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

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

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Contents

Obituary

Robert van den Bosch, Chairman of the WHRS

With the deepest regret and a sense of irreplaceable loss, we announce the unexpected death of our friend, colleague, and leader, Professor Robert VAN DEN BOSCH (56), on 19 November 1978.

As a lifetime specialist in biological control, he had an understanding of the importance of natural enemies in the control of pests; he pioneered in the development of the ecologically sound method of pest control known as integrated pest management. He searched for natural enemies of pests on the continents of Europe, Africa, and Asia, spending much of this hunting time in Iran, Pakistan, Afghanistan, Kashmir, and Japan. His searches resulted in the successful importation and colonization of several natural enemies of oriental fruit fly, black scale, spotted alfalfa aphid, alfalfa weevil, walnut aphid, and various pests of ornamentals. He pioneered in the development of integrated control for alfalfa and cotton pests, and in the formulation of the fundamental concepts of integrated pest management. His expertise is demonstrated in his more than 150 publications.

VAN's world included not only being a researcher, a teacher and an administrator in the Division of Biological Control and in the Department of Entomological Sciences, but he was also concerned with the biological, economic, and social implications of agricultural technology on the environment and humanity. He saw so clearly our mutual problems, their causes, and their solutions. He was a deeply sensitive man who was compelled by his concern to voice and write his opinions in his inimitable style not only to academia, but also to farmers, politicians, environmentalists, farm workers, agribusiness, in truth, to everyone, and he courageously fought to see them implemented.

To those who really knew him he epitomized the virtues of love, honesty, humanity, and unremitting courage — everyone recognized Robert van den Bosch as a free thinker.

His wife, Peggy, his colleagues, students, and friends wish to establish a lasting memorial honoring him for his contributions to all in the form of "The Robert van den Bosch Memorial Fund". Contributions may be sent to the International Center for Integrated and Biological Control, University of California, 1050 San Pablo Avenue, Albany, California 94706, USA.

C.B. Huffaker

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

FAO/UNEP Panel of Experts on Integrated Pest Control

The Panel, chaired by Professor Ray Smith, UC/AID Pest Management and Related Environmental Protection Project Director, Berkeley, met in Rome from 4-9 September 1978, the week following the Panel meeting on Pest Resistance to Pesticides.

1. *Review of the FAO/UNEP Global Programme*

Experts in integrated control reviewed the FAO/UNEP Cooperative Global Programme on integrated control in cotton, rice and sorghum/millet.

Cotton

The 3 regions involved are : Near East, North-East Africa and Latin America. Good progress has been made thus far on the various projects, and the research priorities for implementation of effective integrated systems have been defined.

Rice

The importance of pests as a major component of barriers to significant increases in rice production is widely recognized. Thus, it is most encouraging to note the initiation, during 1978, of the FAO Project Proposal on an " Inter-Country Programme of Integrated Control in Rice : Increasing Effective Rice Production in South and South-East Asia ".

Development of this cooperative inter-country programme for a crop that feeds a majority of the world's population is a major accomplishment. Countries interested in the project are : Bangladesh, India, Indonesia, Malaysia, Philippines, Sri Lanka and Thailand.

Sorghum/Millet

This project has been developed to assist Sahelian countries. Since the pest problem can vary markedly from region to region, pest inventories have to be made with appropriate estimations of the relative importance of insects, mites, nematodes, diseases, weeds and rodents in terms of potential crop losses.

Existing research institutions, such as ICRISAT 1) and the Texas A&M University, which are working on sorghum and millet pests, should be invited to participate in the FAO/UNEP programme.

2. *Possible Extension of the Cooperative Global Programme and Other Regional Activities*

Consideration was also given to possible extension of the programme to vegetables, roots and tubers, stored product pests, and integrated systems for the control of pests and diseases of wheat in the southern countries.

3. *Further Studies*

Further studies were devoted to :

Publications : guide to integrated pest control, training for good crop production and storage, use of pesticides in integrated control programmes, and rice guidelines.

Training courses : status of the practical use of biological control agents and status of resistance breeding in integrated pest control. Excerpts from some of these studies are given below.

