae of *Culex fatigans* were exposed to pre-parasites of *Romanomermis culicivorax*, in the ratio of 1:10, in water with different pH levels at 32-34°C. The survival of the host larvae at different pH levels ranged between 80-100%. However, at pH 7.3 it was observed to range between 30-50%. Maximum parasitism was observed at a pH of 5.7; at higher pH levels, the percentage of parasitism was seen to decline. Higher pH levels were also found to be detrimental for the survival of the post-parasites.

J. Jourdane & S.D. Kulo (1982). Perspectives of the use of Echinostoma togoensis for biological control of intestinal schistosomiasis in Africa. Ann. Parasitol. humaine compar. 57 (5): 443-451

A study of the experimental development of *E. togoensis* in its successive hosts has allowed us to show that this species combines several characteristics considered to be essential with a view to biological control of intestinal schistosomiasis: 1) complete and permanent sterilizing effect on *Biomphalaria pfeifferi*; 2) pathogenicity with respect to the mollusc in infestations with more than 5 miracidia; 3) very clear dominance of intramolluscal stages of *Schistosoma mansoni*; 4) ease and low cost of cycle maintenance (the parasite develops in two common hosts: the planorb and the mouse; 5) high egg productivity in the mouse (10 mice infected with 75 metacercariae produce, on average, 620,000 eggs per day).

D. Rondelaud (1982). Biological control of Lymnaea truncatula by predation: Experimental study of the dynamics of five mollusc species after stopping treatment. Malacologia 22 (1-2): 697-700

The fluctuations in numbers of 5 species of snails were studied for 7 years at 59 stations treated or not by biological means with Zonitid snails during the first 3 years. After biological control for 3 years (1974-1976), *Lymnaea truncatula* disappeared from all habitats. The habitats located on river banks have again been invaded by this species since 1978, most of the habitats on damp valley meadows since 1979, and 2 rushes-covered areas surrounding the heads of springs on hill slopes only in 1980. After the last application of snail control, *Lymnaea glabra* increased in numbers at 3 stations; this increase is temporary or permanent. In all valley meadows where *Zonitoides nitidus* usually lives, snail populations are maintained at a constant and fairly high density. But, if predators (*Zonitoides nitidus, Oxychilus draparnaudi*) have been introduced at *Lymnaea* habitats, these species do not survive in these areas.

L.P.S van der Geest & H. de Barjac (1982). Pathogenicity of Bacillus thuringiensis towards the tsetse fly Glossina pallidipes. Z. ang. Ent. 93 (5): 504-507

Bacillus thuringiensis var. *israelensis* was found to infect adult tsetse flies of the species *Glossina pallidipes*. However, even with very heavy doses, mortality was never higher than about 30%. The bacteria were applied to ears of rabbits which served as hosts for the flies. It could be demonstrated that the bacteria multiplied in the intestines and invaded the haemocoel. Pure preparations of crystals did not cause mortality. The pathogenic action is not limited to the variety *israelensis*: similar results were obtained with the variety *thuringiensis*.

c) Veterinary Entomology

W.N. Beesley (1982). The ecological basis of parasite control: ticks and flies. Vet. Parasit. 11 (1): 99-106

Tick and fly control programmes have undergone radical review in recent years. Insecticidal control measures are now often seen as a means of reducing target populations to a level sufficiently low for final eradication by biological or ecological techniques, the sterile male method being particularly favoured. Immunisation of cattle against ticks, the use of tick-resistant crossbreeds of cattle, tick-repellent grasses and dung-burying beetles are among the additional techniques now being actively investigated.

H.J. Over (1982). Ecological basis of parasite control: trematodes, with special reference to fascioliasis. Vet. Parasit. 11 (1): 85-97

The main ecological components of selected animal trematode infection cycles are considered with regard to the possibilities for control. Because of the complicated nature of interdependency within the host-trematode-intermediate host complex, the ecological base with regard to practical measures is fundamentally wide, but the pressure of social and economic conditions limits operative possibilities considerably.

R.J. Thomas (1982). The ecological basis of parasite control: nematodes. Vet. Parasit. 11 (1): 9-24

The application of control measures requires an understanding of the parasite population pattern in the host and in the environment, and of the factors influencing the population. By using systems analysis, the host-parasite system can be analysed and modelled, and such a model used in simulation studies on control strategies.

