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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Alfred-Serge BALACHOWSKY 1901-1983

Le Président-Fondateur de l'OILB, A.-S. BALACHOWSKY, vient de nous quitter au terme d'une carrière féconde.

Dans *Entomophaga*, Pierre GRISON retrace brillamment les principales étapes de sa vie de chercheur, d'éditeur et d'organisateur. Je me contenterai donc d'évoquer quelques-uns des traits les plus attachants et parfois méconnus de l'exceptionnelle personnalité de BALACHOWSKY.

En tout premier lieu, il faut souligner son énorme puissance de travail et son remarquable esprit de synthèse. En 1933, à l'âge de 32 ans il eut l'audace de se lancer avec P. MESNIL dans la préparation d'un ouvrage magistral de 2000 pages in 4º : « Les insectes nuisibles aux plantes cultivées » qu'il réussissait à publier en 1935-1936. Une phrase de son avant-propos est particulièrement révélatrice du caractère et des aspirations de BALACHOWSKY :

« Seules de patientes recherches, poursuivies avec enthousiasme et optimisme dans le calme et la liberté, sans aucune étreinte ni pression, permettront de franchir les obstacles qui pour le moment paraissent encore infranchissables ».

Ecrivant ces lignes où il évoque avec insistance cette liberté, imaginait-il le déferlement du nazisme sur l'Europe ? Durant les années tragiques de la 2e guerre mondiale, son action fut en parfait accord avec sa pensée qui était aussi celle de son grand ami Pierre LECOMTE DU NOUY : *la foi en la dignité de l'Homme.*

En 1941, il prodiguait ses cours d'Entomologie à l'Ecole Nationale d'Agriculture de Grignon, captivant son auditoire par son érudition et son expérience. Dans le même temps, il exerçait les fonctions de chef de secteur dans un réseau de la Résistance : grâce à un émetteur caché dans la serre de Grignon, il était en liaison régulière avec Londres et organisait des parachutages d'armes dans la région. Sa petite « Rosengart » boueuse qui stationnait dans l'Ecole après chaque randonnée nocturne nous intriguait.

Trahi par un espion infiltré à Londres, le réseau Buckmaster-Prosper était totalement démantelé au début de juillet 1943. Arrêté, emprisonné à Fresne, déporté à Buchenwald, BALACHOWSKY était immédiatement transféré dans l'enfer du tunnel de Dora où V1 et V2 étaient fabriqués dans le plus grand secret – secret garanti par la mort des détenus.

Des amis de BALACHOWSKY réussirent à l'arracher à temps de cet enfer à la faveur de la complicité d'un prisonnier politique allemand anti-nazi qui était devenu assistant du médecin fou et sadique, le SS Ding Schuler, chef de l'Institut d'« Hygiène » du camp de Buchenwald où l'on fabriquait du vaccin contre le typhus. BALACHOWSKY, le futur chef du Laboratoire à l'Institut Pasteur, n'était-il pas l'homme tout indiqué pour participer à cette fabrication ? Revenu à Buchenwald dans un état squelettique, il a pu récupérer toute sa vitalité en s'alimentant des dépouilles autoclavées de lapins qui avaient servi à la préparation du vaccin. Grâce à son énergie inébranlable, son intelligence, son mépris du danger et ses dons de persuasion, il a réussi à sauver de la pendaison le Wing Commander Forest Yeo THOMAS, envoyé spécial de Churchill en France, ainsi que plusieurs de ses camarades. Il les fit d'abord entrer dans le bloc des cobayes humains du médecin fou puis, en leur attribuant l'identité de cadavres, il put les faire transférer dans des camps satellites.

Tout au long de sa vie, avec la même perspicacité et la même fougue, BALACHOWSKY eut l'audace de se lancer à la conquête d'objectifs que d'autres croyaient inaccessibles ; chaque fois il réussit à écarter les obstacles, à convaincre ses interlocuteurs et à leur transmettre sa foi dans l'œuvre à accomplir. Aujourd'hui on peut affirmer que, sans son action, la gestation de l'OILB n'eut jamais été menée à son terme. Parallèlement à son souci permanent de placer l'Entomologie au service de l'Homme, BALACHOWSKY est toujours resté fidèle à la passion de naturaliste qui l'avait marqué dès sa jeune enfance. Ses nombreuses missions l'ont conduit dans presque toutes les régions du globe, du Japon à la Birmanie, de l'Inde à l'Iran et au Liban, de la Laponie à l'Afrique équatoriale, des USA au Mexique, à l'Amazonie, à la Guyane et aux Caraïbes. L'importance et l'intérêt des matériaux qu'il réunissait lors de chaque exploration sont attestés par le nombre considérable des publications qui en ont résulté. A ce titre, les travaux de BALACHOWSKY sur la systématique et la biogéographie des cochenilles demeureront l'une des parties les plus riches de son œuvre scientifique.

Chaque fois qu'il en trouvait l'occasion, il n'hésitait pas à s'insurger contre le discrédit qui s'est abattu sur la discipline systématique au cours des 30 dernières années, alors que la biologie s'engageait de façon trop exclusive vers les voies moléculaire et biochimique en négligeant ses propres racines : les Etres Vivants. BALACHOWSKY aura été l'un des ardents défenseurs des études de base sur les faunes et sur l'écologie dont l'urgence est justifiée par la disparition chaque année d'espèces innombrables qui resteront à jamais inconnues, leur élimination résultant de la dégradation accélérée des milieux naturels de notre planète sous l'effet conjugué de la démographie galopante et de moyens techniques de plus en plus destructeurs.

L'Histoire retiendra le nom de BALACHOWSKY comme celui d'une des figures les plus éminentes de l'Entomologie française et de l'Entomologie mondiale de ce 20e siècle.

L'OILB rend hommage à la mémoire de son fondateur et présente à son épouse, Solange BALACHOWSKY, l'expression de son profond respect.

G. REMAUDIÈRE
Professeur à l'Institut Pasteur

Alfred-Serge BALACHOWSKY 1901-1983

The founder President of IOBC, A.-S. BALACHOWSKY, has passed away, at the end of a prolific career.

In *Entomophaga*, Pierre GRISON has well recounted the main stages in his life as a researcher, editor and organiser. Here, I will just recall a few of the most engaging and, perhaps, less well known sides of the outstanding personality of BALACHOWSKY.

Firstly, it is necessary to emphasise his tremendous capacity for work and his remarkable powers of synthesis. In 1933, at the age of 32, he was bold enough, with P. MESNIL, to launch into the preparation of a colossal work of 2000 pages in 4 volumes : « Pest Insects of Cultivated Plants », which was published in 1935-1936. One sentence in the preface is especially revealing about the character and aspirations of BALACHOWSKY :

« Only patient research, undertaken with enthusiasm and optimism, with peace of mind and freedom, with no restraints or pressures, will enable one to overcome obstacles which at the time appear insurmountable. »

When writing these lines where he earnestly evokes this freedom, did he conceive of the unfurling of Nazism in Europe ? During the tragic years of the Second World War, his deeds were in perfect harmony with his thoughts, which were those also of his great friend Pierre LECOMTE DU NOUY : *faith in the dignity of Man*.

In 1941, he was presenting his entomology courses at the Grignon National Agricultural School, captivating his audience with his erudition and experience. At the same time, he was carrying on his functions as district head in the Resistance : thanks to a transmitter hidden in the greenhouse at Grignon, he was in regular contact with London, and organised dropping of arms in the region. His little muddy « Rosengart » which was parked in the School after each nocturnal outing used to puzzle us.

Betrayed by a spy in London, the Buckmaster-Prosper network was completely broken up at the beginning of July 1943. BALACHOWSKY was imprisoned at Fresne, sent to Buchenwald and then immediately transferred to the hell of the Dora tunnel, where V1 and V2's were made in great secret – secrecy being guaranteed by death of the prisoners.

BALACHOWSKY's friends succeeded in getting him away from this hell with the help of a German anti-nazi political prisoner, who had become the assistant of the mad and sadistic doctor, SS Ding Schuler, head of the Institute of Hygiene, at the Buchenwald camp, where typhus vaccine was being made. Was not BALACHOWSKY, as future head of department of the Pasteur Institute, the obvious choice to participate in this production ? Having returned to Buchenwald looking like a skeleton, he regained his health by eating the autoclaved remains of rabbits which had been used in the vaccine preparation. Thanks to his unwavering energy, his intelligence, his defiance of danger and his powers of persuasion, he succeeded in saving from hanging Wing Commander Forest Yeo THOMAS, special envoy of

Churchill in France, as well as many of his friends. He first arranged for them to become human guinea-pigs of the mad doctor and then, passing them off as dead bodies, managed to have them transferred to other camps.

Throughout his long life, with the same perspicacity and spirit, BALACHOWSKY addressed himself to problems which others believed to be insoluble ; each time he succeeded in overcoming obstacles, and convincing his peers, imparting to them his faith in the work to be done. Today, we may be sure that, without his actions, IOBC would never have been born. Concurrently with his constant preoccupation to place Entomology in the service of Man, BALACHOWSKY always remained loyal to the passion of being a biologist, to which he had aspired since childhood. His numerous expeditions took him to almost all parts of the world, from Japan to Burma, India to Iran and Lebanon, from Lapland to equatorial Africa, USA to Mexico, to Amazonia, Guyana and the Caribbean. His considerable number of publications bear witness to the importance and value of the material collected during his travels. In this respect, BALACHOWSKY's work on the systematics and biogeography of Coccids will remain one of the pinnacles of his scientific achievements.

Whenever the occasion arose, he never hesitated to rebel against the discredit brought upon the discipline of systematics during the past 30 years when the emphasis in biology rested on molecular and biochemical studies, neglecting the basic concept : living organisms. BALACHOWSKY will have been one of the most ardent defenders of fundamental studies on fauna and ecology, which are urgently required in view of the disappearance each year of innumerable species which still remain to be described ; their elimination is resulting in an accelerated degradation of the natural environment of our planet under the combined effects of population explosion and increasingly destructive technical innovations.

BALACHOWSKY will be recorded in history as one of the most eminent figures in French and world entomology in the Twentieth Century.

IOBC pays tribute to the memory of its founder and extends to his widow, Solange BALACHOWSKY, its deepest sympathy.

G. REMAUDIÈRE
Professor at the Pasteur Institute

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IOBC (Global)

List of Working Groups

Trichogramma and other Egg Parasites
- Subgroup Mass Production and Utilization (Chairman S.A. Hassan);
- Subgroup Ecology and Behaviour (Chairman J.C. van Lenteren);
- Subgroup Systematics and Genetics (Chairman J. Voegelé);

Quality Control in Mass-reared Arthropods (Chairman D.L. Chambers).

Heliothis Biological Control (Chairman E.G. King)

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

Working Group on Bruchids (Chairman V. Labeyrie).

International Heliothis Biological Control Work Group Newsletter

The first Newsletter of this group was issued in November 1983, and the second will follow in April 1984. No. 1 is divided into 4 sections: A) Introduction; B) Progress in biological control (individual reports and S-59 project); C) Questionnaire; D) List of scientists researching biological control of *Heliothis* spp.

The primary purpose of the Newsletter is to provide a medium whereby biological control researchers working on *Heliothis* spp. can communicate. Of particular interest is identification and exchange of natural enemies as well as information. There are 14 brief individual reports on progress in biocontrol of *Heliothis*, with reference to various parasites and predators: *Eucelatoria, Cotina (Apanteles), Trichogramma, Chrysopa, Campoletis, Correlia, Hyposotor, Exorista, Coranus, Cermantulus, Microplitis*, in various countries: Australia, New Zealand, India, Thailand, Kenya, USA and Europe.

The S-59 Southern Regional Project, « *Heliothis* spp.: Management Systems for Field Crops », has been in existence for about 18 years. The 1983 Annual Report of the Project is attached to the Newsletter, together with a list of participants, progress report, and recent publications on *Heliothis* spp. by the project. The concept of Cooperative Regional Research is to focus cooperative efforts of state and federal researchers on a problem of broad concern such as *Heliothis*. The research is funded by the USDA and State Agricultural Stations. The next S-59 meeting will be in March 1984 at Stoneville, Mississippi, USA.

A series of workshops was initiated as an outcome of the 1982 meeting of S-59. The series was entitled « Theory and Tactics of *Heliothis* Population Management ». Workshop I emphasised « Cultural and biological Control ». Subjects addressed included: management and control of wild hosts; cropping systems in SW, mid-south and SE USA; *Heliothis* plant interaction; efficacy of entomophagous arthropods; augmentation of entomophagous arthropods; pathogens; behavioural manipulation; conservation and importation of natural enemies. Workshop I will be published in late 1984 as a bulletin of the Arkansas Agricultural Experiment Station. Workshop II will be held on March 16, 1984, and will emphasise chemical control research, while Workshop III will emphasise pheromone and genetic control research.

The questionnaire solicits information from each respondent on *Heliothis* spp. present in each country of respondent, its pest statuts, host plants and principal natural enemies attacking each species. Moreover, each respondent is requested to identify locations rearing *Heliothis* spp. and the rearing medium. An example questionnaire, completed by Drs E.G. King and C. Goodpasture, using species of *Heliothis* in the USA as examples, is attached.

There are 72 persons listed, with addresses, in section D, mainly from the USA, but also from Zimbabwe, Switzerland, United Kingdom, Pakistan, Egypt, Fiji, Malaysia, Poland, China, France, Australia, India, Thailand, Guam and New Zealand.

Report of the East Palaearctic Regional Section, 1981-1983

East Palaearctic Regional Section (EPRS) was established in 1977. At present, the Section consists of 5 Standing Commissions :

- on publications ;
- on entomophagous and phytophagous insects of weeds ;
- on microbiological methods of plant protection ;
- on integrated systems of plant protection ;
- on genetic and other new selective methods of plant protection.

Twelve *ad hoc* parties were set up in the framework of Standing Commissions for solving particular problems in the field of biological control of noxious diseases and weeds.

During 1981-1983, the Section implemented its activities according to the programme approved by EPRS General Assembly at its 2nd session (November 1980, Moscow).

At present, the Section has the objective of summing up results of research and application in practice in EPRS member countries of various methods of biological control : development of unified guidelines on application of biological plant protection means, organisation of international conferences, meetings, symposia.

EPRS has made up annotated lists of entomophagous insects, attacking pests of cereal crops, cotton, codling moth, colorado potato beetle, tobacco thrips and fall webworm moth. A catalogue of entomopathogenic microorganisms, deposited in research institutions of member countries was published. Also of note is the publication of compiled data on economic thresholds of damage, regulating chemical treatments, as well as information on pesticide selectivity, which helps to reduce the noxious effects of chemicals.

A search for new *Trichogramma* species is on-going, as well as the process of improving methods for its identification. Results of work on developing methods of genetic control of crop pests have been summarised. Research is being done on application of viral and other microbiological preparations for crop and forest pest control.

In 1981-1983, 6 issues of EPRS Information Bulletin were published, and contained : data on pesticide selectivity (Romania), catalogues of entomophages, guidelines on entomopathogen registration and evaluation (Czechoslovakia) ; information on technology and prospects for microbiological applications in plant protection (Poland) ; data on economic thresholds of damage (USSR) ; etc.

During the period under review, the Section held 8 meetings of Standing Commissions and *ad hoc* working parties, a meeting of chairmen of Standing Commissions, as well as Council and Executive Committee sessions.

1) Meeting of chairmen of Standing Commissions (1981, Tashkent, USSR).

2) Meetings of members of Standing Commissions :
- on publications – 1981, Tashkent, USSR ; 1983, Budapest, Hungary ;
- on entomophagous and phytophagous insects of weeds – 1982, Poznan, Poland ;
- on microbiological means of plant protection – 1981, Prague, Czechoslovakia ; 1983, Sofia, Bulgaria ;
- on genetic and other new selective methods of plant protection – 1981, Poznan, Poland ;
- on integrated systems of plant protection – 1983, Moscow, USSR.

3) Meeting of *ad hoc* working party on taxonomy of *Trichogramma* (1983, Sofia, Bulgaria).

At these meetings, the reports by chairmen on activities of Standing Commissions were discussed, as well as proposals on publications and on the formation of new *ad hoc* parties. IOBC President, Prof. K. Hagen, took part in the 3rd meeting of chairmen of Standing Commissions.

In 1981-1983, 4 symposia were held in the framework of Standing Commission activities :

1) « Ecological foundation of genetic control of codling moth and other pests » (1981, Poland). Symposium participants discussed 7 reports, summing up results of work on release of codling moth sterile males and artificial rearing methods as well as physical methods of control of stored product pests.

2) « Mass rearing of entomophages, acariphages and technology of their application in glasshouses » (1982, Poland), which dealt with biological control of spider mites, aphids, glasshouse whitefly and mechanization of entomophage rearing methods.

3) « Ecological basis and application of microbe preparations » (1983, Bulgaria). Participants at the symposium considered development and application of microbiological preparations. It was pointed out that further effort should be concentrated on improvement of technology of their production and application to control colorado potato beetle, vegetable and forest pests. Considerable attention should be paid to the role of naturally occurring diseases in reducing pest populations.

4) « Application of *Trichogramma* in integrated systems of plant protection » (1983, Bulgaria). The key problem at present is to develop effective methods of *Trichogramma* and *Citotroga* quality evaluation. Possibilities of mechanization of parasite mass release on vast areas are being studied. New *Trichogramma* species had been identified.