Breeding for Resistance

Status of Resistance Breeding in Relation to Integrated Pest Control. Arthropods

By O.M.B. de Ponti, Institute for Hortic. Plant Breeding, Wageningen, Netherlands

In this review paper, the author draws attention to various examples in the literature of plant breeding for resistance against arthropods, and explains the host/pest interactions involved. The influence of natural selection, domestication and plant breeding on host plant resistance is first discussed. Distinction is made between the terms resistance and tolerance. The development of an insect population on varieties with different levels of resistance and tolerance is illustrated, using the criterion of damage threshold. The importance of host plant resistance in the absence of active control measures is dealt with, in the presence or absence of natural enemies. Consideration is then given to the impact of host plant resistance on the various strategies of integrated control, such as use of pesticides only when the damage threshold is exceeded. The possible adverse effects of resistance on non-persistent virus disease transmission, arising from restless behaviour of the vectors on suboptimal host varieties, is pointed out. The contributions of plant breeding to integrated control through other inheritable characters, such as morphological characters which influence the predatory or parasitizing activity of natural enemies, is discussed. The successful introduction of integrated control strategies, such as host plant resistance, must be accompanied by long-term extension programmes for individual farmers. Centralization of breeding and seed production of insect resistant varieties at regional stations, from where the seed is distributed to local farmers, is important for those countries lacking the means to support all farmers individually.

Resistance to Pesticides

Resistant Mechanisms and Counter Measures

By J. Dekker, Agricultural University, Wageningen, Netherlands

The mechanisms by which fungicide resistance develops are enumerated : a) decreased possibility for the fungicide to reach the site(s) of action in the fungal cell (due either to decreased permeability, increased detoxication or decreased conversion), b) decreased affinity at the site(s) of action, c) changes in the metabolism of a pathogen (circumvention of the site of attack, compensation for the inhibitory effect). Genetically determined resistance may develop through mutation of a single gene, e.g. carbendazim resistance in *Aspergillus nidulans*, or several loci for resistance may be present. Heterokaryotic phenomena may also play a role in development of fungicide resistance, as may hybridization. Build-up of a fungicide-resistant population in the field depends on, among other things, the vigour, virulence and competitive ability of the resistant strains. Counter measures against fungicide resistance are then discussed. The potential mutability of a fungus for resistance to a new chemical can be investigated, but extrapolation to the field cannot necessarily be made from *in vitro* experiments. Attention should be given to the possible use of non-fungicidal chemicals which increase the host plant's resistance. Judicious management of fungicide applications may reduce the chance of serious resistance problems arising in practice.

Development of Alternative Chemicals for Control of Resistant Pests

By G.P. Georghiou, University of California, Riverside, USA

Increasing resistance or cross resistance in pests to synthetic insecticides has prompted the search for alternative

1) ICRISAT : International Crops Research Institute for the Semi-Arid Tropics (India).

chemicals for control of resistant arthropods. One class of insecticides which will play an increasingly important role in pest control is the pyrethroids. However, cross resistance to certain of these compounds has already been noted, e.g. 30x and 2000x cross resistance to permethrin in *Aedes aegyptica* and *Spodoptera exigua*, respectively. Evidence suggests that the resistance is polyfactorial. 'Target site insensitivity' to the organophosphates and carbamates, previously only known in certain mites and the cattle tick, now occurs also in several insect species. Carbamates with higher lipophilicity and lower mammalian toxicity are being developed, as are inhibitors of insect development (diflubenzuron, methoprene). Research continues on anti-juvenile hormones of plant origin, and the identification of toxic natural products which regulate plant host selection and establishment by pest species.