R.D. Moon et al. (1982). Reproduction of Spalangia cameroni on stable fly in the laboratory. J. Kansas Ent. Soc. 55 (1): 77-85

Laboratory cultures of the parasitic wasp *Spalangia cameroni* were established from wild specimens collected in feedlots in eastern Nebraska. When reared on pupae of the stable fly, *Stomoxys calcitrans*, the reproductive success of *S. cameroni* was not greatly influenced by host age. Daily

survival of females was near 1.0 at temperatures between 10 and 28°C, but decreased to zero at an upper lethal temperature of 37.5°C. Daily reproduction peaked at 11 progeny/female at 31.7°C; the upper limiting temperature was 36.4°C. *S. cameroni* produced *ca* 20 female progeny over a life span of 11.4 days; sex ratio and developmental time of progeny were independent of maternal age.

R.H. Richardson et al. (1982). Autocidal control of screwworms in North America. Science 215: 361-368

The larva of the blowfly *Cochliomyia hominivorax*, also known as the screwworm, eats the living flesh of cattle and sheep and other warm-blooded animals. A program to eradicate the screwworm in the United States was initiated in the 1950's. The program was very effective until 1968, but severe screwworm outbreaks occurred in 1972 to 1976 and in 1978. Although the program has again been effective since 1979, the possibility of outbreaks recurring in the future has highlighted the need for a broader understanding of the pest. Studies of screwworm populations in the United States and Mexico indicate that much of the genetic diversity of this insect is distributed among sympatric non-interbreeding populations. A new approach may be required to retain the effectiveness of the control program and to prevent a serious outbreak from threatening the economic viability of the US livestock industry.

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IOBC/GERDAT Colloquium on Crop Loss Assessment and Economic Threshold Evaluation in Cotton, Rice and Maize, Paris, 14-16 April 1982

P. Cochereau (ORSTOM, Ivory Coast). Control of insect pests in African subsistence crops, pp 5-10

The control measures used against crop pests in countries with technologically advanced agriculture are compared with those found in Black Africa, where other approaches must be envisaged and applied in the concept of integrated control.

R. Delattre & J. Le Gall (FR). Plant protection in cotton: network of observation plots for different treatment regimes, pp 11-20

Conventional trials were carried out in small plots to compare various industrial products, mixtures, concentrations, formulations (ULV) and frequency of applications. The second phase of experimentation consisted of confirming the efficacy of these methods. This was done on extensive plots by comparing 3, or sometimes 4, plant protection regimes, viz. no treatment (this serving as the control), "standard" treatment and intensive protection. The experiments over the years have been of value additionally from an ecological viewpoint. Economic aspects have also been considered and all the data analysed for a number of French African countries.

M.J. Aspirot (FR). Assessment of damage in cotton crops as a guide for a warning system, pp 21-24

The author describes experiments carried out in two areas of Chad to assess insect damage to cotton and how to use this data as a basis for determining the need for insecticide treatments. He compared the possibility of using two means for observing damage to the bolls: either by considering flower perforated organs adhering to the stalks or those on the soil. The limitations of this approach are discussed. There were problems in defining a damage threshold before pest populations became appreciable, and the thresholds chosen one year could not be applied the next because of ecological variations. Also, the ability of the plant to compensate for certain insect damage needs to be taken into consideration. The best means of defining an intervention threshold is by correlating the number and nature of plant parts infested, the time of damage and the effects of this damage on yield.

M. Vaissayre (FR). Sampling methods for pest insect populations in cotton in Africa, pp 25-29

The assessment of pest densities in cotton crops is a vital prerequisite to the implementation of rational control of pest populations. The various methods of assessment are described, followed by a discussion of the problems particular to each type of pest. The problems associated with statistical interpretation of the results obtained are briefly considered.