Proceedings of these symposia will be published as separate brochures in 1984.

In November 1982, a joint meeting of EPRS Council and Executive Committee took place in Moscow, which considered implementation of the Section's programme of activity and established 3 *ad hoc* parties, which will be reporting to the Standing Commission on entomophagous and phytophagous insects of weeds :

- on preparing a catalogue of parasites and predators ;
- on biological control of glasshouse crop pests ;
- on introduction of beneficial organisms.

The Council approved Bulgaria's proposal for the establishment of a new Standing Commission on biological control of forest pests. The Council selected staff for the new Commission, developed a draft activity programme for 1984-1986 ; made up a preliminary agenda for the General Assembly session which will take place in Moscow in April 1984.

At present, the Section is preparing the 3rd session of the Standing Commission chairmen, a meeting of members of the Standing Commission on integrated systems of plant protection, and a symposium on the subject « Integrated systems of plant protection ».

In 1984, it is planned to hold a joint EPRS/WPRS symposium in the framework of the Standing Commission on genetic and other new selective methods of plant protection. We hope that this activity will be of interest for both sections and will help to establish closer contacts and to find ways for further cooperation. We would welcome such cooperation with other regional sections, in particular, the exchange of information and beneficial organisms, as well as joint work on key subjects of biological control. Results of

the Section's activity in 1981-1983, as well as its programme for 1984-1986 will be discussed by the 3rd session of the General Assembly, which will be held in Moscow in April 1984.

V.A. Lebedev
Secretary-General

Report of the Western Hemisphere Regional Section

The WHRS compliments the Global Organization for : 1) organizing many conferences in the interest of promoting biological control, 2) sponsoring several working groups which conduct significant research and enhance communication among workers in biological control, and 3) publishing Newsletters which provided timely information in biological control.

The WHRS, with 178 members in 1982, for its part : 1) held a meeting during the joint meeting of the Entomological Society of America and the Entomological Society of Canada in Toronto, Canada, November 1982, and 2) published 10 issues of Newsletters since July 1979. They were well received. Some discussion is underway to produce a Spanish edition.

The WHRS is very much concerned about the delayed publication of Entomophaga, and its consequence of drop in subscribers and membership. Some members are also concerned about the quality of the journal. I personally appreciated the interaction with Dr G. Mathys and Prof. M. Way on the publication issue, and am pleased to learn that corrective measures are being taken.

The WHRS wishes to make the following suggestions for the good of the Organization and the discipline of biological control : 1) the IOBC brochure is a very useful document to publicize the Organization. But as the current version is outdated, a new version is urgently needed. If the list of officers is left out, the document will be valid and useful for a longer time. A large number need to be printed and provided to each Section. They can be distributed during the annual meetings of entomological (and other related) societies in various countries ; 2) the Council prepares and sends a letter to major taxonomic units in various countries stressing the need to educate more taxonomists, not only of insects, but also of plants and microorganisms, etc.

Finally, the WHRS looks forward to dynamic leadership and directions of the Organization.

H.C. Chiang
President 1983

Report of the West Palaearctic Regional Section

The Section's activities have continued very successfully with notable new developments, particularly in collaboration with the EC[1] and also in information flow as well as New Working and Study Group programmes.

Links with EC

Close collaboration has been maintained between WPRS and EC working groups with common interests. Several successful meetings have been held jointly.

Collaboration between EC and WPRS has led to the development of training courses for young workers concerned with integrated control. The first course was held at Bologna in October/November 1983 and dealt with fruit crops and olives. This course, organized by Prof. G. Briolini, was attended by 18 young scientists and proved very successful. The second course is now under consideration for 1984 or 1985 and will deal with cereals and related crops or protected crops.

A seminar on Technology Transfer for IPC is being organized jointly between WPRS and EC to be held in September or October 1984. This is aimed at people who are interfacing with the farmer and its objective is to discuss and examine the application of IPC in the West Palaearctic region. WPRS is also collaborating with FAO and EC in a symposium on olive pests in 1984.

Publications

In the five years up to 1982, WPRS has published 21 bulletins and brochures mainly in relation to various Working Group activities. Other publications are planned including authoritative texts on aspects of pest management.

Special emphasis is now being placed on publicity for which a leaflet has been prepared and is being distributed.

Information Service

A first copy of « PROFILE » – an internal newsletter for WPRS has now been distributed to Council members, members of Commissions and Working Groups and Institutional Members. This aims to rectify the problem of keeping everybody informed of developments both within Council and, in particular, Institutional Members and members of Working Groups. It is planned to produce « Profile » twice annually under the editorship of Dr Boller.

Commission, Working Group and Study Group Activities

These have continued to flourish. Of particular note has been the re-vigoration of the Commission on Identification of Entomophagous Pests by Dr Klinghauf. Several new Working Groups have been established and also a Study Group on Farming Systems Approach to Crop Protection. This Group links across to many other Working Groups, and the improvement of links between other Working Groups has been initiated by formal arrangements for some convenors to join meetings of other Working Groups. This applies particularly to the Working Group on Pesticides and Beneficial Arthropods convened by Dr Hassan and the Group on Models in Integrated Crop Protection convened by Dr Rabbinge.

Council Activities

Dr Ferron has unfortunately had to relinquish the post of Secretary-General but we are glad to report that Mr Jean-Pierre Bassino (France) has agreed to become Secretary-General. Council recognizes that the work of the Secretary-General is extremely onerous and arrangements are being made for some of his activities to be delegated to other members of Council.

General Assembly of WPRS, Stuttgart, October 7th-10th 1985

Arrangements are well advanced and an excellent programme is being devised by our hosts.

M.J. Way
President

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1) European Communities.

Forthcoming Meetings

European Weed Research Society Symposium on Weed Problems in the Mediterranean Area, Lisbon, Portugal, 3-5 April, 1984. Contact : European Weed Research Society, 8, avenue du Président Wilson, 75116 Paris, France.

Symposium on Microbial Control for Spruce Budworm and Gypsy Moth, 10-12 April, 1984, Howard Johnson's Conference Center, Center St Exit 1-91, Windsor, Locks, Conn. 060096, USA. Tel. (203) 623-9811.

IOBC/WPRS Working Group on Modelling in Integrated Pest Management. Meeting on « Use of system analysis data banks and models in integrated crop protection », Holstein, Switzerland, 21-24 May, 1984. Contact : Dr L. Flückiger, Ciba-Geigy Ltd, Basle, Switzerland.

XVII International Congress of Entomology, Hamburg, Fed. Rep. Germany, 20-26 August, 1984. Contact : Secretary-General, Dr T. Tischler, Zoologisches Institut, Abt. Angewandte Ökologie/Küstenforschung, Biologiezentrum der Universität Kiel, Olshausenstrasse 40/60, DE-2300 Kiel 1, Fed. Rep. Germany.

IOBC General Assembly, Hamburg (to be held during the XVII International Congress of Entomology in Hamburg, 20-26 August, 1984).

International Course on Plant Protection, Wageningen, Netherlands, 23 July-2 November, 1984. Contact : Director, International Agricultural Centre, Postbus 88, 6700 AB Wageningen, Netherlands.

International Symposium on Crop Protection, Gent, Belgium, 8 May, 1984. Contact : The Secretary, Int. Symp. Crop Protection, Faculteit van de Landbouwwetenschappen, Coupure links 533, B-9000 Gent, Belgium.

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

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

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

Society for Invertebrate Pathology, Ann. Gen. Sci. Mtg 1984, Davis, California, 5-9 August. Contact : Dr H. Haya, Dept Ent., Univ. Calif., Davis, California, USA. 1985, Sault-Ste-Marie, Ontario, Canada.

Books

Microbial Control of Plant Pests and Diseases. J.W. Deacon. Van Nostrand Reinhold Co. Ltd., Wokingham, UK. 1983. 96 pp. £4.85. ISBN 0 4423 0512 5.

Plant Protection. An Integrated Interdisciplinary Approach. W.H. Sill. Iowa State University Press, Ames IA. 1982. 297 pp. US $ 24. ISBN 0 8138 1665 3. Reviewed by J.P. Aeschlimann in *Protection Ecology 5* (1983) : 375-376.

Insect Pheromones. M.C. Birch & K.F. Haynes. Institute of Biology Studies in Biology No. 147. Edward Arnold, London. 1982. 60 pp. £2.50. ISBN 0 7131 2852 6.

Insects and Mites of Cultivated Plants in South Africa. D.P. Annecke & V. Moran. Russel Friedman Book Enterprises (Pty) Ltd., South Africa. 1983. 383 pp. R39 22 (Biological control is a strong theme throughout).

A New Journal

Journal of Plant Protection in the Tropics

To be published by the Malaysian Plant Protection Society (MPPS). There will be three issues annually, the first scheduled for April 1984. Comprehensive coverage will be given to Agricultural Entomology, Plant Pathology, Plant Nematology, Weed Science, Pest Ecology and Pest Management. Original research papers, brief communications and reviews on tropical pest problems will be considered. Acceptance of a paper will be at the discretion of an editorial committee comprising specialists in the main subject areas mentioned. They will be assisted by an international panel of reviewers. English will be the language of publication.

For further information, please contact the Executive Editor, Journal of Plant Protection in the Tropics, MAPPS, P.O. Box 12351, Kuala Lumpur 01-02, Malaysia.

SELECTED ABSTRACTS

a) Plant Protection

1. INSECT AND MITE CONTROL

i) Entomopathogens

R.W. Campbell (1983). Gypsy moth control trials combining nucleopolyhedrosis virus, disparlure and mechanical methods. J. econ. Ent. 76 (3) : 610-614.

In 1974, six control methods were tested in 0.4 ha plots, separately and in various combinations, to determine their efficacy in reducing populations and protecting foliage from *Lymantria dispar*. Methods tested included removing egg masses, spraying egg masses with nucleopolyhedrosis virus, removing resting and pupation locations for larvae, removing larvae and pupae, removing fall egg masses, and trapping adult males with traps baited with disparlure. Trials were replicated, and each control method was tested at three gypsy moth densities. None of the 29 control methods or combinations tested provided even temporary protection from the insect.

M.O. Odindo (1983). Epizootiological observations on a nuclear polyhedrosis of the African armyworm Spodoptera exempta. Insect Sci. Appl. 4 (3) : 291-298

Field observations were carried out on a natural outbreak of a nuclear polyhedrosis virus of the armyworm *Spodoptera exempta*. Records were kept in four study sites with varying larval density, vegetation cover and climatic conditions. Biotic factors influencing disease outbreaks were also noted. Initial mortality was recorded 11 days after larval outbreak, and the highest mortality occurred 10 days later. The epizootic was highest in sites of high larval density, wide fluctuations of daily temperatures (range 16.2°C), and high relative humidity. Rainfall was recorded in all disease outbreak sites. An acridid *Acrotylus patruelis* fed on larval cadavers in the field. Polyhedral inclusion bodies recovered from the gut of *A. patruelis* caused disease when fed to third instar *S. exempta* larvae in the laboratory. Predation on larvae by the pied crow *Corvus albus* in some observation sites reduced larval numbers, and may have prevented NPV from rising to epizootic levels in such areas.

In sites of high polyhedrosis incidence, the disease led to larval population collapse in 3 weeks following disease outbreak.

R.G. Luttrell et al. (1983). Effect of spray adjuvants on Heliothis zea nuclear polyhedrosis virus efficacy. J. econ. Ent. 76 (1) : 162-167

Certain characteristics of Elcar (*Heliothis zea* nuclear polyhedrosis virus) spray adjuvant treatments were determined in an effort to explain or identify properties of the combination which influence efficacy of the virus against *Heliothis* spp. on cotton. Neither Coax nor Gustol (adjuvants) affected the dosage mortality response of larvae of *H. zea* to Elcar. Laboratory studies also failed to detect ultraviolet screening properties of the adjuvants at the rate tested (2.5 % concentration). Coax and Gustol appeared to primarily affect efficacy by altering feeding or spray characteristics. Third-stage *H. zea* larvae consumed more cotton leaf discs treated with the virus when an adjuvant was included in the treatment. Correlation analysis showed adjuvant rate to be positively related (r = 0.92) to larval mortality, although percent concentration of adjuvant appeared to be more important than rate in influencing the spray characteristics of Elcar treatments.

D.T. Briese & H.A. Mende (1983). Selection for increased resistance to a granulosis virus in the potato moth, Phthorimaea operculella. Bull. ent. Res. 73 (1) : 1-9

Serial exposure of a susceptible laboratory strain of *Phthorimaea operculella* recently obtained from the field to granulosis virus over six generations produced a 140-fold increase in LD50. The evidence suggests that this was due to a change in frequency of a resistance gene within the population. An attempt to select for even greater resistance in an already highly resistant laboratory strain resulted in only a small increase, due mainly to reduced variability in response of the population. The implications of resistance to viral insecticides developing under field conditions are discussed.

Y.X. Yuan et al. (1982). Tests on the toxicity and pathogenicity of nuclear polyhedrosis virus from the noctuid moth Heliothis armigera (bollworm) for vertebrates. Microbiology (Weishengwuxue Tongbao) 9 (3) : 101-105

No abnormalities were observed in seven vertebrate species (including the mouse, rabbit, fowl, pigeon and goldfish) 21, 90 and 180 days after injection with the Sol-43 and 79-4B strains of nuclear polyhedrosis virus.

M.K. Sears et al. (1983). Utilisation of action thresholds for microbial and chemical control of lepidopterous pests on cabbage. J. econ. Ent. 76 (2) : 368-374.

Microbial and chemical insecticides provided control of *Pieris rapae* and *Trichoplusia ni* on cabbage when applied to field plots based on predetermined densities of eggs and small and large larvae. In excess of 90 % of cabbage harvested from plots treated with suspensions of *Pieris rapae* granulosis virus, *Autographa californica* nuclear polyhedrosis virus and *Bacillus thuringiensis* were marketable. The protection of the crop by microbial insecticides was similar to protection in plots treated with chemical insecticides in which marketable heads exceeded 95 %.

R.C. Reardon & K. Haissig (1983). Spruce budworm larval populations and field persistence of Bacillus thuringiensis after treatment in Wisconsin. J. econ. Ent. 76 (5) : 1139-1143

In 1981, 1 year post-treatment, densities of *Choristoneura fumiferana* larvae and levels of defoliation were lower on balsam fir, *Abies balsamea*, in plots treated with Thuricide 16B or Dipel 4L, formulations of *Bacillus thuringiensis* var. *kurstaki*, than in check plots. Viable endospores were recovered from balsam fir foliage in four treated plots, although total field persistence, i.e. duration of pathogenicity, of *B. thuringiensis* was negative.

W.H. McGaughey (1983). Compatibility of Bacillus thuringiensis and captan when used in a mixture for treating seed corn for moth control. J. econ. Ent. 76 (4) : 897-898

Captan (Orthocide) in aqueous suspension at 58.6 mg of a.i./ml prevented germination of *Bacillus thuringiensis* (Dipel) spores but did not kill the spores. Upon dilution with water, spores that had been incubated with captan for 4 h germinated and produced colonies on agar plates. Captan had no effect on the toxicity of *B. thuringienis* to almond moth, *Ephestia cautella*, and only a slight negative effect on toxicity to Indianmeal moth. *Plodia interpunctella*, perhaps because of its effects on the spores to which this species is susceptible. Captan alone was slightly toxic to these insect species, but it did not increase the toxicity of *B. thuringiensis* in mixtures.

H. Hänel & J.A.L. Watson (1983). Preliminary field tests on the use of Metarhizium anisopliae for the control of Nasutitermes exitiosus. Bull. ent. Res. 73 (2) : 305-313

The insect-pathogenic fungus *Metarhizium anisopliae* caused heavy mortality in laboratory groups of the Australian termite, *Nasutitermes exitiosus*, to which infected workers had been added. Conidia of *M. anisopliae* started an epizootic when introduced into field colonies of *N. exitiosus* near Canberra, irrespective of whether the termites were treated by dusting or spraying in the mound itself, or dusting in nearby feeding sites. In some cases, the disease persisted for at least 15 weeks, and by this time few healthy termites could be found in almost half the treated colonies. Samples of workers taken from treated colonies showed high levels of contamination by *Metarhizium*, irrespective of the state of the colony, but the factors that inhibited the completion of fungal development in the nest are unknown.

D.L. Hostetter et al. (1983). Effect of the fungicide Kocide on the entomopathogenic fungus Erynia (= Zoophthora) phytonomi of the alfalfa weevil in Missouri. J. econ. Ent. 76 (3) : 619-621

The effect of a fungicide Kocide 101 WP | 77 % cupric hydroxide, $Cu(OH)_2$ copper equivalent 50 % | on the naturally occurring entomopathogenic fungus *Erynia (= Zoophthora) phytonomi* infecting alfalfa weevil, *Hypera postica*, larvae was determined. Tests were confined to an alfalfa field with a 3-year history of *E. phytonomi* in developing alfalfa weevil populations. Seven treatment blocks, each of which received one application of Kocide (2.24 kg/ha in 187 liters of water), were sampled weekly for the incidence of *E. phytonomi* in weevil larvae. No differences in the incidence of *E. phytonomi* occurred between the Kocide-treated plots and the control plots. Mortality rates among weevil larvae collected from the treated and untreated plots ranged from 83 to 98 %. These

results indicate that the use of the fungicide Kocide at recommended application rates would not inhibit the expression of *E. phytonomi* in larval populations of the alfalfa weevil.