Pest Control in Grain Storage in Developing Countries : an Overview

By B.R. Champ, CSIRO, Canberra, Australia

The safe storage of grain must be based on the proven principles of sound storage practice if long-term efficacy is to be achieved, viz. adequate drying of the commodity, a high standard of hygiene, suitable storage and transport facilities, regular inspections, minimum and judicious use of chemicals, and use of resistant varieties. Physical means of eliminating pests are desirable, but costly. Control strategies for developing countries are discussed, both at the local, subsistence level, and in international trade. Incentive and capacity to carry out improvements to storage systems are the major constraints currently limiting introduction of improved technologies into storage practice. The major control strategies are outlined : drying, chemicals (which remain the principal economically-viable basis for disinfecting and protecting grain in storage), fumigants (especially use of CO_2), airtight storage or use of a nitrogen atmosphere, heating and cooling techniques, including aeration. Grain storage is essentially an integrated control exercise, using combinations of these technologies. In conclusion, the author emphasizes the need to improve communication. Intensive research and development creates a rapidly changing situation in which it is difficult for workers in developing countries to keep informed on current activities and technology. It is recommended that FAO give high priority to assessing the situation and correcting the deficiencies in interchange of information if the scarce resources available in the storage pest control field are to be used to maximum advantage.

Use of Granulosis Viruses in Biological Control

By J. Huber, Biologische Bundesanstalt, Darmstadt, Fed. Rep. of Germany

The rationale, development and successful uses of baculoviruses in insect pest control are discussed. Most research has been concentrated on certain nuclear polyhedrosis viruses, 5 of which have, or are nearing registration in the USA and Canada. Field experiments with granulosis viruses (GV) have been more limited. However, promising results have been obtained with the GV of *Laspeyresia pomonella* in Australia, USA, Canada, Switzerland and Germany ; application of 10^{11} capsules/ha gave comparable or better control than chemical insecticides. Moreover, this GV is also infective to *Rhyacionia buoliana*, a serious pest of pine. In Australia, a single application of the GV of *Phthorimaea operculella* was reported to give control at least equal to 8-10 pesticide applications. Although the GV of *Argyrotaenia velutinana* acts too slowly to prevent crop damage, it may be useful in long-term control of leafroller populations. Other potentially valuable GV's include those of *Plodia interpunctella* (as a protectant for stored in-shell nuts), *Agrotis segetum*, *Choristoneura murinana* and *Adoxophyes orana*. In the latter case, the GV not only reduced the existing population, but also the 2nd and 3rd generations following application.

Development of techniques for the production of granulosis virus preparations for microbial control of the codling moth, Laspeyresia pomonella L. (Lep. Tortricidae), and estimation of production costs (Brassel, J. [1978]. Bull. Soc. ent. suisse 51 : 155-211)

Techniques have been devised for mass production of the virus. As a preliminary step, the suitability of diapausing larvae for virus production was investigated. Diapausing L_4 reared under short-day conditions could be infected more easily than those obtained under long-day conditions. The infection of a larval population ranging from 2 to 3-day-old L_4 to 1 to 5-day-old L_5 by dipping once into a virus suspension containing 10^4 virus particles/ml resulted in a high rate of infection, with optimum larval weight. After infection, larvae were fed again.

Two media for mass rearing of codling moth larvae were compared : one based on agar and the other on sawdust. The latter was preferred because of its resistance to bacterial and fungal contamination. In order to avoid virus epizootics, mass breeding of larvae has to be separated from the virus production unit.

L_4 and L_5 larvae to be infected with the virus were driven out of the mass rearing medium by the application of heat. With the aid of a special device, the larvae leaving the medium were collected and dipped into the virus suspension. Larvae were then transferred to an agar medium into which they bore and continue to develop. Four days after infection, the heavily infected larvae were driven out of the medium by means of a heated sandbath, and finally collected for virus production. Forty to 65 % of the larvae present in the medium before the first heating were obtained as virus dead larvae. The average virus yield is of the order of 5.5×10^{12} virus particles per rearing tray. An average multiplication factor of 1.4×10^7 has been calculated. Storage of virus material proved to be best when glycerin was added and subsequently frozen at — 20°C.

The costs of virus production approximately equal the costs of a commonly used insecticide. Costs are doubled by addition of skim-milk powder or Etalfix (detergent) for practical application.