D. Gonzalez & L.T. Wilson (USA). A food-wed approach to economic thresholds: a sequence of pests/predaceous arthropods on California cotton, pp 31-43

The value of an adequate food base for predaceous arthropods as provided by *Tetranychus* is relevant for the development of economic thresholds for this group and also for pests that occur later in the season. A higher predaceous potential was reflected in greater levels of *Geocoris* and of *Orius* on untreated plants with abundant food, as compared with lower predator numbers on insecticide-treated plants having lower food levels. The higher numbers of *Geocoris* and *Orius* were significant because they persisted through July-August. In the San Joaquin Valley, an increase in predators during this period is highly beneficial, because *Lygus* and lepidopterous worms may damage cotton at this time. Policy guidelines on effects from chemicals on arthropods need re-evaluation. The assessment of disruptive effects of chemicals must include their impact on the arthropods that constitute the principal sources of food for predaceous arthropods. The indirect effect of chemicals against beneficial-predaceous insects via disruption of their food chain is highly significant because a considerably longer time-interval is required to replenish the food supply, than is needed for beneficial-predaceous adults to reinvade a field. Results from this study support our contention that at least four components must be considered seasonally in developing economic thresholds for pest management programs: 1) the plants, 2) the complex of key pests, 3) the complex of beneficial arthropods, and 4) sources of food in the form of minor "pests" required to support significant numbers of predaceous arthropods in agricultural crops.

L.T. Wilson (USA). Development of an optimal monitoring program in cotton: emphasis on spidermites and Heliothis spp., pp 45-50

To develop a monitoring program requires that not only the spatial pattern of distribution of a species be known, but also the cost of sampling the area(s) within the host plants occupied by a species. As sample unit size (plant, branch, leaf, etc.) decreases, cost to sample each unit decreases, while the number of units required to estimate a population parameter with a given reliability increases. The concept of cost-reliability allows for available sampling procedures to be compared and the best one to be chosen. The paper discusses several ways in which monitoring costs have been reduced for *Tetranychus* spp., *Heliothis* spp. and predators without reducing the reliability of the estimate. These include the use of subsampling plans, binomial sampling and sequential sampling.

C. Sengonca (DE). The principal cotton pests and their economic thresholds in the Kilikien Plain in Southern Turkey, pp 51-56

Agrotis ypsilon, Tetranychus cinnabarinus, Bemisia tabaci, Heliothis armigera, Platyedra gossypiella, Earias insulana, Spodoptera littoralis are the major pests of cotton in the Kilikien Plain in Southern Turkey; *Aphis gossypii, Spodoptera exigua, Empoasca* spp. are occasional pests and *Thrips tabaci, Nezara viridula, Lygus* spp., *Oxycarenus hyalinipennis* are of little importance. Pest control is improved if the exact time of appearance and the biology and ecology of these insect pests are known. *A. ypsilon* can be controlled effectively and economically by seed treatment. Seed sterilization and the destruction of crop residues significantly reduce the offspring and infestation of *P. gossypiella* and *E. insulana*. The number of chemical treatments for *T. cinnabarinus, B. tabaci, H. armigera, S. littoralis* can be reduced by the application of economic thresholds.

R. Delattre (FR). Crop loss assessment and plant protection intervention thresholds, pp 57-70

Crop loss assessment due to pests is a fundamental element in the economic analysis which must take into consideration cotton prices and the cost of phytosanitary measures. These elements vary from one country to another, which explains the divergence of theoretical intervention thresholds. Because of the attributes of the cotton plant, particularly its remarkable potential for adaptation and recovery, the damage and losses suffered at harvest are generally substantially less than the sum of damages observed during the growing season. It is difficult to estimate the different types of compensation of which the plant is capable when, for example, it benefits from subsequent rainfall. Thus when establishing a tolerance threshold, it is necessary to take into account variations in sowing dates, general cultural care and soil conditions. It is necessary also to consider the fact that chemical treatments may be variable in their effect and duration on pests. Chemical interventions are sometimes associated with unintended effects which are unfavourable (phytotoxicity) or indirect (bioecological equilibrium), the biological and economic consequences of which are difficult to evaluate. The author attempts to show with the aid of diagrams the relationships between the different factors mentioned, emphasising the positive and negative consequences. He concludes that the system of traditional treatments, of regular calendar applications, remains the means of control best adapted to the conditions of cotton production in tropical Africa. More sophisticated systems will not be appropriate until the methods for evaluating pest populations are better developed and more rapid. A broader knowledge of the unintended effects of treatments and the compensatory potential of the damaged plant is also required.

J. Brenière (FR). Assessment of crop losses caused by rice pests in West Africa, pp 71-80

There are only a few methods of evaluating crop losses due to insect pests in rice in Africa. Such methods are a prerequisite to control efforts and a forecasting system. Economic thresholds are difficult to establish because of the numerous variables which must be taken into consideration when determining them. Methods should be as simple as possible: an overall comparison of insecticide-treated and untreated plots; specific methods for rice borers which cause damage from flowering onwards. Losses prior to flowering may be calculated by estimating the reduction in number of fruiting tillers. The author describes research undertaken in French West Africa and Madagascar to develop a forecasting system based mainly on egg counts. Simple and reliable methods for correlating symptoms of infestation with yield loss need to be developed in order to secure a well managed integrated control system.