D.G. Holdom (1983). In vitro culture of the aphid pathogenic fungus Entomophthora planchoniana. J. Aust. ent. Soc. 22 (3) : 188

The isolation and culture of *Entomophthora planchoniana in vitro* is described for the first time. The pathogen was isolated in liquid medium and then transferred to solid medium where sporulation occurred. Conidia from one culture were used successfully to reinfect aphids.

M.J. Samways (1983). Interrelationship between an entomogenous fungus and two ant-homopteran mutualisms on guava trees. Bull. ent. Res. 73 (2) : 321-331

On guava trees at Nelspuit, South Africa, there was a mutualism between the ant *Anoplolepis custodiens* and the mealybug *Planococcus citri* which raised the population levels of both. When ants were excluded from half the trees, their overall population level also dropped by half. Further, they moved their nests to be as near as possible to their main food source, the honeydew of the mealybugs. When deprived of their ant mutualists, the mealybugs were heavily preyed on by coccinellids such as the ant-intolerant *Exochomus flavipes* and the ant-tolerant *Scymnus* spp. Later, the mealybugs were almost totally eliminated by the primary entomogenous fungus *Cladosporium* sp. near *C. oxysporum*. The coccinellids, now without food, were forced to abandon the trees. In contrast, in trees where ants were allowed to continue their normal activity, the epizootic among the mealybugs was delayed by 14 days. This limitation by the ants of disease allowed a basal but fragmented mealybug population to survive. As the mealybugs declined, the ants switched to attending the aphid *Aphis gossypii*. Fifteen days after the epizootic struck the ant-attended mealybug population, it began to devastate the aphid population. With both mealybugs and aphids at a low level, the ant population declined. However, the ant-homopteran mutualisms, although severely hit by the epizootic, nevertheless remained intact.

L.K. Miller et al. (1983). Bacterial, viral and fungal insecticides. Science (Wash.) 219 (4585) : 715-721

Microorganisms that are pathogenic to insects provide a wealth of biological material that can be exploited by humans to control insect pests. Innovative applications of a few such entomopathogens are found thoughout the world, but widespread commercial production of microbial insecticides awaits further studies of the biology, ecology and pathogenicity of the agents. Genetic engineering techniques may be used to increase the virulence of these microorganisms, as well as to make them more tolerant of physical and chemical conditions and perhaps to broaden their host ranges. The use of microbial insecticides could decrease our dependence on chemical pesticides.

ii) Parasites and Predators

W.R. Ingram (1983). Biological control of graminaceous stem-borers and legume pod-borers. Insect Sci. Appl. 4 (1/2) : 205-209

Graminaceous crops are attacked by lepidopterous stem-borers all over the world causing severe crop loss. Chemical control of stem-borers is difficult and biological control is preferable for peasant farming systems. The most important genera are *Diatraea, Chilo, Eldana, Sesamia* and *Busseola*. Their natural enemies include egg, larval and pupal parasites and predators. The parasites are cued by different stimuli, some to host plant, others to borer tunnels or frass. Biocontrol was first attempted against *Diatraea* spp. in the New World where *D. saccharalis* is now under fair control in several countries. In the Old World, attempts have been made to control *C. sacchariphagus* and *E. saccharina* without much success. In East Africa, releases of exotic parasites against *B. fusca, S. calamistis, C. partellus* and *E. saccharina* have not been very successful and further work is suggested. Leguminous crops suffer from attacks of lepidopterous pod-borers. The most damaging species are *Etiella zinckenella, Maruca testulalis, Cydia* spp. and *Lampides boeticus*. There are relatively few records of important parasites and fewer still of predators, however, large parts of the world are still unsurveyed for natural enemies. Successful control using introduced parasites has been reported from Canada against *C. nigricana* and Mauritius against *E. zinckenella* and *M. testulalis*. There appears to be scope for introductions of Caribbean parasites into Africa.

G.O. Poinar, Jr et al. (1983). Field test of the entomogenous nematode, Neoaplectana carpocapsae, for control of corn rootworm larvae. Prot. Ecol. 5 (4) : 337-342

The entomogenous nematode, *Neoaplectana carpocapsae*, was applied at the time of planting to 16 ha of corn (maize) in Nebraska, at the rate of 10,000 per linear meter. One adjacent area of 16 ha served as control and another received an application of Lorsban 15 G insecticide granules at 10.7 kg/ha. Sampling for rootworm larvae 58 days after planting showed significantly fewer insects in the nematode-treated area than in the control or the insecticide-treated areas. The possibilities of using nematodes for rootworm control are discussed.

R.G. van Driesche & G. Taub (1983). Impact of parasitoids on Phyllonorycter leafminers infesting apple in Massachusetts, USA. Prot. Ecol. 5 (4) : 303-317

In commercial apple orchards of western and central Massachusetts, the *Phyllonorycter* leafminer problem was found to be due solely to *P. crataegella*. Sixty-six % of all parasitoids found attacking leafminer larvae were the eulophid species *Sympiesis marylandensis* and 10 % were the braconid *Pholetesor ornigis*. Parasitism of « tissue-stage » larvae on a host generational basis in 1980 ranged from 5.4 to 21.9 % at sprayed sites, and from 19.7 to 43.3 % at unsprayed sites. In 1981, total parasitoid impact (parasitism plus hosts fed upon by adult parasitoids), as estimated from tagged cohorts of leafminers ranged from 0 to 11.8 % at sprayed sites, and from 13.4 to 76.7 % at unsprayed sites. Feeding on hosts by adults of *S. marylandensis* was responsible for 25 % of all parasitoid-caused host mortality.

C.F.J. Bong & P.P. Sikorowski (1983). Use of the DD 136 strain of Neoaplectana carpocapsae for control of corn earworm. J. econ. Ent. 76 (3) : 590-593

Field trials were conducted in the summer of 1981 to determine the effectiveness of the DD 136 strain of *Neoaplectana carpocapsae* in controlling corn earworm, *Heliothis zea*, larvae. The corn ears were artificially infested with *H. zea* larvae and subsequently sprayed with nematodes at 0, 4×10^3 and 4×10^4 nematodes/ml suspension. Eighty-eight percent control was obtained with 4×10^4 nematodes/ml in early June but less, 80 and 58 %

respectively, was observed in late June and early July. Thus, *N. carpocapsae* survives better and is more effective in the early part of the season. All ears in the treated and control plots received some damage, but damage in all the treated plots was significantly lower than in the control.

C.S. Creighton & G. Fassuliotis (1983). Infectivity and suppression of the banded cucumber beetle by the mermithid nematode Filipjevimermis leipsandra. J. econ. Ent. 76 (3) : 615-618

In micro field plot cages, an application of *Filipjevimermis leipsandra* to the soil in the egg stage resulted in parasitization of 50 to 100 % ($\bar{x}$ = 78 %) of *Diabrotica balteata* larvae. More multiple infections of insect larvae occurred in caged soil containing the highest level of nematode eggs. In a greenhouse pot test and in caged and uncaged small field plots, *F. leipsandra* applied to the soil in the egg and preparasitic stages appeared highly promising in protecting sprouted corn seedlings from *D. balteata*. In a laboratory infectivity test, the rate of larval parasitism declined significantly over a 10-day period when *D. balteata* were introduced into soil initially inoculated with *F. leipsandra*.

R.T. Ervin et al. (1983). Comstock mealybug : cost analysis of a biological control program in California. J. econ. Ent. 76 (3) : 605-609

Levels of damage caused by Comstock mealybug were estimated and compared to costs of an eradication and biological control program in California. Damage to apple, peach and lemon was considered. Results of analysis indicate substantial short and long-term financial benefits were gained from research investments in a biological control program. Results of the analysis show that the successful use of biological control was also an economic success.

M.A. Hoy et al. (1983). Release and evaluation of a laboratory-selected, pyrethroid-resistant strain of the predaceous mite Metaseiulus occidentalis in southern Oregon pear orchards and a Washington apple orchard. J. econ. Ent. 76 (2) : 383-388

A laboratory-selected strain of the spider mite predator *Metaseiulus occidentalis* was released into two southern Oregon pear orchards and a Washington apple orchard in June 1980. The permethrin and organophosphorus insecticide (OP)-resistant predators became established in all three orchards, overwintered and survived repeated permethrin applications during 1980 and 1981. By summer 1981, the predators had spread into adjacent trees in release areas in both states. Foliage damage was substantially reduced compared with trees lacking the permethrin-OP-resistant predators in Oregon in 1981. In Washington in 1980, spider mite populations were significantly lower and *M. occidentalis* populations significantly higher on release trees than on control trees. In 1981, the frequency and rates of permethrin applications caused high mortality of the resistant *M. occidentalis* and high spider mite densities developed on all sampled trees. Permethrin resistance levels remained high in the orchard populations after two field seasons, despite the polygenic nature of this resistance. Future releases should be considered, especially where releases can be made into each tree and selective acaricides can be used to manage spider mite-predator densities until a more stable relationship occurs.

N.F. Knop & M.A. Hoy (1983). Factors limiting the utility of Homeopronematus anconai in integrated pest management in San Joaquin valley vineyards. J. econ. Ent. 76 (5) : 1181-1186

A survey showed that the tydeid mite *Homeopronematus (Pronematus) anconai* occurs in all grape-growing areas of the San Joaquin Valley of California. High temperatures and the pesticides used in vineyards were examined as factors that might explain why *H. anconai* populations are low in commercial vineyards during the summer. Cyclic high temperatures and long days were not detrimental to egg hatch, development or reproduction of *H. anconai*, but sulfur and three acaricides are toxic and may limit vineyard populations. Most insecticides commonly used in California vineyards were also found to be toxic. Suggestions for selective pesticide use are made in the context of the role of *H. anconai* as an alternate prey of *Metaseiulus (Typhlodromus) occidentalis*, an effective predator of the Pacific spider mite, *Tetranychus pacificus*.

D. Moore (1983). Hymenopterous parasitoids of stem-boring Diptera (e.g. Oscinella frit) in perennial ryegrass (Lolium perenne) in Britain. Bull. ent. Res. 73 (4) : 601-608

A study was made at Hurley in southern England of the hymenopterous parasitoids of the stem-boring larvae of *Oscinella* spp. and *Geomyza tripunctata* in perennial ryegrass plants *(Lolium perenne)* taken from swards managed in different ways. Six species of parasitoids were identified after their emergence from stem-borer pupae ; four of these were also identified in the parasitoid larval form parasitising stem-borer larvae. Parasitism exceeded 45 % during 1980 but was only about 20 % in 1981. Of the species of *Oscinella*, larvae of *O. frit* were always the most highly parasitised and those of *O. vastator* the least, irrespective of their frequency of occurrence. *G. tripunctata* also showed less parasitism than *O. frit*. The braconid *Chasmodon apterus* was responsible for 95 % of the parasitism in 1980 and 85 % in 1981. The higher parasitism in 1980 probably resulted from greater synchrony between the populations of the adults of *C. apterus* and those of the stem-boring larvae. Samples from eight other sites in the UK gave results similar to those obtained from Hurley.

G.J. Dean (1983). Survival of some aphid predators with special reference to their parasites in England. Bull. ent. Res. 73 (3) : 469-480

Studies in southern England on aphids in cereals and adjacent wasteland included observations on the survival of aphid-specific predators (Coccinellidae and Syrphidae) and the more polyphagous *Chrysoperla carnea*, with particular reference to their parasites. Counts were made of all the predator stages found on samples of shoots in each plot and, in wheat only, collected with a vacuum sampler. All stages of predators seen were collected and reared in the laboratory to estimate mortality and parasitism rates. Overwintering survival outdoors of *Coccinella septempunctata* was studied in partly sheltered and exposed netting cages over dense ground cover. At least 90 % of predator eggs hatched in the laboratory, and no parasites were reared from them or from larvae. In cereals, there were significantly fewer larvae than eggs of Coccinellidae, probably because of cannibalism, whereas eggs and larvae of *Chrysoperla carnea* and Syrphidae (mainly *Episyrphus balteatus)* occurred in similar numbers. Unlike Coccinellidae, however, there were fewer

cocoons of *C. carnea* and syrphid pupae on the shoots than expected. Since larval mortality was apparently small, it is suggested that many larvae pupate in the soil. Two parasite species emerged from coccinellid pupae and one from the adults, compared with two species from *C. carnea* cocoons and nine species from syrphid pupae. Parasitism rates were usually small (<25 %). More individuals of *Coccinella septempunctata* survived overwinter in partly sheltered than in exposed cages.

P.R. Atkinson (1983). Environmental factors associated with fluctuations in the numbers of natural enemies of a population of citrus red scale, Aonidiella aurantii. Bull. ent. Res. 73 (3) : 417-426

Natural enemies of *Aonidiella aurantii* were counted in suction-machine samples taken fortnightly over 41 months from an orchard of orange trees in the Swaziland lowlands, a region where biological control of the scale is difficult. Changes in the log population intensity/« twig » (Δ log N) of four species were, in each case, calculated over four thermal constants of 5000, 10,000, 15,000 and 20,000 hour-degrees above 12°C (h°>12°C). The middle two constants were assumed to approximate to the thermal constants of the generation times of the natural enemies. For each natural enemy, Δ log N measured over each thermal constant was related by regression analysis to climatic and biotic indices to see how the interval over which population change was measured affected the conclusions. The longer the interval, the greater was the percentage of the explained variation in Δ log N, and the greater the number of indices that became significant. However, at 20,000 h°>12°C, population change was measured over rather long intervals for short-lived species like *Aphytis*. At both 10,000 and 15,000 h° > 12°C, the number and the identity of the significant indices in the regression tended to be the same. Consequently, conclusions about the factors affecting the natural enemies were based on these regression results. *A. africanus*, *Comperiella bifasciata* and *Rhyzobius lophanthae* responded directly to changes in their host's numbers, but *Habrolepis rouxi* responded inversely and was unlikely to have been effective. Furthermore, it was sensitive to high summer temperatures, as was *A. africanus* and possibly *R. lophanthae*. *C. bifasciata* was not sensitive to high summer temperatures but was adversely affected by the hyperparasitoid *Marietta javensis*. None of the natural enemies was affected by prevailing saturation deficits.

T.F. Mueller (1983). The effect of plants on the host relations of a specialist parasitoid of Heliothis larvae. Ent. exp. appl. 34 (1) : 78-84

Microplitis croceipes, a parasitoid of *Heliothis* larvae, was reared on 9 host insect/plant combinations. In general, parasitoid survivorship was (1) higher in host larvae that were reared on cotton than in hosts reared on either bean or tomato, (2) higher in *H. zea* hosts than in *H. virescens* and (3) higher in a laboratory strain of *H. zea* than in a wild strain. A series of parasitoid oviposition preference tests showed that wasps laid more eggs in host larvae on cotton plants than on bean and more on bean than on tomato. However, the wasps did not distinguish between *H. zea* and *H. virescens* hosts. Wasp oviposition preferences were not conditioned by the host insect/plant combination in which the parasitoid developed. These results indicate that the plant on which host larvae feed is an important factor in determining both the likelihood of parasitoid attack and the probability of successful parasitism.

M.P. Parrella et al. (1983). Compatibility of insect growth regulators and Chrysocharis parksi for the control of Liriomyza trifolii. J. econ. Ent. 76 (4) : 949-951

The insect growth regulators (IGRs) cyromazine 75W | N-cyclopropyl-1,3,5-triazine-2,4,6-triamine | and Ro 13-5223 IE (ethyl | 2-(p-phenoxyphenoxy) ethyl | carbamate) were evaluated for their ability to control *Liriomyza trifolii* and for their compatibility with the endoparasite *Chrysocharis parksi*. These IGRs provided > 80 % control of *L. trifolii* : cyromazine acted on larvae within mines and significantly ($P>0.05$) reduced larval emergence and pupation compared with the control. In contrast, Ro 13-5223 had no effect on larval emergence and pupation but, instead, reduced adult emergence significantly ($P>0.05$) compared with the control. Both IGRs demonstrated compatibility with *C. parksi* ; no significant difference ($P>0.05$) was detected when parasite emergence was compared from treated and untreated plants.

J.W. Turner (1983). Influence of plant species on the movement of Trissolcus basalis – a parasite of Nezara viridula. J. Aust. ent. Soc. 22 (3) : 271-272

The rate of movement of *Trissolcus basalis* over lower leaf surfaces of soybean, sunflower, bean, mung bean and cowpea was measured in the laboratory. Leaves of sesame appeared repellant to wasps and no measurements could be made. The rate of movement on soybean was a third of the mean of that on the other 4 species. Oviposition by wasps caged over plants on which eggs of *Nezara viridula* had been distributed was assessed. The percentage of eggs parasitised was less on soybean than on other species. It is suggested that the density and length of trichomes inhibit wasp movement and, thus, the effectiveness of *T. basalis* as a biological control agent of *N. viridula* on soybeans.

T.G. Vazirani (1983). Sticholotis chittagongi sp. n., a predator on aphids on Ziziphus in Bangladesh. Bull. ent. Res. 73 (2) : 301-303

Sticholotis chittagongi sp. n., reported as feeding on aphids infesting *Ziziphus mauritiana* in Bangladesh, is described. It is compared with *S. amator*, from which it differs in size, shape of pronotum and male genital characters.