G. Mathys, Paris

International Workshop on Bacillus thuringiensis in Darmstadt (Fed. Rep. of Germany)

By J.M. Franz and A. Krieg, BBA, Darmstadt, Fed. Rep. of Germany

A colloquium organized by H.T. Dulmage (USA), H.D. Burges (UK) and A. Krieg (Fed. Rep. of Germany) for the Society for Invertebrate Pathology (SIP) took place in Darmstadt, Fed. Rep. of Germany, on September 6 to 8, 1978. It was the second Workshop dealing with *Bacillus thuringiensis* ; 25 experts from 8 nations (North America, Western Europe) participated, all of them being actively engaged in research on and application of *Bacillus thurin-*

giensis (*B.t.*), and belonging to Research Stations, University or Industry.

Papers and discussions centered on the following topics : 1) Host spectrum, serology and chemistry of crystal toxins ; 2) microbiology of the bacillus (genetics, production, interaction) ; 3) formulations and persistence of spore/crystal preparations ; 4) their applications to control pest insects in agriculture, forestry and stored products.

Further, reports were given on the activity of certain isolates of *B.t.* active against medical pests, as far as this efficacy was not due to non-specific exotoxins. This refers to the effect of various strains of *B.t.* (different serotypes) on lice and flies and, particularly of serotype $H_{1_{11}}$ on mosquito larvae. Here, new developments are apparent.

In the section on serology, crystal antigens of *B.t.* were of particular interest ; in biochemistry, emphasis was placed on the so-called autolytic mechanism of crystals as well as on the isolation and characterization of the toxophorous group of the crystal glycoprotein. Recent contributions to the genetics of *B.t.* indicate that the crystal toxin is coded by a plasmid. In addition, transduced phages have been isolated which may facilitate genetic engineering with *B.t.* in the future.

The scientific programme included a visit to the insect pathological laboratories of the Institute for Biological Control (BBA) and of the Laboratory for Cell Biology (Zoological Institute, Technical University of Darmstadt). Main emphasis was given to demonstration of the production of insect pathogenic viruses *in vivo*, as well as *in vitro*. Examples were shown of the diagnosis and pathology of insect diseases, quality control of preparations containing viruses and bacteria, as well as results of field tests with insect pathogenic viruses and *B.t.*, with special consideration of application technology.

One of the final conclusions was that the use of *B.t.* preparations as a selective means of control of plant pests (lepidopteran larvae) has become increasingly important throughout the world, particularly in the USA, USSR (not represented at this workshop) and, more recently, in South America and South-East Asia. Additionally, the development of specific anti-mosquito preparations based on *B.t.* is of great interest to WHO.

Optional Testing of Pesticides for their Incidence on Beneficial Arthropods in the Federal Republic of Germany

The Working Group of the WPRS on Pesticides and Beneficial Arthropods, headed by Professor Franz, Darmstadt (DE) has established and reached agreement on 7 tentative guidelines for evaluating the impact of pesticides on the following species, 4 of which are recognized by the BBA (*) :

Laboratory methods :

* *Trichogramma cacoeciae* Marchal, representative of the micro-hymenoptera
* *Coccygomimus (Pimpla) turionellae* (L.), representative of the bigger Ichneumonidae
* *Phygadeuon trichops* Thomsen, representative of the macro-hymenoptera
* *Chrysopa carnea* Steph. (Chrysopidae)

Pales pavida (Tachinidae)

Leptomastix dactylopii How. (Encyrtidae)

Coccinella septempunctata L. (Coccinellidae)

The official testing performed by designated institutes is not compulsory but can be requested at a cost of 500 DM. For more details : Dr Herfs, Biologische Bundesanstalt für Land- und Forstwirtschaft, 3300 Braunschweig (DE).

G. Mathys

Notes on Biological Control in the Solomon Islands

By J.H. Stapley, Ministry of Agriculture and Rural Economy, P.O. Box 25, Honiara, Guadalcanal

Introduction

Biological methods of control have been reasonably successful in the Solomon Islands in recent years. Such methods are to be encouraged, not solely because of the dangers from wide-spectrum insecticides and possible damage to the environment, but because of the difficulties associated with the use of insecticides in these remote islands. There is the problem of transporting material, the high cost of insecticides which is increasing all the time, the reluctance of the local people to purchase spray machinery and their inability to use it when available.