Li Li-Ying (China). Integrated rice insect pest control in the Guangdong Province of China, pp 81-88

There are about 13 species of rice insect pests which are common and of major significance in Guangdong Province, China. Rice pest management in China is based on cultural practices, biological control, insecticides, light traps, varietal resistance and other control methods. Natural control by preservation of natural enemies of pests plays a very positive role in the integrated control of rice pests. The major measures and techniques of these control methods are mentioned in this paper. A list of main insect pests of rice, their natural enemies and some examples of the results of rice pest integrated control in Guangdong Province, China, are also given.

P.A.C. Ooi (Malaysia). Attempts at forecasting rice planthopper populations in Malaysia, pp 89-98

The two rice planthoppers that have caused devastating damage to rice crops in Peninsular Malaysia are *Nilaparvata lugens* and *Sogatella furcifera*. A surveillance system has been set up to monitor these pests. A case study in the off-season crop of 1980 in the Tanjung Karang Irrigation Scheme showed that hopperburn could be predicted a month before it happened. In the following main season, both surveillance records and ecological factors suggested that the pest would be under natural control and the forecast was accurate. The main factors considered in forecasting rice planthoppers were: migration, brachyptery, pest population, predator:prey ratio, history of outbreaks and prevailing field conditions.

H.C. Chiang (USA). Factors to be considered in refining a general model of economic threshold, pp 99-103

A general model of economic threshold was developed in 1979 on the basis of the European corn borer in Minnesota. It has been tested and adopted on various insects in Europe and South America. On the basis of these experiences and other studies in Minnesota, the model has now been refined to consider the factors of plant stress, host tolerance and insect phenology.

M. Stengel (FR). Control of the European corn borer (Ostrinia nubilalis) in Alsace (eastern France): methods for forecasting damage, pp 105-114

In Alsace, the European corn borer (ECB) is strictly monovoltine. Larvae mine the plants causing lodging and ear drop, with yield losses up to 50% (about 2-3 tonne/ha). The optimum date for insecticide applications (i.e. flight max.) was found to be the third week after the start of the flight in caged borers or 4-5 weeks after capture of the first male in pheromone traps. The economic threshold is reached when 10-12% of plants have one egg mass 3 weeks after the start of the flight. It is determined by checking 5×100 plants (100 in each corner and 100 in the middle of a field). The threshold varies with variety and cultural conditions, being 6% for early cultivars and 15% for the later ones. *Bacillus thuringiensis*-based treatments were as effective as chemical insecticides; *B.t.*-induced mortality *per se* was less effective but compensated for by the effects of natural enemies, which are greatly reduced by chemical treatments. Use of *Trichogramma maidis* for control has been investigated since 1974. The parasitoid was released on three occasions per season from the start of egg laying ($3 \times 100{,}000$ parasitised eggs/ha; 705 eggs at each of 142 points per hectare), and proved more effective than chemical treatments, reducing ECB populations by 90-95%. The author describes a method for predicting, the previous autumn, the areas at risk from ECB the following year, in order that there will be sufficient time for the necessary *Trichogramma* stocks to be prepared.

J.-P. Bassino (FR). Thresholds and risks of losses in maize and wheat crops. Rationalised protection, importance of natural enemies, ongoing research in France, pp 115-120

It is difficult to establish economic thresholds since they vary with current commercial practices. "Indicative intervention thresholds" are used in maize and wheat; these are non-acceptable risk levels. The decision to treat or otherwise may be taken either at a high level (potential risk of high infestation) or for each field (after assessing the pest(s) present). Systematic chemical control appears to be one of the causes of the recent pest population explosions in these two crop plants. There is insufficient knowledge of sampling methods, dangerous pest levels and the role of beneficials – naturally-occurring parasites and predators. Studies must be directed towards the establishment of forecast intervention thresholds and indirect means for evaluating the risk of losses.