L.W. Bledsoe et al. (1983). Morphology and development of the immature stages of Pediobius foveolatus. Ann. ent. Soc. Am. 76 (6) : 953-957

Immature *Pediobius foveolatus* were dissected from their host, *Epilachna varivestis*, at 6-h intervals to provide descriptions and illustrations of the parasitoids' preimaginal morphology and development. Observations were made of living or freshly killed specimens with the aid of phase microscopy. The eggs and three larval stages are hymenopteriform. Parasitoid eggs did not enlarge after oviposition. The 1st and 3rd instars possess distinctive cephalic skeletons. The pupa is exarate. Descriptions and measurements of the various stages and structures are presented.

Y. Shirota et al. (1983). Biology of Aphidius rhopalosiphi, a parasitoid of cereal aphids. Ent. exp. appl. 34 (1) : 27-34

Aphidius rhopalosiphi produced 212 offspring on average but in one case 509 deposited eggs were found. Superparasitization occurred but the frequency distribution of parasitoid larvae in aphids differed significantly from random, indicating a certain degree of host discrimination. Average life

span of adults was 13.1 days and sex ratio was 1 : 1. It changed in time among successively produced offspring. Handling time was about 2 s and was somewhat longer in the fourth instar than in the second. Second and third aphid instars were preferred for oviposition. Functional response was sigmoid and, at an aphid density of 100 aphids per cage, percentage parasitization decreased.

I.J. Wyatt (1983). Simple calculator models of predator-prey interactions : logistic population growth. Prot. Ecol. 5 (4) : 327-336

The equation, previously proposed by the author to depict the interaction between pests and their natural enemies, has been extended to take account of self-limitation of the pest by increasing its density on the growing plant. If, during any day n, the daily kill by natural enemies, K_n, increases by a factor p to $K_n p$; and also if the carrying capacity of the plant, M_n, increases by the plant growth rate, r ; then a pest population of size a_n, increasing daily by a factor q, can be estimated for succeeding days by the recurrence equation : $a_{n+1} = a_n(q - a_n(q - 1)/M_n - {}_1r) - K_n p$

Three examples are given, interpreting experiments with *Myzus persicae* and *Aphidius matricariae* on chrysanthemums, and with *Tetranychus urticae* and *Phytoseiulus persimilis* on runner beans.

G.E. Rotheray (1983). Feeding behaviour of Syrphus ribesii and Melanostoma scalare on Aphis fabae. Ent. exp. appl. 34 (2) : 148-154

Capture efficiencies and handling times of each instar of *S. ribesii* and *M. scalare* using *A. fabae* as prey were measured. For each instar, *S. ribesii* had higher capture efficiencies and shorter handling times than *M. scalare*. After encounters with aphids, the rate of forward movement decreased and casting for prey increased. Casting rates were higher in *S. ribesii* than *M. scalare*.

K. Porter (1983). Multivoltinism in Apanteles bignellii and the influence of weather on synchronisation with its host Euphydryas aurinia. Ent. exp. appl. 34 (2) : 155-162

The gregarious endoparasite, *Apanteles bignellii*, is specific to the nymphalid butterfly, *Euphydryas aurinia*, in the British Isles. The synchronisation between host and parasitoid is described at a site near Oxford, England, where both occur. Three regular generations of *A. bignellii* occur in one generation of the host in the studied population. Relevant features of the biology of *A. bignellii* and *E. aurinia* are described, including a method of distinguishing the number of *Apanteles* larval instars based upon shed cuticle remnants. Mechanisms for host-parasitoid synchronisation are outlined, especially a protracted parasitoid cocoon stage when the host is unavailable for attack during the chrysalis, adult and egg stages. Cool, but sunny weather conditions in spring can influence the degree of parasitisation experienced by final instar host caterpillars. The timing of adult *A. bignellii* emergence and subsequent attack on early instar hosts can lead to additional, partial, generations of parasitoids from second and fifth instar hosts.

M.G. Fitton et al. (1983). An African ichneumonid in Australasia. Bull. ent. Res. 73 (3) : 465-468

The occurrence of the African ichneumonine *Ctenochares bicolorus* in Australia and New Zealand as a parasite of the crop pest *Chrysodeixis chalcites/C. eriosoma* is reported. The advent of the species to Australasia is discussed in relation to the known distribution and host associations of the genus.

R.A. Werner et al. (1983). Laboratory and field evaluation of insecticides against the spruce beetle and parasites and predators in Alaska. J. econ. Ent. 76 (5) : 1144-1147

Nine insecticides were tested by topical application on mixed sexes of adult spruce beetles, *Dendroctonus rufipennis*. The decreasing order of toxicity of LD_{50} was : permethrin, chlorpyrifos, fenvalerate, fenitrothion, pirimiphos-ethyl, pirimiphos-methyl, etrimphos, phosmet and carbaryl. Permethrin, chlorpyrifos and fenitrothion were further tested for remedial efficacy against white spruce bolts infested with adult beetles. Fenitrothion at 2 % provided the best remedial control of emerged and nonemerged spruce beetles but had a high impact on parasites and predators, whereas 2 % permethrin was almost equally effective, but with the least impact on parasites and predators. *Medetera* sp., *Elachertus* sp. and *Rhizophagus* sp. sustained the greatest mortality from the remedial treatments.

D.G. Martinez & R.L. Pienkowski (1983). Comparative toxicities of several insecticides to an insect predator, a nonpest prey species and a pest prey species. J. econ. Ent. 76 (4) : 933-935

We determined that certain insecticides registered for use on alfalfa may be useful in reducing population levels of a pest, the potato leafhopper, *Empoasca fabae*, while conserving a predator, *Reduviolus americoferus*. This pattern of effectiveness may occur through relatively reduced toxicity to the predator and through reduced toxicity to a nonpest alternate prey in alfalfa grown for hay, the tarnished plant bug, *Lygus lineolaris*. Toxicities of methidathion, azinphosmethyl, carbofuran, methomyl, carbaryl and malathion were determined for adults of the three insect species. LC_{50}s for all six insecticides were higher for *R. americoferus* than for potato leafhoppers ; in all but one case, LC_{50}s for tarnished plant bugs were intermediate. Selectivity ratios for *R. americoferus* over potato leafhopper were highest for azinphosmethyl and lowest for methomyl.

P.W. Tipping & P.P. Burbutis (1983). Some effects of pesticide residues on Trichogramma nubilale. J. econ. Ent. 76 (4) : 892-896

A laboratory bioassay was developed to assess the effects of pesticide residues on adult emergence and parasitism of the egg parasitoid *Trichogramma nubilale*. Tests were conducted on 1, 7, 14 and 21-day greenhouse and field-weathered spray residues from pepper plants at two dosage rates of five pesticides. These were *Bacillus thuringiensis*, carbaryl, methomyl, methyl parathion and permethrin. *T. nubilale* was highly sensitive to all the synthetic chemicals ; methyl parathion was the most toxic. Permethrin residues had no adverse effects on parasitoid emergence, but parasitism rates were always significantly reduced. *B. thuringiensis* sprays, tested in the greenhouse only, did not reduce emergence from or parasitism of European corn borer (ECB), *Ostrinia nubilalis*, eggs. Field-weathered carbaryl and methomyl residues did not reduce parasitoid emergence, but carbaryl residues reduced parasitism rates up to 21 days postspray. Parasitism increased over time at the lower dosage rate of methomyl.

L.A. Hull & R. van Starner (1983). Impact of four synthetic pyrethroids on major natural enemies and pests of apple in Pennsylvania. J. econ. Ent. 76 (1) : 122-130

The impact of four synthetic pyrethroids upon major apple pests and natural enemies was studied in Pennsylvania

orchards from 1975 to 1980. The pyrethroids were tested alone in dilute and airblast applications and at reduced rates in combination with standard insecticides recommended for use in Pennsylvania's integrated pest management (IPM) system. These materials were generally very active against the codling moth, *Laspeyresia pomonella*, the oriental fruit moth, *Grapholitha molesta*, an apple budmoth, *Platynota idaeusalis*, and the white apple leafhopper, *Typhlocyba pomaria*. The pyrethroids showed some potential for reducing populations of the apple aphid, *Aphis pomi*. Fenvalerate and permethrin were somewhat active against mites, but European red mite, *Panonychus ulmi*, and twospotted spider mite, *Tetranychus urticae*, populations generally reached highest densities on pyrethroid plots. The pyrethroids were very toxic to the predatory mites *Amblyseius fallacis* and *Zetzellia mali* but less toxic than standard insecticides to a mirid predator, *Hyaliodes vitripennis*. *Stethorus punctum*, the key natural enemy in Pennsylvania's apple IPM program, also was susceptible to these pyrethroids, but results after applying low rates of pyrethroids for 3 years indicated possible selectivity in favour of *S. punctum* with these new chemicals. These studies indicated several potential avenues for the careful introduction of the synthetic pyrethroids into existing IPM programs for deciduous-tree fruits.

iii) Behavioural and Other Means

D.G. Campion & B.F. Nesbitt (1983). The utilisation of sex pheromones for the control of stem-borers. Insect Sci. Appl. 4 (1/2): 191-197

This paper reviews progress made in the identification of the sex pheromones of lepidopterous stem-borers and the use of these pheromones in crop protection. These uses include population monitoring with pheromone traps and control by mass trapping and mating disruption, and case histories for *Ostrinia nubilalis* and *Chilo suppressalis* are considered in detail to illustrate the problems encountered in applying these techniques. The pheromone blend, trap design, trap siting and pest biology are important factors in any monitoring system, and so far little progress has been made in correlating pheromone trap catches with subsequent larval infestations and crop damage by stem-borers. Control by mass trapping using pheromone traps has been little explored and is thought unlikely to provide a satisfactory control technique for many stem-borers. Control by mating disruption has been more extensively examined with encouraging results. The main potential of this technique would seem to lie in controlling pests of rice, maize and sugar-cane grown under plantation conditions.

B.R. Critchley et al. (1983). Control of pink bollworm, Pectinophora gossypiella, in Egypt by mating disruption using an aerially applied microencapsulated pheromone formulation. Bull. ent. Res. 73 (2): 289-299

A large-scale mating disruption trial for the control of *Pectinophora gossypiella* was carried out in the Fayoum Province of Egypt during the 1981 cotton season. Two areas, each of 50 ha, were sprayed with a microencapsulated formulation of the sex pheromone (a 1:1 mixture of (Z,Z)- and (Z,E)-7, 11-hexadecadienyl acetate) as the sole means of controlling this pest. Five applications of 10 g a.i./ha were made during the season using fixed-wing aircraft. The pheromone treatments were compared with conventional insecticide spray treatments in two other 50-ha areas of cotton. From comparisons of rosetted flowers, percentage boll infestation, gross yield of seed cotton and lint quality, it was concluded that the pheromone treatment was equal in effect to the insecticide sprays.

P.D. Gardner et al. (1983). California red scale : cost analysis of a pheromone monitoring program. J. econ. Ent. 76 (3): 601-604

The benefits of a pheromone monitoring program developed to detect *Aonidiella aurantii* were estimated and compared to the program's research costs in the Yuma County, Arizona, Citrus Pest Control District. The results showed that, for real interest rates between 5 and 10 %, the benefit-cost ratio was > 1. The 22 % calculated internal rate of return compares favourably to commonly accepted estimates of returns on agricultural research funds. We concluded that the funds for red scale research and the monitoring program have greatly assisted citrus growers in the West and have indirectly benefited society.

C.P. Schwalbe et al. (1983). Disruption of gypsy moth mating with disparlure. J. econ. Ent. 76 (4): 841-844

Field tests were conducted in sparsely infested areas of Massachusetts to evaluate the effectiveness of microdispersable formulations of racemic disparlure in disrupting mating of *Lymantria dispar*. The incidence of mating of laboratory-reared female moths placed in treated plots was significantly less than that in control plots, and the degree of mating disruption was correlated with the amount of disparlure applied. The number of male moths captured in (+)-disparlure-baited traps was also correlated with the incidence of mating. In plots treated with 50 g/ha, only 2 % mating was observed, compared with 65 % mating in control plots.

D.R. Johnson (1983). Relationship between tobacco budworm catches when using pheromone traps and egg counts in cotton. J. econ. Ent. 76 (1): 182-183

The seven-component pheromone of *Heliothis virescens* was used as bait in a cone or TP 75-50 trap to monitor adult moths in South Carolina. A direct relationship was found between the number of *H. virescens* moths captured by using pheromone traps and egg counts in cotton fields. Pheromone traps effectively monitored population fluctuation of *H. virescens* during 1979 and 1980.

C. Sartwell et al. (1983). Mating disruption of western pine shoot borer with widely spaced releasers of synthetic pheromone. J. econ. Ent. 76 (5): 1148-1151

Damage of *Eucosma sonomana* to *Pinus ponderosa* was significantly reduced (46 to 73 %) by mating disruption with low seasonal dosages (3.5 to 5 g/ha) of synthetic pheromone (4:1 mix of Z-9 and E-9 dodecenyl acetates) released from widely spaced (20 to 50 m) point sources in three Oregon tests covering 225 ha. Commercially available Hercon laminated tape dispensers were as effective as laboratory-prepared polyvinyl chloride releasers.

G. Jilani & H.C.F. Su (1983). Laboratory studies on several plant materials as insect repellants for protection of cereal grains. J. econ. Ent. 76 (1): 154-157

Three plant materials that are common in Pakistan, rhizomes of *Curcuma longa* (turmeric), leaves of *Azadirachta indica* (neem), and leaves of *Trigonella foenum-graecum* (fenugreek), were evaluated for their repellency against the adults of the three species of stored-product insects, *Tribolium castaneum*, *Sitophilus granarius* and *Rhyzopertha dominica*. Turmeric power was the most

effective of the three against *S. granarius* and *R. dominica*, and also the most effective of the solvent extracts against *T. castaneum*. For each plant material, the petroleum ether extracts were more effective than the acetone and ethanol extracts. The petroleum ether extract of fenugreek deteriorated much faster than the similar extracts of turmeric and neem. The petroleum ether extract of neem was the most effective of the three plant materials against penetration by *R. dominica*.

J.E. Slosser (1983). Potential of Heliothis spp.-resistant cottons in limited-irrigation situations. J. econ. Ent. 76 (4) : 864-868

Cotton cultivars with *Heliothis* spp.-resistant characters (glabrous, nectariless and high gossypol) were grown under Rolling Plains conditions of limited irrigation and low nitrogen inputs. To assess resistance, data were taken on oviposition rate, numbers of larvae, and damage to squares and soft bolls. In the initial screening studies conducted from 1976 to 1978, larval numbers and damage to squares were lower in the resistant cultivars « HG-BR-8-N », « HC-6-1-N », « La 17801 » and « HG-P-9-13 » than in the nonresistant cultivar « Lankart Sel. 611 ». However, yields were generally the same in all cultivars. These results prompted irrigation management studies in 1979 and 1980. When multiple irrigations were not managed to avoid *Heliothis zea* oviposition peaks, resistant cultivars did suppress damage in relation to nonresistant cultivars. However, when cotton was grown dryland, or when irrigations were managed to avoid oviposition peaks, damage to squares and soft bolls sustained by resistant and nonresistant cultivars was the same. The resistant cultivars rarely produced higher yields than the nonresistant cultivars in any of the irrigation management schemes.

L.E.N. Jackai & S.R. Singh (1983). Varietal resistance in the integrated pest management of cowpea pests. Insect Sci. Appl. 4 (1/2) : 199-204

Control of cowpea insect pests has been almost entirely achieved through the use of chemicals by progressive farmers. However, the peasant farmer has traditionally tended to rely on chance and has often been unable to obtain yields that would be profitable. This paper examines the farmer's dilemma and the possibility of using host plant resistance (HPR) as an adjunct to other control methods in developing a sound integrated pest management of cowpea pests. The status of HPR in cowpea is reviewed with a view to identifying the areas where progress has been made with respect to the measurement and identification of resistance to formulate an effective integrated pest control program. The difficulties in achieving this are discussed in the light of our present data bank and the diversity of cowpea pests.

J.E. Carpenter et al. (1983). Fall armyworm : inheritance of gamma-induced deleterious effects and potential for pest control. J. econ. Ent. 76 (2) : 378-382

Male *Spodoptera frugiperda* were exposed to substerilizing dosages (6, 8, and 10 krad) of gamma radiation and mated with untreated females. The inherited deleterious effects resulting from the irradiated P_1 males were observed for several generations. Reduced fecundity and egg hatch, together with an increased incidence of larval and adult mortality, were expressions of the inherited deleterious genes. The data obtained from this study were used in a theoretical model to assess the feasibility of employing these genetically altered insects and their progeny in *S. frugiperda* control. In this model, a single release of 10-krad males produced suppressive action for at least three generations.

F.I. Proshold et al. (1983). Release of backcross insects on St. Croix to suppress the tobacco budworm : behaviour and interaction with native insects. J. econ. Ent. 76 (3) : 626-631

During four releases of backcross insects to suppress native populations of *Heliothis virescens* on St. Croix, U.S. Virgin Islands, the behaviour of backcross insects and their interaction with native insects were studied. Backcross females were observed actively flying, feeding and mating earlier than native females ; however, no difference in time of oviposition or preference for oviposition sites was detected. Activity time of backcross and native males appeared to coincide. Mating interaction was at random between native and backcross insects when backcross insects were placed in the field as pupae and allowed to emerge. When adults were released, greater than expected intramating frequencies were observed, apparently as a result of inadequate dispersal of insects released as adults. Mating interaction between native and backcross insects was verified by an increase in sterility of native females with increased numbers of released insects. Backcross females with eupyrene sperm in their spermathecae were commonly collected.