Examples to Date

Tetrastichus brontispae Fer., a parasite of the coconut leaf beetle, *Brontispa longissima* Guest., became established in the Solomon Islands after its introduction in 1968. The parasite is still present but incidence of *Brontispa* is now much reduced. Use, in practice, of the *Oecophylla* ant against the nutfall bug, *Amblypelta cocophaga* China, and the pentatomid *Axiagastus cambelli* Dist. which lives on coconut spadices, is now well documented. *Oecophylla* is known to exert pressure against the *Pantorhytes* weevil on cocoa, driving it off the trees when present. More recently, satisfactory control of the brown plant hopper, *Nilaparvata lugens* Stal. has been achieved. This year, it is planned to release *Rhabdionvirus oryctes* into wild populations of *Scapanes australis* Stern, one of the most serious pests of coconut.

The Brown Plant Hopper on Rice

During 1975, good control of the brown plant hopper (BPH) was achieved on irrigated rice on the Guadalcanal Plains by means of 2 naturally occurring predators, *Cyrtorhinus chinensis* and *C. lividipennis* Reut. All rice fields were under constant surveillance to determine the relative population densities of BPH and its predators. It had been known since 1971 that BPH was a limiting factor in rice production, and hitherto, it had been controlled by aerial spraying. The importation, from the International Rice Research Institute (IRRI) in the Philippines, of BPH-resistant rice varieties provided a temporary solution. However, after 18 months of continuous growing of these varieties, the resistance appeared to break down. Presumably, a new biotype of BPH had arisen. All varieties subsequently imported from IRRI have been attacked by BPH to a greater or lesser extent.

New varieties of rice have been found to exhibit tolerance to BPH, and grow better than resistant varieties. Some BPH develop on tolerant varieties, so allowing populations of *Cyrtorhinus* to build up and persist. The interactions of rice variety, BPH and *Cyrtorhinus* are complex, but certain facts are clear. Varieties susceptible to BPH allow rapid development of the hoppers, which cannot be controlled by *Cyrtorhinus*. However, a variety exhibiting tolerance is more slowly colonised by BPH and, consequently, there is time available

for *Cyrtorhinus* populations to have a far greater predatory influence.

By planting tolerant varieties, the rice grown during 1976 was kept reasonably free from BPH, except when it was necessary to spray against armyworms. *Cyrtorhinus* populations were drastically reduced by spraying, with consequent rapid development of BPH, leading to'hopper burn'. An alternative control approach might be to use *Bacillus thuringiensis* against armyworm. Although this product has given satisfactory kill in laboratory tests, aerial application has so far been disappointing. The problems of utilizing predators in BPH control on rice in the Solomon Islands were discussed at the International Rice Conference in Los Banos in April 1977.

Oil Palms

An outbreak of the bagworm, *Mahasena corbetti* Tams., on oil palm occurred in 1976 on the Guadalcanal Plains. About 50 acres were heavily attacked and palms partially defoliated. Only about 5 % pupal and no larval parasitism was observed. An egg mass parasitized by *Telenomus* sp. was also found. It is hoped that parasites of this species of bagworm will increase in due course.

Grassland

Two species of dung beetle, *Onthophagus gazella* and *O. sagitarius*, were introduced into the Solomon Islands from Australia in 1972; it was assumed that as there is no natural ungulate fauna in the Solomons (as in Australia), there would be no coprophagous fauna either. The Australians had brought many species of dung-burying beetles from South Africa where there is abundant fauna of this kind. During 1976, the dung beetles were found to be well established (about 10-20 beetles/pat) at all release points and many others. They were also found some 50 to 100 miles from the nearest release point, indicating good dispersal, often over the sea. The act of burying dung below ground level undoubtedly enriches the soil, but it remains to be seen whether this habit of the beetles will influence bush flies and, more importantly, the buffalo fly, which utilises dung pats as breeding grounds. It is hoped to determine the effect on fly populations in due course.

Conclusions

The methods described above to control the brown plant hopper on rice, and those suggested for control of buffalo flies are not biological control *sensu stricto*, the control programmes benefiting from being self-operating once initiated. These controls have been developed by approaching the problems in a practical rather than an academic manner. It is likely that the predatory action of *Cyrtorhinus* had not been effective previously as the rice varieties succumbed too quickly to attacks of BPH; the crop was either lost or sprayed, with consequent elimination of the predator. The importance of BPH as a major pest on irrigated rice in the Solomon Islands is due to the crop being a monoculture in the midst of 500,000 acres of grass plains. Similarly, *Scapanes* has become a pest of coconuts due to plantations being estab'ished in cleared bush. If one could only swap the location of the 2 crops around, the pest problems would not arise.