Conclusions and Recommendations

French version, pp 121-123; English version, pp 124-125

1. Introduction

Subsistence crops and cotton form two entities with distinct characteristics and production techniques. In most tropical countries, the former are rarely subject to systematic chemical control measures by small farmers, whilst cotton production is often based on a well-defined pesticide schedule. In French Tropical Africa, the treatment schedules are based on extensive research which has facilitated minimising the number of interventions, so as to optimise yield by incorporating appropriate fertilisation procedures.

In view of this situation, the Colloquium participants feel it expedient to make specific recommendations for the two crop types, after the following general considerations.

2. General Points

2.1 Quantitative loss assessment depends on an intimate knowledge of the interactions between the pest – host – environment (biotic and abiotic). The determination of economic thresholds is conditioned by knowledge of the relationship between losses and pest population dynamics. It is necessary to establish forecasting systems which incorporate the effects of mortality factors and, in particular, the impact of natural enemies in the field.

2.2 The economic threshold is of value only when the control measures proposed are practicable and their cost/benefit ratio known. It must be simple enough for direct use by the farmer. The sampling methods for risk determination, linked to the threshold, must also be as simple and rapid as possible.

2.3 In all cases, it is vital to set up a pilot experiment to test the control strategy under practical conditions.

2.4 This applies also to the establishment of an effective extension service which is a key element in the dissemination of implementable programs developed by research.

2.5 An example of particularly effective cooperation which incorporates the above principles is that of the International Working Group concerned with protection of maize. This Group, the International Working Group on Ostrinia (IWGO), operating under the aegis of IOBC, constitutes a model which merits consideration for other crops.

2.6 The Colloquium participants wish to emphasise the importance of ongoing and long-term research, on every level, from the administrator to the farmer, from research to application, in order to implement the above recommendations.

3. Subsistence Crops

3.1 Crop losses should be determined in order to make the public authorities and decision-makers aware of the magnitude of losses due to pests, and to establish the need for monitoring and control programs. To accomplish this, it is necessary to determine the key pest(s) for each crop, to concentrate efforts against this (these) pest(s), and to establish a small number of observation posts within the framework of coordinated pilot projects.

3.2 In developing countries, faced with financial problems, exclusive reliance on chemical control may be thought to reflect modernisation. The Colloquium participants feel, on the contrary, that the only practicable solution is the implementation of integrated pest control.

3.3 This action requires:
a) the development of applied research;
b) training of specialised personnel, at all levels;
c) assurance of long-term funding.

4. Cotton

Although the methodologies used in addressing the biological questions are similar, there are widely differing social, economic and biological factors affecting cotton production, and it is not, therefore, practical to present a single recommendation regarding cotton production practices.

4.1 In temperate zones, the establishment of systems based on economic tolerance thresholds calls for the following measures:
4.1.1 The establishment of simple and cheap methods for assessing seasonal levels of pests and their enemies, in relation to optimal crop production practices.
4.1.2 The establishment of methodologies for long-term forecasting of pest outbreaks, crop growth and yield losses.

4.2 In areas of tropical Africa, research should be aimed at the following:
4.2.1 Informative analyses of pests and phenological development in relation to climate and trapping (pheromones, etc.).
4.2.2 Integration of biological control techniques into the present chemical control programs (*Trichogramma* spp., *Trichospilus* spp., Baculovirus, Densovirus, *Bacillus thuringiensis*).
4.2.3 Research into chemicals modifying insect behaviour.
4.2.4 Evaluation of the physiological effects (nutritional or stimulatory) of pesticides on plants.

5. General Recommendations on Experimental Methodology

The design and analysis chosen for the experiment should not be excessively restricted by statistical constraints. The following general points may be noted:

5.1 Plot Size

In general, large plots are preferable to small ones since they permit a better evaluation of the biological interrelations within the agroecosystem (pests, natural enemies, crop growth and development, environmental factors). Moreover, large plots allow better account to be taken of arthropod migrations and pesticide drift. However, certain equipment, such as ULV electrostatic sprayers, will allow recourse to smaller plots.

5.2 Experimental Design

Because of statistical constraints, traditional designs, such as randomised complete blocks or latin squares, are not necessarily suited to biological studies. A factorial experiment incorporating a "split-plot" design may be more appropriate for answering biological questions.

5.3 Statistical Analysis of Data

Regression analyses are often used because they permit development of biological response functions, involving relationships such as yield/pests and/or pest/natural enemies. They also avoid the statistical constraints imposed by an analysis of variance.

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