M.N. Nabi (1983). Field cage trials with thiotepa-sterilised males of the potato moth, Phthorimaea operculella. Bull. ent. Res. 73 (3) : 405-409

Males of *Phthorimaea operculella* less than 24 h old were sterilised with thiotepa by circulatory fumigation in the laboratory and then released in cages in a potato field in New Zealand. Laboratory-reared sterile males, normal males and females were released in different ratios. Sterile males competed successfully in mating to suppress reproduction between laboratory-reared normal males and females. Laboratory-reared sterile males were also released in different numbers into field cages containing the resident population and additional field-collected males and females. The results showed that the sterile males were slightly less competitive than normal ones, but they were effective in suppressing the population in the cages.

iv) Techniques

A.C. Cohen (1983). Improved method of encapsulating artificial diet for rearing predators of harmful insects. J. econ. Ent. 76 (4) : 957-959

Methods were refined for encapsulating small units of artificial diets for rearing predators for use in biological control of harmful insects. A stirring, heating module, which held diet and encapsulating materal at constant temperature, facilitated production of uniform capsules. Several encapsulating materials and applicators were tested. With this method, the media (high or low lipid content) were formed into capsules that had suitable size and wall thickness for feeding several species of immature and adult predaceous insects.

L.F. Goldstein et al. (1983). Rearing Trichogramma nubilale on ultraviolet-irradiated eggs of the European corn borer. J. econ. Ent. 76 (4) : 969-971

Trichogramma nubilale may be reared on eggs of European corn borer (ECB), *Ostrinia nubilalis*, which have been killed by ultraviolet (UV) radiation. A dosage of 30 min is sufficient to cause 100 % mortality in ECB eggs 0 to 4 h old. *T. nubilale* reared for 5 consecutive generations on dead, UV-irradiated eggs exhibit a slightly shortened life span, but

there were no significant changes in the number of progeny per female, adult emergence, sex ratio and progeny produced per ECB egg.

F.I. Proshold et al. (1983). Release of backcross insects on St. Croix to suppress the tobacco budworm : methodology and dispersal of backcross insects. J. econ. Ent. 76 (4) : 885-891

In 1977, a pilot test was initiated on St. Croix, U.S. Virgin Islands, to test the feasibility of controlling *Heliothis virescens* by releasing backcross insects possessing an inherited male sterility resulting from hybridization. During 1979 and 1980, four separate releases were made. Of released males captured, fewer than 15 % were trapped farther than 1.6 km away. Males placed in release cages as pupae dispersed farther than those released as adults. Eggs oviposited by released females were collected as far as 8 km from the release site though most were collected near release sites. Ratios of eggs oviposited by released or native females were similar on pigeon pea, *Cajanas cajan*, and on *Bastardia viscosa*, the two most important hosts for tobacco budworm on St. Croix. These data show the need for frequent release sites in future suppression programs with backcross tobacco budworms.

O.T. Jones et al. (1983). Development of a monitoring trap for the olive fly, Dacus oleae, using a component of its sex pheromone as lure. Bull. ent. Res. 73 (1) : 97-106

A major component of the sex pheromone of *Dacus oleae* has recently been identified as a spiroacetal. The use of this compound as a lure for use in the development of a monitoring trap for that species is described. Polyethylene vials gave a slower release rate of the spiroacetal than rubber septa or microfibres, but even in polyethylene vials a loading in excess of 10 mg was required (optimum 20 to 25 mg) to obtain catches in delta traps which were comparable with those in unbaited vertical yellow sticky traps. In studies in an olive grove near Granada, Spain, a 25-mg spiroacetal lure used with a vertical yellow trap gave catches of males of *D. oleae* which were four times as great as those in delta traps with the same lure or in unbaited yellow traps. The height of the trap had no apparent effect on catch. Previously recorded components of the sex pheromone did not prove to be effective when combined with the spiroacetal. Combined monitoring of *Prays oleae* and *D. oleae*, using their respective pheromones in the same trap, appears to be feasible with delta traps.

T.J. Perfect et al. (1983). Population sampling for planthoppers, leafhoppers and their predators in flooded rice. Bull. ent. Res. 73 (2) : 345-355

Studies on the precision levels and efficiencies of available insect suction samplers (D-Vac and FARMCOP) were undertaken in the Philippines to determine the best possible sampling procedure to derive absolute population estimates of delphacids, cicadellids and their predators in flooded rice. The D-Vac suction sampler when used in conjunction with an enclosure placed over the rice hill prior to sampling was found to be the most suitable. The sampling procedure adopted is described in detail, and sampling efficiencies for the D-Vac are given for nymphs and adults of the delphacids and cicadellids and their predators. These values could be used by other workers following the sampling procedures described here on modern rice varieties grown under flooded conditions to achieve absolute population estimates.

E.M. McVeigh et al. (1983). A technique for tethering females of Spodoptera littoralis to evaluate pheromone control methods. Bull. ent. Res. 73 (3) : 441-446

A fast and simple method of preparing virgin females of *Spodoptera littoralis* for exposure in the field is described. Low predation rates were achieved by tethering the moths on a short (20 cm) piece of cotton thread directly to the plants and by keeping unnecessary daytime exposure to a minimum. Consistently high levels of successful mating were recorded in both berseem and cotton fields in Egypt, suggesting the suitability of the tethering technique for measuring reduction of mating levels in pheromone control trials.

P. Castanera et al. (1983). Electrophoretic study of enzymes from cereal aphid populations. II. Use of electrophoresis for identifying aphidiid parasitoids of Sitobion avenae. Bull. ent. Res. 73 (4) : 659-665

The effect of parasitism by the aphidiid wasp *Aphidius uzbekistanicus* on the isoenzyme banding patterns of 14 soluble enzymes separated by one-dimensional slab polyacrylamide gel electrophoresis from crude homogenates of its main host, *Sitobion avenae*, is described. Parasitism was found to be detectable using any 12 of these enzymes. The differences observed between the banding patterns for three enzymes (esterase, malate dehydrogenase and malic enzyme) separated from the adults of five primary parasitoid species attacking this aphid (*A. picipes*, *A. uzbekistanicus*, *Ephedrus plagiator*, *Praon volucre* and *Toxares deltiger*, are also described. Esterase was found to be the best enzyme for taxonomic differentiation of all aphidiid species examined. The use of electrophoresis for assessing percentage wasp parasitism in integrated management studies of cereal aphids is discussed.

v) General : Integrated Pest Management

E.H. Smith (1983). Integrated pest management (IPM) – specific needs of developing countries. Insect. Sci. Appl. 4 (1/2) : 173-177

The concept and practice of IPM has emerged over the past two decades or more. The primary impetus for its development has come from developed countries. IPM technology transfer to developing countries has followed the earlier pattern of the « green revolution ». The technology being proposed requires high energy inputs and an intensive infrastructure to support it. These conditions simply do not exist in most developing countries. IPM programs for developing countries must be based on their own socioeconomic situation rather than on simple technology transfer. Better understanding of cropping systems must be the keystone to development of IPM programs. Chemical control should play a secondary role. Cultural and biological control and plant resistance adapted to subsistence farming holds the greatest promise. Little attention has been given to the reciprocal feature of studies of traditional agriculture. These practices embrace a wealth of time-honoured ecological wisdom which if unravelled could provide useful leads for modern agriculture. The sequence of steps contributing to this process are proposed.

S.B. Sagnia (1983). Possible integrated pest management tools for the effective control of cereal stem-borers in The Gambia. Insect Sci. Appl. 4 (1/2) : 217-219

The current status of the cereal stem-borer problem on various crops in The Gambia is discussed. Various control

strategies that can be properly selected and integrated are identified. These strategies offer promise for an effective and more economical control of stem-borer infestations and their implementation, it is envisaged, would go a long way in reducing losses due to these pests. The implementation of these strategies would not, also, be free of constraints. These constraints are discussed and ways of solving them suggested.

2. CONTROL OF PLANT PATHOGENS

R.G. Linderman et al. (1983). Strategies for detecting and characterising systems for biological control of soilborne plant pathogens. Pl. Dis. 67 (10) : 1058-1064

The authors consider the following : *Fusarium*-suppressive soils, control of *Phytophthora* root rot of avocado by spore-forming bacteria and/or actinomycetes, control of root-knot nematode by the fungus *Dactylella oviparasitica*, antagonists of *Sclerotium cepivorum*, the nonpathogenic strain (K84) of *Agrobacterium radiobacter* to control *A. tumifaciens*, take-all decline, cyst nematode decline and chestnut blight decline. The physicochemical treatments affecting antagonist or pathogen growth described include soil pH changes, crop sequence/fertiliser, soil fumigation and soil steaming. The key questions to be answered when a potential biocontrol situation is identified are listed. Key experiments to identify the suppressive d factor(s) can then be conducted. The management of microorganisms in biocontrol systems, and the improvement of biocontrol agents by genetic manipulation are briefly discussed. The authors conclude that the potential for biological control of plant pathogens is great but has yet to be widely exploited.

R.J. Scheffer (1983). Biological control of Dutch elm disease by Pseudomonas species. Ann. appl. Biol. 103 (1) : 21-30

No abstract

G. Godoy & R. Rodriguez-Kabana (1983). An enzymatic technique for obtaining Meloidogyne females for biological control studies. Nematropica 13 (1) : 75-78

No abstract

3. CONTROL OF WEEDS

R.D. Goeden (1983). Critique and revision of Harris' scoring system for selection of insect agents in biological control of weeds. Prot. Ecol. 5 (4) : 287-301

Harris' scoring system has been used mainly as a model for predicting, shortly before, during, or after their initial release, the effectiveness of introduced phytophagous insects as biological control agents. Harris, however, meant his system to provide a simple method of recognizing potentially effective biological control agents, or at least eliminating unpromising candidates, before host-specificity determination began. A revision of this scoring system is offered, that attempts to satisfy better the original, intended use of Harris' system. Four selected agents are rated comparatively under the original and revised systems.

D.P.A. Sands (1983). Identity of Cyrtobagous sp. introduced into Australia for biological control of Salvinia. J. Aust. ent. Soc. 22 (3) : 200

The species of *Cyrtobagous* introduced into Australia for biological control of salvinia *(Salvinia molesta)* is not *C. singularis* but a closely related, undescribed species.

J.F. Vayssières & A.J. Wapshere (1983). Life-histories and host specificities of Ceutorhynchus geographicus and C. larvatus, potential biological control agents for Echium. Bull. ent. Res. 73 (3) : 431-440

The two weevils *Ceutorhynchus geographicus* and *C. larvatus*, which live and develop on *Echium plantagineum* (Boraginaceae) in the western Mediterranean regions, are potential biological control agents for this plant, which is an important weed in Australia. Adults bite holes in the leaves and petioles, but this damage is not great in comparison with that caused by their larvae, which mine the collar and root, causing massive necrosis and often the death of the plant. *C. larvatus* larvae are found especially in the aerial parts of the collar of the plant, while those of *C. geographicus* attack principally the rootstocks. Quarantine safety testing was based on plants selected by the criteria already used for the *Echium* leafminer *Dialectica scalariella*, and it was confirmed that the two weevils would be safe and effective agents for the biological control of *E. plantagineum* in Australia.

D.P.A. Sands & R.C. Kassulke (1983). Acigona infusella, an agent for biological control of waterhyacinth (Eichhornia crassipes) in Australia. Bull. ent. Res. 73 (4) : 625-632

The biology and host specificity of a South American moth, *Acigona infusella*, were studied in quarantine facilities in Australia. In choice tests on the host specificity of *A. infusella*, slight feeding by larvae occurred on ginger, lettuce, banana, bullrush *(Typha orientalis)* and water primrose *(Ludwigia peploides)*, but in starvation tests only waterhyacinth *(Eichhornia crassipes)* and pickerel weed *(Pontederia cordata)* supported complete development. A decrease in larval mortality and increase in egg-mass size of *A. infusella* occurred when a microsporidian, *Vairimorpha* sp., infecting the colony was eliminated, suggesting that these insects may then perform more effectively as biological control agents in Australia than in South America. The damage to waterhyacinth caused by larvae of *A. infusella* may complement attack by other biological control agents already established in Australia.

b) Public Health

A.E.S. Foo & H.H. Yap (1983). Field trials on the use of Bacillus thuringiensis serotype H-14 against Mansonia mosquitoes in Malaysia. Mosquito News 43 (3) : 306-311

A suspension concentrate of *Bacillus thuringiensis* serotype H-14 formulation (Tecknar ®, SAN 402-1 SC) was tested against laboratory reared late third/early fourth instar larvae of *Mansonia uniformis* as well as naturally occurring *Mansonia* larvae using Hudson knapsack sprayers on small plots in swampy ditches on Penang Island, Malaysia. Six dosages ranging from 1.1 to 11.40 kg/ha were used in two experiments. Mean dosage/response values at the 50 % level for the introduced and natural population were 0.66 and 1.19 kg/ha, respectively, whereas, the mean dosage/response values at 95 % level were 11.02 and 25.98 kg/ha for the introduced and natural population, respectively. Higher dosages of the *B. thuringiensis* H-14 formulation were needed to achieve control of the *Mansonia* larvae when compared with other vector mosquitoes. The heterogeneity of the response of *Mansonia* population towards *B. thuringiensis* H-14 was also observed. The comparable

dosage/response values for introduced and natural populations suggest that caged introduced populations can be used as a bioassay method for *Mansonia* larvae in the field.

C.H. Schaefer & S. Kirnowardoyo (1983). An operational evaluation of Bacillus thuringiensis serotype H-14 against Anopheles sundaicus in west Java, Indonesia. Mosquito News 43 (3) : 325-329

A brackish water lagoon (*ca* 4.5 ha) was treated 6 times, from the last week in June until the first week in August 1982, with a liquid formulation containing *Bacillus thuringiensis* serotype H-14 toxin. Except during conditions of strong winds, doses of 1.1 to 2.3 kg/ha gave good control of larvae of *Anopheles sundaicus*, the main vector of malaria in the coastal areas of many islands of Indonesia. Adult populations of *An. sundaicus* in nearby hamlets were steadily reduced following successful larvicide treatments but readily increased following a control failure.

J.R. Samples & H. Buettner (1983). Ocular infection caused by a biological insecticide. J. Inf. Dis. 148 (3) : 614

A healthy 18-year-old farmer splashed a solution of Dipel ® *(Bacillus thuringiensis)* in his right eye. While being treated with antibiotic and steroid ointments, a corneal ulcer developed. *B. t.*, susceptible to gentamycin at 1 µg/ml, grew in cultures taken from the ulcer. This is believed to be the first reported occurrence of an infectious disease in a human caused by *B. t.* Caution should be exercised when working with biological insecticides.

M.W. Service (1983). Biological control of mosquitoes – has it a future ? Mosquito News 43 (2) : 113-120

This paper was presented at the Memorial Lecture dedicated to the memory of Harry H. Stage. The author briefly inspects the armory of potential biological control agents for mosquitoes, including viruses, bacteria, fungi, nematodes, predatory fish, *Toxorhynchites* and the triclad *Dugesia*. He concludes that genetic control or use of predators such as *Toxorhynchites* will not be practical ; *Bacillus thuringiensis* is the front runner but *B. sphaericus* eventually may prove to have better prospects. Certain of the mermithids have considerable potential, but will be more difficult to use as biocontrol agents. While the future looks exciting, biological control at present offers little to alleviate suffering from mosquitoes.

R.J. Stewart et al. (1983). Sampling Culex tarsalis immatures on rice fields treated with combinations of mosquitofish and Bacillus thuringiensis H-14 toxin. J. econ. Ent. 76 (1) : 91-95

Data from field collections of third and fourth-stage larvae of *Culex tarsalis* and pupae were used to calculate expected frequencies based on the negative binomial distribution. The data fit the negative binomial with a dispersion constant (kc) of 0.0525. The decision limits for a sequential sampling plan were then calculated. Aerial applications of *Bacillus thuringiensis* serotype H-14 toxin controlled *C. tarsalis* larvae without producing any detrimental effects to predators. The best control was obtained on a field treated with *B. thuringiensis* H-14 toxin and stocked with mosquitofish.

L.A. Lacey & S.L. Oldacre (1983). The effect of temperature, larval age and species of mosquito on the activity of an isolate of Bacillus thuringiensis var. darmstadiensis toxic for mosquito larvae. Mosquito News 43 (2) : 176-180

An isolate of *Bacillus thuringiensis* var. *darmstadiensis* (H-10) with preferential toxicity for mosquitoes was evaluated in the laboratory against *Culex quinquefasciatus*, *Aedes aegypti*, *Anopheles albimanus* and *An. quadrimaculatus* ; the LC_{50} values for 2nd instar larvae were 0.41, 3.96, 4.62 and 5.38 viable spores $\times 10^4$/ml, respectively. There was a strong positive correlation between temperature and larvicidal activity against fourth instar *Cx. quinquefasciatus* exposed to 3.46×10^4 viable spores/ml at 18, 24 and 31°C. Second instar *Cx. quinquefasciatus* and *Ae. aegypti* were approximately 10× more susceptible to the spore-crystal suspension than were fourth instar larvae.