Information from Malaysia

A Survey of the Natural Enemies of Sugar-cane Aphids in Perak, Malaysia

G.T. Lim & Y.C. Pan, Entomology Dept, Sugarcane Exp. Stn, Gula Perak Berhad, Malaysia

Three species of sugar-cane aphids, namely, *Ceratovacuna lanigera* (Zehnt), *Longiunguis sacchari* (Zehnt) and *Hysteroneura setariae* (Thos.) were recorded in the Gula Perak Berhad plantation. A survey was made of the natural enemies of these important sucking pests. Among the former, were two species of hymenopterous parasitoids and 23 species of predators, as follows:

Order/Family	Parasitoid/Predator
Hymenoptera	
Aphelinidae	*Aphelinus* sp.
Encyrtidae	*Aphidencyrtus* sp.
Coleoptera	
Coccinellidae	*Menochilus sexmaculata* (F.)
	Synonycha grandis Thunb.
	Illeis bistigmosa Muls.
	Chilocorus politus Muls.
	Chilocorus nigritus (F.)
	Cryptogonus fulvoterminatus Boh.
	Pullus pallidocollis Muls.
	Pullus sp.
	Coelophora inaequalis (F.)
	Spilocaria bissellata Muls.
	Coccinella repanda Th.
	Coccinella arcuata (F.)
	Rodolia sp.
	Scymnus sp. ? *nubilus* Muls.
Diptera	
Syrphidae	*Eristalinus quinquestriatus* F.
	Cephalochrysa maxima (Bezzi) ssp. *demeijerei* Lindner
	Paragus serratus F.
	Eumerus insistens Curran
Lepidoptera	
Pyralidae	*Isauria aphidivora* Meyr.
Neuroptera	
Chrysopidae	*Chrysopa* sp.
Hemerobiidae	*Italochrysa* sp. near *aequalis* Walker
	Micromus sp.

These natural enemies play an important role in suppressing sugar-cane aphid populations in Perak, Malaysia.

Abstracts from Entomophaga 23 (4), 1978
(Prepared by Courtesy of B. Hurpin, INRA)

ENTOMOPHAGA, volume 23 (4), 1978

Huguette DE BARJAC, Institut Pasteur, Paris, France. A new candidate for biological control of mosquitoes: *Bacillus thuringiensis* var. *israelensis*.

The new serotype 14 which was discovered in the *Bacillus thuringiensis* Berliner group and named variety *israelensis* is a major pathogen of mosquito larvae. Its larvicidal activity is closely similar to that of *Bacillus sphaericus*. The toxicity of *B. thuringiensis* var. *israelensis* to mosquito larvae is due to a proteic endotoxin in its crystals, the nature and mode of action of which are like those of other *B. thuringiensis* strains which are pathogens for lepidoptera larvae.

S.A. HASSAN, G.A. LANGENBRUCH & G. NEUFFER, BBA, Darmstadt & Landesanstalt für Pflanzenschutz, Stuttgart, Fed. Rep. of Germany. Influence of the host in mass rearing on the effectiveness of the egg parasite *Trichogramma evanescens* to control the European corn borer, *Ostrinia nubilalis*.

The effectiveness of a strain of *Trichogramma evanescens* Westw. especially adapted to the European corn borer, *Ostrinia nubilalis* Hübner, was examined in 4 field experiments. The parasites were reared on either the Angoumois grain moth, *Sitotroga cerealella* (Oliv.), or the Mediterranean flour moth, *Ephestia kuehniella* Zell., and were released in separate experimental plots. There were no significant differences in efficiency between the two methods of rearing *Trichogramma* tested.

D.E. BERUBE, Agriculture Canada Research Station, Regina, Saskatchewan, Canada. The basis for host plant specificity in *Tephritis dilacerata* and *T. formosa* (Dipt. : Tephritidae).