R.E. McLaughlin & J. Billodeaux (1983). Effectiveness of Bacillus thuringiensis var. israelensis against Psorophora columbiae breeding in rice fields. Mosquito News 43 (1) : 30-33

Bacillus thuringiensis var. *israelensis (B.t.i.)* was applied for control of *Psorophora columbiae* larvae to rice fields being flooded for a second rice crop in August and September 1980. Rates of 2 commercial wettable powder formulations applied in a water suspension ranged from 0.25 kg/ha to 0.6 kg/ha. Active ingredients, expressed as the potency value (International Toxic Units), ranged from 8.1×10^8 to 1.9×10^9/ha. Three applications by airplane resulted in 91, 96 and 99 % reductions of very dense (4.5 to 18.6 larvae/dip) larval counts as compared to counts taken 24 h prior to treatment. The *B.t.i.* was also adhered to rice hulls and applied prior to flooding the rice fields or at the time of flooding, and at the same rates as applied in water suspension. The rice hull tests resulted in inadequate control.

P.M. Stark & M.V. Meisch (1983). Efficacy of Bacillus thuringiensis serotype H-14 against Psorophora columbiae and Anopheles quadrimaculatus in Arkansas ricelands. Mosquito News 43 (1) : 59-62

Bacillus thuringiensis serotype H-14 *(Bti)* was tested in small rice plots and in commercial rice fields. Application rates of 0.5 and 1.0 kg/ha in small plots resulted in 100 % mortality of *Psorophora columbiae* at 24 h post-treatment and slight residual activity 48 h post-treatment (i.e. 13 and 27 % respectively). It was also applied by airplane against 2 species at 1.0 kg/ha in 2 large field trials. Larval mortality of *Ps. columbiae* was 69 and 89 % after 24 h exposure in cups. Mixed natural populations of *Anopheles quadrimaculatus* larvae (mainly 1st and 2nd stages) were also reduced by 97 %.

S. Jaronski & R.C. Axtell (1983). Effects of temperature on infection, growth and zoosporogenesis of Lagenidium giganteum, a fungal pathogen of mosquito larvae. Mosquito News 43 (1) : 42-45

Isolates of *Lagenidium giganteum* from North Carolina (NC) and Louisiana (LA) optimally infected *Culex quinquefasciatus* larvae at 21 to 29°C. Infection rates below 15°C and above 32°C were markedly reduced. Sporulation by the NC isolate in larvae was optimal from 19 to 32°C, inhibited below 19°C and completely absent at 10°C. The LA isolate sporulated in larval cadavers less successfully ; the optimum temperature was 18°C. At temperatures above 21°C, the infected larvae were killed too rapidly for the fungus to attain maturation, and the *Lagenidium* perished. When cadavers with fungus of either isolate were subjected to

10°C for 4 days and then returned to 25°C, the fungus successfully sporulated, but after 10 days at 10°C, no sporulation occurred upon return to 25°C.

A.W. Sweeney et al. (1983). Field tests of the mosquito fungus Culicinomyces clavisporus against the Australian encephalitis vector Culex annulirostris. Mosquito News 43 (3) : 290-297

Aqueous suspensions of *Culicinomyces clavisporus* conidia were applied to 5 different breeding habitats of *Culex annulirostris*. This species was controlled in 3 unpolluted sites at dose rates of 10^{10} and 5×10^{9} conidia/m^2 with 95-100 % reductions of late-instar larvae occurring during the first week after application. Approximately 80 % mortality of larvae was achieved in a pond polluted with sewage effluent treated with 10^{10} conidia/m^2 but the fungus was ineffective when this rate was applied to an anaerobic pond polluted with decaying plant debris. Examination of larvae removed from the latter site revealed that the conidia failed to germinate and penetrate the host cuticle under these conditions. Larvae which hatched in one of the unpolluted sites 5 days after treatment were controlled by the fungus but there was no evidence that it persisted or recycled to provide significant larval control beyond this period in any of the other treated sites.

S. Jaronski & R.C. Axtell (1983). Persistence of the mosquito fungal pathogen Lagenidium giganteum (Oomycetes : Lagenidiales) after introduction into natural habitats. Mosquito News 43 (3) : 332-338

Two isolates (North Carolina and Louisiana) of *Lagenidium giganteum* were introduced into natural freshwater mosquito breeding sites in North Carolina in June 1982 and their establishment and persistence monitored through the remaining mosquito breeding season. The North Carolina isolate on agar media was introduced into a flooded woodland that had populations of *Anopheles punctipennis, Culex restuans, Cx. territans, Aedes vexans, Psorophora ferox* and *Ps. columbiae*. A liquid culture of the Louisiana isolate was added to a flooded depression that was a source of *An. punctipennis, Cx. restuans, Cx. territans* and *Ae. vexans*. The fungus became established at both sites, remaining at enzootic levels when larvae were scarce and recrudescing when larval populations increased after flooding. Infections during the observation period ranged from 0 to 100 % among larvae collected from the sites and 20 to 100 % among laboratory-reared larvae (*Cx. quinquefasciatus*) exposed in the sites for 24-48 h. Mosquito larvae added to water samples drawn from the sites and held in the laboratory became infected with the fungus even when natural larval populations were very low or absent. Results indicate that *L. giganteum* recycled for the entire season despite periodic scarcity of hosts and short-term drought. When the water temperature dropped to below 18°C, infection of mosquito larvae by the fungus ceased.

J.A. George et al. (1983). Efficacy of Dugesia tigrina (Tricladida : Turbellaria) in reducing Culex numbers in both field and laboratory. Mosquito News 43 (3) : 281-284

The placement of 300 laboratory-reared planarians into each of 5 catch basins in Ontario, Canada, during early July produced a significant reduction of 81 % in *Culex* larvae in treated basins over that in the non-treated basins from August 23 until September 27, 1979, and an average reduction of 74 % for the entire season (July-September). In laboratory tests, *Culex* adults reared from 100 first instar wild larvae in 2 liters of water were reduced by over 90 % by the presence of 4 or more planarians, while even with 16 planarians, an average of 1.3 adults still emerged. With 80 planarians and 500, 1000 or 2000 first instar larvae in 12 litres of water, emergence of adults was reduced by an average of 80, 89 and 88 %, respectively. With 2000 feral larvae, emergence was reduced even in the absence of planarians due to overcrowding.

F.S. Mulligan et al. (1983). Survival and predatory efficiency of Gambusia affinis for control of mosquitoes in underground drains. Mosquito News 43 (3) : 318-322

Mosquitofish, *Gambusia affinis*, survived in an impounded water area within an underground storm drain system in Fresno, CA, through a 14-wk period during the summer of 1982. The number and relative condition (K-factor) of the stocked fish slowly declined with the depletion of the food supply, as determined by fish gut content analysis, at the tenth week after introduction. However, the mosquitofish were effective in reducing the number of adult *Culex quinquefasciatus* produced in the drain system. Reductions of 75, 89 and 94 % below those of an untreated control area were obtained after the first, second and third month, respectively. While female mosquitofish (gravid before introduction) produced offspring, no mating of fish within the drain was found.

K.O. Kloter et al. (1983). An experimental evaluation of six different suction traps for attracting and capturing Aedes aegypti. Mosquito News 43 (3) : 297-302

Common types of portable suction traps were evaluated to determine their efficacy for attracting and capturing *Aedes aegypti*. Six different traps were equally spaced around the circumference of a circle (radius = 5 m). At the beginning of each trial, mosquitoes were released at the center of the circle and recaptured over a 2 h period. Before the next trial, traps were rotated clockwise to the next position. Six trials were done for each experiment. Experiments were conducted day or night during which traps were or were not baited with dry ice. A Fay-Prince trap captured significantly more male mosquitoes under all conditions and more female mosquitoes in trials without dry ice. The efficacy and practicality of several trap types is discussed regarding their potential for use in *Ae. aegypti* surveillance. A UV Fay-Prince trap is recommended for *Ae. aegypti* adult surveillance.

R.P. Meyer et al. (1983). The « AFS Sweeper », a battery-powered backpack mechanical aspirator for collecting adult mosquitoes. Mosquito News 43 (3) : 346-350

The « AFS (Arbovirus Field Station) Sweeper » was designed and constructed to collect mosquitoes from various resting sites in the southern San Joaquin Valley of California. The sweeper offers backpack portability and manœuvrability, rapid exchange of screened collecting cartons, and increased suction from a 12-volt DC blower powered by 2 gel cell 6V8A batteries that are connected in series. Field trials demonstrated that when the sweeper was operated for either 10 or 15 minutes per collection, the unit was effective for collecting male and female *Culex tarsalis, Cx. quinquefasciatus* and *Culiseta inornata* from different types of vegetation associated with foothill and valley agricultural habitats. The male to female sex ratios of *Cx. tarsalis* collected by the sweeper were significantly higher in the habitats sampled than the ratios in concurrent collections from artificial shelters.

J.O.A. Onyeka (1983). Studies on the natural predators of Culex pipiens and C. torrentium in England. Bull. ent. Res. 73 (2): 185-194

The natural predators of *Culex pipiens* and *C. torrentium* in artificial containers and ponds were studied in southern England, using serological techniques. The antisera were from rabbits immunised by injections of saline extracts of the species of *Culex* into the inguinal lymph nodes and made relatively more specific by absorption. The gut contents or whole individuals of 1098 potential predators were smeared on to filter paper and tested. The most important predators in the ponds were Odonata nymphs while those of artificial containers were larval Dytiscidae. Diptera and Araneae preyed on emerging adults. The length of time a mosquito meal remained detectable in the gut of predators varied from a minimum of 8 h for the newt *Triturus vulgaris* to 24 h for the zygopteran *Ischnura elegans*. The results of laboratory tests indicated that the anisopteran *Sympetrum striolatum* was potentially more important as a biological control agent for larval culicines in ponds than the zygopteran *Coenagrion puella*.

S.D.K. Sempala (1983). Interactions between immature Aedes africanus and larvae of two predatory species of Toxorhynchites in Zika Forest, Uganda. Bull. ent. Res. 73 (1): 19-24

Studies conducted in Zika Forest, Uganda, on the breeding interactions between *Aedes africanus* and two mosquito predators, *Toxorhynchites brevipalpis conradti* and *T. kaimosi*, revealed a significant reduction in the numbers of *A. africanus* larvae and pupae in tree holes that were also inhabited by the predator larvae. There was a tendency for seasonal peaks in numbers of *A. africanus* to be followed two months later by peaks in *Toxorhynchites* spp. Cannibalism appeared to play an important role in the regulation of the population size of the two species of *Toxorhynchites*. The implications of these results in relation to the possible use of *Toxorhynchites* mosquitoes for biological control of *A. africanus* and other mosquitoes breeding in tree holes are discussed.

D.L. Bailey et al. (1983). Effects of indigenous Toxorhynchites rutilus rutilus on Aedes aegypti breeding in tire dumps. Mosquito News 43 (1): 33-37

A study in Jacksonville, Florida, showed that a dense natural population of the predator, *Toxorhynchites rutilus rutilus*, significantly reduced a natural population of *Aedes aegypti* in a tire dump, when compared with 2 other tire dumps with very low levels of *Toxorhynchites*. Production of prey pupae and adults was virtually eliminated by mean levels of 1 to 5 predator larvae per tire during a 10-week study. In these studies, the predator was most effective in tires located under trees, and least effective in open areas.

J.W. Amrine, Jr (1983). Measuring stream discharge and calculating treatment rates of Bacillus thuringiensis (H14) for blackfly control. Mosquito News 43 (1): 17-21

A modified float method for measuring stream discharge for blackfly control is presented as well as a calculator program to assist in calculations and to provide a printed record. In addition, a calculator program is presented that provides a method for calculating rates of material [specifically *Bacillus thuringiensis* var. *israelensis (Bti)*] to be applied to streams for blackfly control and cost for treatment.

A. Cedeno-Leon & J.D. Thomas (1983). The predatory behaviour of Marisa cornuarietis on eggs and neonates of Biomphalaria glabrata, the snail host of Schistosoma mansoni. Malacologia 24 (1-2): 289-297

The predatory behaviour of *Marisa cornuarietis* was evaluated as an agent for the control of *Biomphalaria glabrata*. The results show that predation by *Marisa* is influenced both by endogenous and exogenous factors. Although some *Marisa* preyed deliberately on *Biomphalaria* eggs and juveniles, a minority did not do so during the experiment. There is evidence that *Marisa* predation tends to increase with experience, age and onset of sexual maturity. Mature females ingest significantly more eggs than mature males. Predation is also enhanced by the presence of plant food in flow systems but depressed by heterotypic conditioning. The possible cause of these effects is discussed. The above considerations, and the fact that the rate of predation by *Marisa* does not increase with egg density, shows that *Marisa* is not a good predator. The conclusion that *Marisa* can only be effective as a predator if it is present at high densities, of about 1 per 150-300 cm^2, is supported by field observations.

A. Cedeno-Leon & J.D. Thomas (1982). Competition between Biomphalaria glabrata and Marisa cornuarietis: feeding niches. J. appl. Ecol. 19: 707-721

To evaluate the potential of *Marisa cornuarietis* as an agent for the biological control of *Biomphalaria glabrata* (a snail host of human schistosomes), various components of their feeding niches were measured when the two species were kept separately and together in competitive situations. The three measurements of the extent to which snails find species of aquatic plants ingestible in precompetitive situations indicate that *Marisa* is likely to be a better competitor than *Biomphalaria* and that juveniles of both species are better able to adapt to novel food items than their adult conspecifics. The α indices in competitive situations confirm that *Biomphalaria* is more adversely affected by interspecies competition than *Marisa*. Possible reasons for the differences between the responses of the two species to novel food items and in competitive abilities are discussed. It is concluded that further field tests to evaluate *Marisa* as a biological control agent would be justified.

Operational biological control of onchocerciasis in West Africa. Summary of a report by P. Guillet. From the Soc. Invert. Path. Newsl. 15 (3): 21-22

The author describes a highly successful operational use of biological control. A campaign was initiated in 7 West African countries (Benin, Ghana, Ivory Coast, Mali, Niger, Togo and Upper Volta), with the aid of the World Bank, FAO, UNDP und WHO and a group of donor countries, to plan, organise, implement and evaluate a programme against onchocerciasis. The biology of the parasite and its blackfly vector are briefly described. The Onchocerciasis Control Programme (OCP) is presently implemented by larviciding over an area of approximately 750,000 km^2. Abate®, a 20 % emulsifiable concentrate of the organophosphate temephos, is the insecticide of choice at present, but two species of the *Simulium damnosum* complex have developed resistance. *Bacillus thuringiensis* H-14, being effective, selective and stable, has been used as an alternative insecticide. Research in West Africa has shown that the best type of formulation for use in fast-flowing water is an aqueous suspension of free spores and crystals. A water dispersible concentrate, Teknar® (Sandoz), is now used

operationally against OP-resistant *Simulium* populations at a uniform dose rate of 1.6 mg/l/10 min. Teknar is extremely stable and can be stored for more than 16 months in the sun without losing potency. For logistical reasons, mainly aircraft capacity, it is not possible to treat rivers with discharges above 20 m^3/s routinely. Thus, present areas of resistance are controlled by alternating Teknar (dry season) and chlorphoxim (rainy season), an OP against which the resistance developed by larvae is unstable. Industry is therefore actively working towards improving the formulations in use, by both increasing endotoxin concentration and adding agents to delay loss of toxin from the larval feeding zones. Research should also be intensified to isolate and test new strains. In addition, a better knowledge of feeding behaviour, especially the way in which blackfly larvae catch small particles (0.5 to 1.0 µm), may lead to a greater understanding of certain physico-chemical properties which could guide industry in the design of better formulations. The use of *B. t.* H-14 in an operation like the OCP, only 6 years after its discovery, is a remarkable achievement. The alternation of *B. t.* in the dry season and chlorphoxim in the wet season decreases the selection pressure by chemicals sufficiently to avoid resistance making chlorphoxim useless ; this is an excellent example of the beneficial integration of control methods.

c) Veterinary Entomology

S.M.S. Huda et al. (1983). Sterilisation of the Australian sheep blowfly, Lucilia cuprina, by gamma radiation. J. Aust. ent. Soc. 22 (3) : 201-204

Pupae of *L. cuprina* irradiated 1 day before emergence were completely sterilised by 5 krad. A dose of 3 krad which produced infecundity in females caused *ca* 98 % sterility in males and the competitiveness of those males was 80 %. Irradiation in nitrogen gave no significant increase in competitiveness. When sterile and untreated flies of both sexes were allowed to mate, there was no evidence of assortative mating and the mating propensity of irradiated males was not less than that of untreated males.

D.L. Williamson et al. (1983). Integration of insect sterility and insecticides for control of Glossina morsitans morsitans in Tanzania. I. Production of tsetse flies for release. Bull. ent. Res. 73 (2) : 259-265

A colony of *Glossina morsitans morsitans* was established in the laboratory in Tanga, Tanzania. After being expanded to the planned level of 60,000 flies, the stabilised colony was used to support a field trial using surplus males that were sterilised and released. The production system consisted of an adaptation of the *in vivo* rearing techniques developed at the Tsetse Research Laboratory, England. Goats were hosts for 90 % of the production ; the balance was fed on rabbits. Techniques were developed to standardise the pupal off-take from stabilised colonies in each of three separate insectary units. Puparia were collected daily and kept separately until 52 % emergence had occurred ; these emerging flies, mostly females, were used to replenish the stock colony as needed. Further eclosion was prevented by chilling the remaining puparia (mostly males) quickly at 4°C and then storing at 10 ± 1°C for up to four days prior to irradiation and shipment to the field. About 68 % of the males produced were available for sterilisation. During the 15-month period of production in support of the field experiments, 1.3 million puparia were produced ; 0.6 million of these puparia were released at a production cost of $ 220 per thousand.

D.L. Williamson et al. (1983). Integration of insect sterility and insecticides for control of Glossina morsitans morsitans in Tanzania. II. Methods of sterilisation, transportation and release of sterilised flies. Bull. ent. Res. 73 (2) : 267-273

Surplus puparia from a colony of about 50,000 females of *Glossina morsitans morsitans* provided males for sterilisation and release in an experimental assessment of the sterile insect technique in Tanzania. Excess males were stored late in the puparial stage at 10 ± 1°C for up to four days prior to being irradiated at ambient temperatures in a nitrogen atmosphere with 11.8 krad in a radioactive caesium (^{137}Cs) source. Puparia chilled at 8 ± 1°C were transported to the field release area twice weekly for manual release. At the release sites, the adults emerged synchronously within 60 min and were automatically marked as they crawled through sand containing fluorescent powder.

D.B. Gates et al. (1983). Integration of insect sterility and insecticides for control of Glossina morsitans morsitans in Tanzania. III. Test site characteristics and the natural distribution of tsetse flies. Bull. ent. Res. 73 (3) : 373-381

Detailed data from a preselected release site in Tanzania were collected preparatory to testing the insect sterility concept against *Glossina morsitans morsitans*. The site was at Mkwaja Ranch, a north-eastern coastal cattle-ranching enterprise, in which about 195 km^2 was encompassed by a 1-km-wide fly barrier constructed at an average cost of $ 37/ha. Weekly surveys of flyround transects spaced 1 km apart were conducted over a 14-month period. The estimated male density of *G. m. morsitans* in the release site was about 630/km^2 and for *G. pallidipes*, 255/km^2. The only other species of tsetse found was *G. brevipalpis*, which was restricted to drainage areas during periods of low rainfall.

D.L. Williamson et al. (1983). Integration of sterility and insecticides for control of Glossina morsitans morsitans in Tanzania. IV. Application of endosulfan as an aerosol prior to release of sterile males. Bull. ent. Res. 73 (3) : 383-398

As part of a programme to test the sterile insect technique against *Glossina morsitans morsitans* in Tanzania, two aerial applications of endosulfan were applied to a 195-km^2 test area. The applications were made with a 28-day interval to provide an initial reduction in the target species prior to the release of sterile males. A Cessna 310 aircraft equipped with a rotary atomiser and operating at night was used to apply the insecticide at a dosage of about 20 g/ha. Flyround surveys within 48 h following the spraying operations indicated that a 100 % reduction of *G. m. morsitans* adults was achieved in both applications, while *G. pallidipes* was reduced by 91.5 % in the first and 100 % in the second.

D.L. Williamson et al. (1983). Integration of insect sterility and insecticides for control of Glossina morsitans morsitans in Tanzania. V. The impact of sequential releases of sterilised tsetse flies. Bull. ent. Res. 73 (3) : 391-404

A field trial of the sterile insect technique was conducted in Tanzania using males of *Glossina morsitans morsitans* that were reared, irradiated and packaged at Tanga. The experimental site was a 195-km^2 area 110 km to the south. Following two applications of endosulfan as an aerosol at an interval of 28 days, irradiated puparia of *G. m. morsitans*

were released twice weekly at stations distributed throughout the experimental site. Each of the 120 release stations was serviced every 14 days with puparia which produced sterile adults synchronously within 30 min after placement. Over the 15-month experimental period, an average of 81 % control of *G. m. morsitans* was obtained, whereas *G. pallidipes*, against which no releases were carried out, recovered to prespray levels within five months. The released sterile insects were found to be highly competitive and to survive well in the field. Immigration of indigenous flies from outside the perimeter barrier surrounding the experimental plot provided a continuous influx of fertile flies that provided the nucleus of the 19 % residual population. Under operational conditions, the prevention of migration should result in the elimination of an indigenous *G. m. morsitans* population subjected to the combined stress of population reduction by two applications of endosulfan aerosols and sequential releases of sterile males.

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H.D. Burges, A. Krieg, P. Luthy & H. de Barjac. Respectively : Glasshouse Crops Research Institute, Littlehampton, UK. ; Institut für biologische Schädlingsbekämpfung, Darmstadt, FRG ; Eidgenössische Technische Hochschule, Zurich, Switzerland ; Institut Pasteur, Paris, France. Guidelines for safety tests and registration of bacterial pesticides.

Guidelines intended for the advice of interested firms and governmental agencies have been formulated for safety tests and registration of new bacterial pesticides. For the registration of a new microbial product, information is required on the identity of the bacterium, its biological properties, production, formulation, quality control, application and efficacy. For safety assessment, a series of tests on infectivity, toxicity and allergenicity, etc., in laboratory mammals is arranged in 3 tiers.

B. Cartwright, G.W. Angalet & R.D. Eikenbary. Respectively : Department of Entomology, Virginia Polytechnic Institute and State University, Blacksbury, Va ; USDA-SEA, Beneficial Insects Research Laboratory, Newark, FRG ; Department of Entomology Oklahoma State University, Stillwater, OK, USA. Parasitism by Perilitus coccinellae (Hym. : Braconidae) of indigenous coccinellid hosts and the introduced Coccinella septempunctata (Col. : Coccinellidae) with notes on mortality.

Parasitism of *Coccinella septempunctata* by *Perilitus coccinellae* varies seasonally with an 11 % overall rate among beetles overwintering which is less than that reported in Europe. *P. coccinellae* may parasitize *C. 7-punctata* twice yearly.

J. Davy, Dept. of Entomology, University of California, Davis, CA, USA. Predators and parasites of temporary row crop pests : agents of irreplaceable mortality of scavengers acting prior to other mortality factors ?

A study was conducted with the cabbage looper, *Trichoplusia ni*, to determine : 1) whether naturally occurring entomophagous arthropods impart irreplaceable mortality to the cabbage looper in celery, and 2) whether entomophagous arthropods are present to impart such mortality to *T. ni* eggs and 1st instar larvae when the crop is sensitive to the pest. The majority of *T. ni* mortality through the medium larva stage is explained by parasites which induce mortality that is not entirely replaceable by predators or abiotic factors. Naturally occurring predators and parasites of *T. ni* should be an important part of a celery IPM program and the use of insecticides not toxic to these entomophages is advisable.

R. Reimann & H.G. Miltenburger. Institute of Zoology, Cell Biology Laboratory, Technical University, Darmstadt, FRG. Cytogenetic studies in mammalian cells after treatment with insect pathogenic viruses Baculoviridae. I. In vivo studies with rodents

The results presented demonstrate that NPVs of *Autographa californica* and *Mamestra brassicae* as well as GVs of *Laspeyresia pomonella* do not induce cytogenetic disorders or structural chromosome damage in rodents under experimental conditions. Numerical aberrations do not occur.

J.H. Lashomb & A.L. Steinhauser. Dept. of Entomology, University of Maryland, College Park, MD, USA. Within-tree response of Nantucket pine tip moth, Rhyacionia frustrana (Lep. : Tortricidae) parasitoids to varying host densities

The numerical response of Nantucket pine tip moth, *Rhyacionia frustrana*, parasitoids to varying host densities is described. Response surface analysis showed that high rates of parasitism (greater than 50 %) occurs more frequently at low host densities.

G.G. Soares, Jr. INRA, Station de Recherches de Lutte Biologique, La Minière, France. Pathogenesis of infection by the hyphomycetous fungus, Tolypocladium cylindrosporum in Aedes sierrensis and Culex tarsalis (Dip. : Culicidae)

The mode of infection and cycle of development of *Tolypocladium cylindrosporum* was examined in *Aedes sierrensis* and *Culex tarsalis*. Larvae were found to be infected through the external cuticle, the pharynx and the midgut. Blastospores and conidia were both infective, although for equal numerical concentrations blastospores proved more virulent.

M.A. Hoy & K.B. Smith. Dept. of Entomological Sciences, University of California, Berkeley, CA, USA. Evaluation of Stethorus nigripes (Col. : Coccinellidae) for biological control of spider mites in California almond orchards

Stethorus nigripes was imported from Australia in 1978 and released in California during 1978-1980. Laboratory and field cage studies evaluated aspects of *S. nigripes* biology considered likely to affect establishment. The tests indicated that most females became non-reproductive during late fall. *S. nigripes* also is susceptible to pesticides used to control key insect pests in almonds. Releases to establish this predator were discontinued after 3 years, as *S. nigripes* sensitivity to pesticides and its requirement for prey during winter seem sufficient to account for its failure to establish.

M.W. Brown & E.A. Cameron. Dept. of Entomology, the Pennsylvania State University, University Park, PA, USA. Natural enemies of Lymantria dispar (Lep. : Lymantriidae) eggs in Central Pennsylvania, USA, and a review of the world literature on natural enemies of L. dispar eggs

Throughout the world, gypsy moth egg parasites and hyperparasites have been recorded from 6 different hyme-

nopterous families ; egg predators have been found in 13 families representing 5 orders of arthropods. Vertebrate predators of gypsy moth eggs are in 6 families of birds and 3 families of mammals. The authors present the results of a survey for the natural enemies of gypsy moth eggs, and other associated arthropods, in central Pennsylvania, USA, and then a summary of the literature on the natural enemies of gypsy moth eggs throughout the world.

J.P. Latgé, B. Papierok & L. Sampedro. Institut Pasteur, Paris, France. Aggressiveness of Conidiobolus obscurus towards Acyrthosiphon pisum (Hem. : Aphididae). I. Conidial behaviour on the cuticle before germ-tube penetration into the insect

Seven strains of *Conidiobolus obscurus* were classified into 2 groups depending on their pathogenicity against the pea aphid. Variations in germination patterns on the aphid cuticle were related to differences in pathogenicity of the strains.

B.G. Joshi, S. Sitaramaiah & G. Ramaprasad. Div. of Entomology, Central Tobacco Research Institute, Rajahmundry, India. Field observations on impact of egg parasite Telenomus remus (Hym. : Scelionidae) on tobacco caterpillar, Spodoptera litura (Lep. : Noctuidae) in tobacco nurseries in Andhra Pradesh, India

From the results, it can be concluded that *Telenomus remus* can effectively reduce the population of *Spodoptera* when the pest density is high but that inundative releases of *Telenomus* seem necessary after every 2 years to ensure effective control of the population of *S. litura* in tobacco nurseries.

E. Bruzzese. Keith Turnbull Research Institute, Dept of Crown Lands and Survey, Frankston, Australia. The host specificity of Hartigia albomaculatus (Hym. : Cephidae) and its potential effectiveness in the biological control of European blackberry

The host specificity of the cephid stem-borer *Hartigia albomaculatus* was studied to determine its suitability for the biological control of European blackberry *(Rubus fruticosus)* in Australia. Field observations indicated that the insect was specific to *R. fructicosus* ; however, laboratory tests showed that it can attack some cultivated *Rubus* and garden rose *(Rosa* spp.) varieties.

M.I. Mohamed, M.A. Zaher & M.F. Hassan. Faculty of Agriculture, Cairo University, Cairo, Egypt. Observations on Cheyletus cacahuamilpensis, a predator of the tenuipalpid mite Dolichotetranychus floridanus

Aspects of the biology of *Cheyletus cacahuamilpensis*, a predatory mite of the lawn grass pest *Dolichotetranychus floridanus*, were studied. The total number of *D. floridanus* attacked during the predator's life span averaged 223.6 per female and 104.4 per male.

G.D. Butler, Jr. USDA, Western Cotton Research Laboratory, Phoenix, AZ, USA. Development time of Coccinella septempunctata in relation to constant temperatures (Col. : Coccinellidae)

Development times at constant temperatures were determined for the egg, larval and pupal stages of *Coccinella 7-punctata*, recently introduced to USA. These development rates are similar to those reported in the European literature.

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W.P.J. Overmeer & A.Q. van Zon. Laboratory of Experimental Entomology, University of Amsterdam, Netherlands. A standardized method for testing the side effects of pesticides on the predaceous mite, Amblyseius potentillae (Acarina : Phytoseiidae)

A method is described for testing pesticides on the predaceous mite, *Amblyseius potentillae*. Twenty pesticides (commercial products) were tested on this species using the method mentioned as part of a joint pesticide test programme being carried out by the Working Group « Pesticides and Beneficial Arthropods ».

M.R. Strand & S.B. Vinson. Texas A & M University, Dept. of Entomology, College Station, Texas, USA. Stimulation of oviposition and successful rearing of Telenomus heliothidis (Hym. : Scelionidae) on non-hosts by use of a host-recognition kairomone

The purpose of this study was to determine whether *T. heliothidis* could be induced to oviposit into kairomone coated non-host eggs and whether such eggs could support successful parasitoid development. The experiments showed that *T. heliothidis* could successfully develop in 2 lepidopteran species which were not recognized as hosts by *T. heliothidis* in the absence of the kairomone.

C.M. Ignoffo, A.H. McIntosch, C. Garcia & M. Kroha. USDA, Biological Control of Insects Research Laboratory, Columbia. Effects of successive in vitro and in vivo passages on the virulence of the entomopathogenic fungus, Nomuraea rileyi

The objective of this study was to quantitatively determine whether changes in the virulence of conidia of the entomopathogenic fungus occurs after repeated *in vivo* passages through a susceptible insect host or when cultured *in vitro* on a semisynthetic medium. There was not significant decrease or increase in the activity of conidia after 12 *in vivo* serial passages in larvae of *Trichopulsia ni* or after 12 *in vitro* serial passages on a semi-synthetic medium.

V.H. Fedde, G.F. Fedde & A.T. Drooz. USDA, Forest Service, Southeastern Forest Experiment Station, Athens, Georgia & Research Triangle Park, North Carolina, USA. Factitious hosts in insect parasitoid rearings

Guidelines for choosing surrogate laboratory hosts for rearing parasitic Hymenoptera are given. A survey of 43 instances in which « unnatural » hosts were used in rearing revealed the search should not be limited to closely related taxa. Ease of rearing was the common denominator for host selection. A case study, i.e. selection of *Eutrapela clemataria* (Lep. Geometridae) as a factitious host for the egg parasite *Telenomus alsophilae* illustrates the adaptation of a readily parasitized and productive candidate to available rearing methods for a successful attempt in biological control.

A. Vey, J. Fargues & P. Robert. INRA, Station de Recherches de Pathologie Comparée, St-Christol & Station de Recherches de Lutte Biologique, La Minière, France. Histological and ultrastructural studies of factors determining the specificity of pathotypes of the fungus Metarhizium anisopliae for scarabeid larvae

Experimental infection of scarabeid larvae by injection and contamination of the integument have been carried out with 2 pathotypes of the entomogenous fungus *Metarhizium*

anisopliae, in larvae of *Oryctes thinoceros* and *Cetonia aurata*. Histological and ultrastructural studies of infected insects have revealed several factors which arise at the level of the cuticle and of the body cavity and participate to the determination of the specificity of such strains.

M. Mani, S. Nagarkatti & K. Narayanan. National Centre for Biological Control, Indian Institute of Horticultural Research, Bangalore, India. Influence of parasitism by Eucelatoria bryani (Dip. : Tachinidae) on the consumption and utilisation of chickpea flour diet by Heliothis armigera (Lep. : Noctuidae)

The tachinid *Eucelatoria bryani* was imported from USA for trials against *Heliothis armigera* in India. It was recovered by the authors from *H. armigera* infesting tomato fruits around Bangalore following releases. The present study was carried out to determine the effect of this promising parasite on the food consumption of *H. armigera* in the laboratory.

D.P. Peschken. Research Station Agriculture Canada, Regina, Saskatchewan, Canada. Host specificity and biology of Cystiphora sonchi (Dip. : Cecidomyiidae), a candidate for the biological control of Sonchus species

The host specificity of *Cystiphora sonchi*, a promising biocontrol agent of the sow-thistles, *Sonchus arvensis*, *S. oleraceus* and *S. asper*, was investigated. *C. sonchi* produced viable galls on *Sonchus* species only, thus confirming European field records. *C. sonchi* was approved for release in Canada.

D. Culin & K.V. Yeargan. Dept. of Entomology, University of Kentucky, Lexington, USA. Feeding behavior and prey of Neoscona arabesca (Araneae : Araneidae) and Tetragnatha laboriosa (Araneae : Tetragnathidae) in soybean fields

Neoscona arabesca and *Tetragnatha laboriosa* are the 2 most abundant species of orb-weaving spiders found in soybean fields in central Kentucky. Due to their abundance, and suggestions that spiders may act as beneficial predators in agroeco-systems, a comparative study was undertaken to examine the feeding behavior and prey composition of these two species.

G.J. Hallman & G. Sanchez. Instituto Colombiano Agropecuario, Espinal, Tolima, Colombia. Possibilities for biological control of Antigastra catalaunalis (Lep. : Pyralidae), a new pest of sesame in the Western Hemisphere

The sesame leafroller, *Antigastra catalaunalis*, is a recently introduced pest of sesame, *Sesamum indicum* (Pedaliaceae), in the New World. This paper describes the results of a survey for parasites of *A. catalaunalis* with the objective of discovering possible sources for introduction and biological control. Four parasites have been found attacking *A. catalaunalis* in Colombia. A literature search resulted in a list of 19 insect and 1 nematode parasites. Some of these parasites are widespread and well known, and an attempt should be made to have them sent to Colombia. Some also parasitize other important pests in that country.