This paper reports observations which indicate that host-parasite synchronization between the gall forming tephritids, *Tephritis dilacerata* Loew. and *T. formosa* Loew. and their respective host plants, *Sonchus arvensis* and *S. asper*, provides the basis for host specificity in these closely related flies.

V.H. WADDILL, University of Florida, Homestead, Florida, USA. Sexual differences in foraging on corn of adult *Labidura riparia* (Derm. : Labiduridae).

A significantly greater number of adult female *Labidura riparia* (Pallas) was found foraging on corn (male : female, 1:4.16) than was expected from the male/female ratio (1:1.63) caught in pitfall traps. The apparent requirement of the female for more food than the male is offered as an explanation of the differences in their foraging activity.

F.C. TINGLE, T.R. ASHLEY & E.R. MITCHELL, U.S. Department of Agriculture, Gainesville, Florida, USA. Parasites of *Spodoptera exigua, S. eridania* (Lep. : Noctuidae) and *Herpetogramma bipunctalis* (Lep. : Pyralidae) collected from *Amaranthus hybridus* in field corn.

These 3 species of lepidopterous larvae were collected from *Amaranthus hybridus* growing in field corn during 1975 and 1976 at Hastings, Florida. Nine native species of parasites, representing the Braconidae, Eulophidae, Ichneumonidae and Tachinidae, emerged from these larvae. All the species of parasites from the lepidopterous larvae that feed on *Amaranthus hybridus* are also reported as parasites of *S. frugiperda*, a serious pest of corn. Therefore, these larvae on *A. hybridus* may be a source of the parasites found attacking *S. frugiperda*.

Karla S. RITTER & Y. TANADA, University of California, Berkeley, USA. Interference between two nuclear polyhedrosis viruses of the armyworm, *Pseudaletia unipuncta* (Lep. : Noctuidae).

The larva of *Pseudaletia unipuncta* (Haworth) is susceptible to 2 nuclear polyhedrosis viruses (NPV), the typical (TNPV) and the hypertrophy (HNPV) strains. The interference between the 2 viruses is studied primarily in the tracheal and fat tissues.

A.Q. VAN ZON & M. WYSOKI, University of Amsterdam, Netherlands. The effect of some fungicides on *Phytoseiulus persimilis* (Acarina : Phytoseiidae).

The effect of 11 fungicides on different developmental stages of the predatory mite *Phytoseiulus persimilis* A.-H. was investigated. Special attention was paid to the effect that these compounds may have on the survival of adult females and juveniles, on the hatching of eggs and on the fecundity of the females. It appears possible to group the fungicides in 3 classes, based on their effect in residue tests on females and newly hatched juveniles : a) with very low effect ; b) with low effect on females at the recommended concentration and with moderate effect on the juveniles and c) with high effect on females (100 % mortality) at the recommended concentration.

E.S. DEL FOSSE, University of Florida, Gainesville, USA. Effect on water-hyacinth of *Neochetina eichhorniae* (Col. : Curculionidae) combined with *Orthogalumna terebrantis* (Acari : Galumnidae).

Seven hundred mottled water-hyacinth weevils, *Neochetina eichhorniae* Warner, were released in a Fort Lauderdale, Florida, canal on a mat of water-hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach. At the time of weevil release, the mat contained water-hyacinth mites, *Orthogalumna terebrantis* Wallwork. The results indicate that the combination of *N. eichhorniae* and *O. terebrantis* can significantly reduce size and density of water-hyacinth in natural situations. In addition, *O. terebrantis* is a much more important biological control agent than has been suspected in the past, because it opens water-hyacinth to increased attack by phytopathogens and saprophytes.

R. DELORME & R. FRITZ, INRA, Versailles, France. Effect of some fungicides on *Entomophthora aphidis*.

A method for measuring the toxicity of various fungicides on the development of *Entomophthora aphidis* Hoff. attacking *Aphis fabae* Scop. is described. It concerns laboratory studies of the preventive, curative and antisporulating activity of 19 fungicides.

A. BOURNIER, A. LACASA & Y. PIVOT, Ecole Nationale Supérieure Agronomique, Montpellier, France. Biology of the predatory thrips *Aeolothrips intermedius* (Thys. : Aeolothripidae).