M.A. Altieri, S. Annamalai, K.P. Katiyar & R.A. Flath. Respectively : Division of Biological Control, University of California, Berkeley, USA ; Crop Protection Branch, MARDI, Serdango, Sedangor, Malaysia ; Facultad de Agronomia, Universidad del Zulia, Maracaibo, Venezuela ; USDA, Western Regional Research Center, Berkeley, CA, USA. Effects of plant extracts on the rates of parasitization of Anagasta kuehniella (Lep. : Pyralidae) eggs by Trichogramma pretiosum (Hym. : Trichogrammatidae) under greenhouse conditions

The present studies were designed to determine (1) the optimal doses of redroot pigweed's, *Amaranthus retroflexus*, extracts that cause optimal parasitization by *Trichogramma pretiosum* using as experimental host, eggs of the Mediterranean flour moth, *Anagasta kuehniella*, (2) the time that these extracts actively evoke responses and (3) the effect of applications of *A. retroflexus* in solid spray patterns or in a mosaic along with extracts of two other plants.

M.H. Julien, R.C. Kassulke & K.L.S. Harley. CSIRO, Div. of Entomology, Long Pocket Laboratory, Brisbane, Australia. Lixus cribricollis (Col. : Curculionidae) for biological control of the weeds Emex spp. and Rumex crispus in Australia

The biology and host specificity of a colony of *Lixus cribricollis* originating in Morocco were studied in quarantine in Australia. *L. cribricollis* adults are long lived, have an aestivation and are univoltine. *Rumex crispus*, *Emex australis* and *E. spinosa* were shown to be the only satisfactory hosts of 40 species of plants from 17 families that were exposed to sexually mature adults. It was concluded that *L. cribricollis* may be a useful biological control agent for these weeds.

J. Tagawa, Y. Sato & T. Tanaka. Dept. of Ecology, Faculty of Science, Kyoto University, Kyoto, Japan. Developmental interactions between the armyworm Leucania separata (Lep. ; Noctuidae) and its parasite Apanteles ruficrus (Hym. : Braconidae)

The developmental interactions between the gregarious endoparasitoid *Apanteles ruficrus* and the armyworm, *Leucania separata*, were investigated. The parasitoid preferred younger host larvae and developed in 9.5 days irrespective of host age at the time of parasitization. The growth of parasitized host larvae was depressed. The parasitoids have an ability to regulate the size of the host and the parasitoid itself according to the number of eggs laid when the host larva is very small.

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R. Gaugler, B. Kaplan, C. Alvarado, J. Montoya & M. Ortega. New Jersey Agricultural Experiment Station, New Brunswick, New Jersey ; New York State Museum, Albany, New York, USA ; Centro de Investigaciones Ecologicas del Sureste, San Cristobal de las Casas, Chiapas, Mexico ; Departamento de Ecologia Humana, UNAM, Mexico. Assessment of Bacillus thuringiensis serotype 14 and Steinernema feltiae (Nematoda : Steinernematidae) for control of the Simulium vectors of onchocerciasis in Mexico

Field evaluations of *Bacillus thuringiensis* serotype 14 and the nematode *Steinernema feltiae* (= *Neoaplectana carpocapsae*) were conducted against *Simulium ochraceum* and

other simuliid vectors of onchocerciasis in Mexico. *B. thuringiensis* was highly toxic, causing up to 100 % larval mortality, but only for short distances downstream. Stream treatment with *S. feltiae* did not result in significant larval mortality because the infective-stage nematodes were either not ingested or were injured during ingestion.

T. Hofsvang & E.B. Hågvar. Agricultural University of Norway, Ås, Norway. Functional responses to prey density of Ephedrus cerasicola (Hym. : Aphidiidae), an aphidiid parasitoid of Myzus persicae (Hom. : Aphididae)

The functional responses of the parasitoid *Ephedrus cerasicola* parasitizing *Myzus persicae* on a paprika plant, were studied for single females at different host densities (1 to 120 aphids per 1.8 dm^3) during 3 different time periods (1, 6, 24 h) at 21°C. Although no sigmoid functional response could be demonstrated in this study, *E. cerasicola* nevertheless controls aphid populations in small glasshouses.

R. Zuparko. John Muir Institute, Berkeley, California, USA. Biological control of Eucallipterus tiliae (Hom. : Aphididae) in San Jose, Calif., through establishment of Trioxys curvicaudus (Hym. : Aphidiidae)

Trioxys curvicaudus was released in 1978 in San Jose where the aphid was still a pest. Recovery of the parasitoid was made later the same season. Studies in 1979 and 1980 demonstrated that *T. curvicaudus* had become established in San Jose and was exerting a controlling influence on the aphid.

H.S. Salama, A. Sharaby & M. Ragaer. National Research Centre, Dokki, Cairo, Egypt. Chemical changes in the haemolymph of Spodoptera littoralis (Lep. : Noctuidae) as affected by Bacillus thuringiensis

Analyses of the haemolymph of the larvae of *Spodoptera littoralis* indicated the presence of a group of amino acids, some of which showed an obvious quantitative decrease as a result of treatment with *Bacillus thuringiensis*. The increase in the content of some amino acids in infested larvae may be attributed to the possible dissolution of protein crystals of *Bacillus thuringiensis*. *B. thuringiensis* was found to affect also the concentration of some ions of the haemolymph of *S. littoralis*. The pH value of the haemolymph, however, showed no change after treatment with *B. thuringiensis*.

D.A. Fillman & W.L. Sterling. Texas Agricultural Experiment Station, College Station, Texas, USA. Killing power of the red imported fire ant (Hym. : Formicidae) : a key predator of the boll weevil (Col. : Curculionidae)

The red imported fire ant *Solenopsis invicta* has been identified as an important predator of the boll weevil, *Anthonomus grandis*. The evidence of immature weevil mortality due to the ant is usually definitive, thus, it is possible to estimate the killing power.

Rami Kfir. Plant Protection Research Institute, Pretoria, South Africa. Functional response to host density by the egg parasite Trichogramma pretiosum

The effect of host density on parasitism by *Trichogramma pretiosum* was studied by exposing groups of 150, 300, 600 or 1200 eggs of potato tuber moth to 2, 4 or 8 female parasites per group. Increasing host density had a beneficial effect. The parasite exhibited a functional response, became more efficient, parasitised more hosts and produced more female progeny. On the other hand, the efficiency of the parasite dropped, it parasitised fewer hosts, and the proportion and number of female progeny fell.

J.H. Brower. Stored-Product Insects Research and Development Laboratory, USDA, Savannah, Georgia, USA. Eggs of stored-product Lepidoptera as hosts for Trichogramma evanescens (Hym. : Trichogrammatidae)

The study was designed to determine host preference of *T. evanescens* for eggs of 5 species of stored-product pyralid moths and to assess suitability of these hosts for parasite development. It appears that inundative releases of *Trichogramma* into commodity storages could play an important role in suppression of stored-product moth populations.

A. Badawi A. & A. Abou-Awad. National Research Centre, Dokki, Cairo, Egypt. Amblyseius gossypii (Acarina : Phytoseiidae) as a predator of the tomato erineum mite, Eriophyes lycopersici (Acarina : Eriophyidae)

The predatory mite, *Amblyseius gossypii*, completed its life cycle when fed on the tomato erineum mite, *Eriophyes lycopersici*, in the laboratory. The durations of the immature stages and of the adult stage were determined.

B.A. Peleg. The Israel Cohen Institute for Biological Control, Rehovot, Israel. Effect of a new insect growth regulator, RO 13-5223, on hymenopterous parasites of scale insects

The insect growth regulator, RO 13-5223, did not affect the normal development of immature stages of *Metaphycus bartletti* and *Aphytis holoxanthus*, parasitoids of *Saissetia oleae* and *Chrysomphalus aonidum*, respectively. Spraying citrus trees had no adverse effect on the activity of other parasitoids.

J. Chazeau. ORSTOM, Nouméa, New Caledonia. Two predators of Tetranychidae in New Guinea : Stethorus exspectatus n.sp. and Stethorus exsultabilis n.sp. (Col. : Coccinellidae)

Stethorus exspectatus and *S. exsultabilis* are described from Papua New Guinea, with records of their prey and new data on the distribution of *Stethorus* in the Pacific area.

T. Hofsvang & E. B. Hågvar. Agricultural University of Norway, Ås, Norway. Superparasitism and host discrimination of Ephedrus cerasicola (Hym. : Aphidiidae), an aphidiid parasitoid of Myzus persicae (Hom. : Aphididae)

Myzus persicae at different densities on a paprika plant were exposed at 21°C to single females of the parasitoid *Ephedrus cerasicola* during different exposure periods. *E. cerasicola* discriminates between unparasitized and parasitized aphids. Larvae in superparasitized aphids developed slower than single larvae.

C.B. Huffaker, J. Hamai & R.M. Nowierski. Division of Biological Control, University of California, Berkeley ; Montana State University, Bozeman, Montana, USA. Biological control of puncturevine, Tribulus terrestris in California after twenty years of activity of introduced weevils

Fifteen years of field tests were conducted in California on 1,200 plots infested with the annual puncturevine *(Tribulus terrestris)* in order to examine the effect of 2 introduced

weevils, *Microlarinus lareynii* and *M. lypriformis*, on puncturevine. Since 5 of the 6 series of plots marked a substantial reduction in viable seed production and puncturevine coverage, it is suggested that the 2 introduced weevils curtailed the puncturevine population's capacity to compensate in the natural situation and significantly contributed to the decline in puncturevine density.

M. Mani & A. Krishnamoorthy. Indian Institute of Horticultural Research, India. Recovery of two exotic parasites, Trichogramma brasiliensis (Hym. : Trichogrammatidae) and Eucelatoria bryani (Dip. : Tachinidae) from Heliothis armigera (Lep. : Noctuidae) in tomato fields

Field trials were conducted with 2 exotic parasites, *Trichogramma brasiliensis* and *Eucelatoria bryani* in tomato fields around Bangalore. Both the parasites were recovered from *H. armigera* in the fields. Parasitism by *T. brasiliensis* ranged from 34.6 to 51.3 % ; by *E. bryani*, it ranged from 0.0 to 8.0 %.

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W.L. Sterling, D.A. Dean, D.A. Fillman & D. Jones. Respectively : Dept. Entomology, Texas A&M University, College Station, TX ; Dept. Entomology, Oregon State University, Corvallis, OR ; Dept. Entomology, University of Kentucky, Lexington, KY, USA. Naturally-occurring biological control of the boll weevil (Col. : Curculionidae)

Red imported fire ants, *Solenopsis invicta*, are effective predators of the boll weevil, *Anthonomus grandis*, in east Texas cotton fields. Boll weevils caused no economic loss in 11 years due to mortality attributed primarily to ants.

J.A. McMurtry, H.G. Johnson & M.H. Badii. Dept. Entomology, University of California, Riverside, CA, USA. Experiments to determine effects of predator releases on populations of Oligonychus punicae (Acarina : Tetranychidae) on avocado in California

Experiments were conducted to determine if mass releases of certain species of phytoseiid mites could produce more effective suppression of *O. punicae* than natural predation. Of the phytoseiid species tested in this study, 3 of the 4 specific predators of mites showed marked numerical responses to increases of the prey *(O. punicae)* population.

Y. Sato & T. Tanaka. Dept. Zoology, Faculty of Science, Kyoto University, Kyoto, Japan. Effect of the number of parasitoid (Apanteles kariyai) eggs (Hym. : Braconidae) on the growth of host (Leucania separata) larvae (Lep. : Noctuidae)

The developmental interactions between *Apanteles kariyai* and its host were investigated. The parasitoid laid more eggs in older hosts. Host size increased proportionally as the instar advanced, but the number of eggs laid per host did not increase accordingly. The parasitoid larvae control host growth in such a way that the more numerous they are relative to their host size, the more they contribute to the size of their host.

P.A. Stansly. Dept. Entomology, Texas A&M University, College Station, TX, USA. Introduction and evaluation of Chilocorus bipustulatus (Col. : Coccinellidae) for control of Parlatoria blanchardi (Hom. : Diaspididae) in date groves of Niger

Chilocorus bipustulatus was successfully established in oases of the Air Mountain region of Northern Niger, where it became the major cause of mortality among adult females of the armored scale, *Parlatoria blanchardi*. This resulted in significantly lower scale infestation of date palms in a test plot.

G. Riba. INRA, Station de Lutte Biologique, La Minière, France. Field plot tests using an artificial mutant of the entomopathogenic fungus, Beauveria bassiana (Hyphomycetes) against the European corn borer, Ostrinia nubilalis (Lep. : Pyralidae)

An artificial mutant of *Beauveria bassiana* has been selected because of its aggressiveness to the larvae of *Ostrinia nubilalis*. A granulated formulation increased the efficacy of this microorganism compared to the same strain in liquid formulation. A 14 % higher harvest yield was obtained and 96 % of the 1st and 2nd larval instars of the pest were killed.

M.H. Badii & J.A. McMurtry. Dept. Entomology, University of California, Riverside, CA, USA. Feeding behaviour of some phytoseiid predators on the broad mite, Polyphagotarsonemus latus (Acari : Phytoseiidae, Tarsonemidae)

The paper describes the feeding pattern and differences in the feeding traits of 4 phytoseiid predators on broad mite : *Typhlodromus rickeri, T. porresi, T. annectens* and *Euseius stipulatus*.

C. Sengonca & S. Gerlach. Institut für Pflanzenkrankheiten der Universität, Bonn, FRG. The influence of leaf surface features on the effectiveness of the predatory thrips, Scolothrips longicornis (Thys. : Thripidae)

The leaf surface of cotton leaves and green leaves of different ages had a great influence on the longevity and the effectiveness of the predatory thrips. Cotton leaves are more favourable than bean leaves which have a high density of hooked trichomes.

Y.A. Duodu & F.F. Antoh. CIBC, West African Substation, c/o Crops Research Institute, Kumasi ; Dept Biological Sciences, University of Science and Technology, Kumasi, Ghana. Effects of parasitism by Apanteles sagax (Hym. : Braconidae) on growth, food consumption and food utilization in Sylepta derogata larvae (Lep. : Pyralidae)

Laboratory studies were made of the growth, food consumption and food utilization by parasitized and unparasitized *Sylepta derogata* larvae. Growth was lower in parasitized than in unparasitized larvae. Parasitized larvae consumed significantly less food than unparasitized larvae.

P.L. Sherlock. Rothamsted Experimental Station, Harpenden, UK. Some pathogenic effects of a species of Pleistophora (Protozoa, Microsporida) for Agrotis exclamationis and other noctuids

Larvae of noctuids were inoculated *per os* with spores of a species of *Pleistophora* isolated from *Agrotis exclamationis*. The mean median lethal dose for mainly 3rd instar larvae of

A. exclamationis, the growth and the feeding rate of inoculated larvae were investigated. Larvae of *Noctua pronuba*, *Phlogophora meticulosa* and *Spodoptera littoralis* but not *Agrotis segetum* were also susceptible to infection. This microsporida is probably insufficiently pathogenic for use in the biological control of noctuids.

J.A. McMurtry, M.H. Badii & H.G. Johnson. Dept. Entomology, University of California, Riverside, CA, USA. The broad mite, Polyphagotarsonemus latus, as a potential prey for phytoseiid mites in California

As an initial step in investigating the potential of biological control of broad mite in California, various species of native and introduced Phytoseiidae were tested to determine their ability to develop and reproduce on *P. latus*. Of the species tested in the present study, *Euseius stipulatus*, *Typhlodromus rickeri*, *T. annectens* and *T. porresi* appear to be the best candidate predators for broad mite in California.

H.D. Nsiama She, J.A. Odeibiyi & H.R. Herren. Dept. Agricultural Biology, University of Ibadan, International Institute of Tropical Agriculture, Ibadan, Nigeria. The biology of Hyperaspis jucunda (Col. : Coccinellidae) an exotic predator of the cassava mealybug Phenacoccus manihoti (Hom. : Pseudococcidae) in Southern Nigeria

The life cycle and some other aspects of the biology of *H. jucunda*, an imported predator of the cassava mealybug in Nigeria, were studied in the laboratory. In Latin America, it is a natural enemy of *Phenacoccus herreni*.

I. Larget-Thiery, S. Hamon & H. de Barjac. Service de lutte biologique, Institut Pasteur, Paris, France. Susceptibility of Culicidae to β-exotoxin of Bacillus thuringiensis

The ß-exotoxin of *B. thuringiensis* H 1 acts as a larvicide and as an adulticide when ingested at high concentrations by *Aedes aegypti*, *Anopheles stephensi* or *Culex pipiens*. Sublethal concentrations of ß-exotoxin induce a delay in larval moulting and teratological effects on larvae and pupae.

B. Papierok, B. Valadao, L. Torres & M. Arnault. Service de lutte biologique, Institut Pasteur, Paris, France. Contribution to the study of the specificity of the entomopathogenic fungus Zoophthora radicans (Zygomycetes, Entomophthorales)

About 40 strains of *Zoophthora radicans* were isolated in France from Homoptera, Lepidoptera, Diptera and Hymenoptera. The pathogenic bahaviour of 8 of these strains was studied simultaneously on the aphid *Acyrthosiphon pisum*. The 8 strains differed from one another in infectivity and in their ability to produce conidia and to form rhizoids. The results establish quantitatively the existence in *Z. radicans* of an adaptation of strains to a host taxonomically related to the host from which the strain was isolated.

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