The biology of *Aeolothrips intermedius*, which is common in France, and a predator of *Thrips tabaci* larvae, was studied. Thrips were reared at 26 °C, 80 % RH in a 16/24 h photoperiod. Duration of the various instars, adult behaviour, fecundity and predatory activity were recorded.

J. CLARET, CNRS, Gif-sur-Yvette, France. The facultative diapause of *Pimpla instigator* (Hym. : Ichneumonidae). II. The effect of temperature.

The photoperiodic induction response curves of *Pimpla instigator* larvae were compared at different levels of constant temperature.

G. RIBA, INRA, Guyancourt, France. Recombination after heterocaryosis in the entomogenous fungi, *Paecilomyces fumosoroseus*.

Heterocaryosis in *Paecilomyces fumosoroseus* (Wize) Brown is possible by hyphal anastomosis or protoplast fusion of an auxotrophic and benlate resistant strain and another auxotrophic strain. Recombination appears after heterocaryosis. This method is considered for the genetic improvement of entomogenous fungi.

Two additional papers appear on p. 8.

ENTOMOPHAGA, volume 24 (1), 1979

B.A. CROFT & J.G. MORSE, Dept of Entomology, Michigan State University, USA. Research advances on pesticide resistance in natural enemies.

Recent research on the factors governing resistance development among arthropod natural enemies is reviewed, including selection studies of resistance development in the predatory mite *Amblyseius fallacis* (Garman) and *Tetranychus urticae* Koch, and patterns of toxicity to pesticides, and mixed function oxidase activity in a group of pests, predators and parasites.

C. LAUMOND, H. MAULEON & A. KERMARREC, INRA, Antibes & Petit-Bourg (Guadeloupe), France. New data on the host spectrum and parasitism of the entomophagous nematode, *Neoaplectana carpocapsae*.

Laboratory tests under controlled conditions were carried out in Antibes, Guadeloupe and Madagascar, to investigate the host range of *Neoaplectana carpocapsae* Weiser, 128 insect species and a few other arthropods were tested. Results confirmed that the potential host range of *N. carpocapsae* is very broad, in spite of some cases of resistance, mainly in Diptera.

M.H. JULIEN, J.E. BROADBENT & N.C. MATTHEWS, Div. of Entomology, CSIRO, Indooroopilly, Queensland, Australia. Effects of *Puccinia xanthii* on *Xanthium strumarium* (Compositae).

Xanthium strumarium, an important weed in Australia, was inoculated in the laboratory with the rust *Puccinia xanthii* Schw. in order to study the effects on the plant. Attack by *P. xanthii* was shown to shorten the plant life cycle and reduce plant growth rate and productivity. The overall effects of the rust may achieve control of the weed in the field.

R.H. CHERRY, Agricultural Research Center, University of Florida, Ft Lauderdale, USA. Lethal temperatures of citrus blackfly *Aleurocanthus woglumi* (Hom. : Aleurodidae) and its parasite, *Amitus hesperidum* (Hym. : Platygasteridae).

Seasonally acclimatized citrus blackfly (CBF), *Aleurocanthus woglumi* Ashby, and its parasite, *Amitus hesperidum* Silv., were exposed to extreme temperatures for 3-h periods and survivorship measured. Correlating lethal temperature data with field meteorological conditions shows that short-term temperature exposures cannot be expected to stop the potential spread of CBF or *A. hesperidum* through Florida.

A. VEY & R. CAUSSE, INRA, St-Christol-les-Alès & Avignon, France. The effect of exposure to γ rays upon the multicellular hemocytic reaction of *Mamestra brassicae* larvae (Lep. : Noctuidae).

Exposure of *Mamestra brassicae* L. larvae to a γ ray dose of 7,000 rad causes weakening of the multicellular defence reaction of the host to *Aspergillus flavus* Link. The hemocytic process gives rise to granulomas which are not so voluminous or well-organized as those found in non-treated animals, and from which the fungus makes an early escape.

R.E. MCFADYEN, CIBC, South American Sub-Station Tucuman, Argentina. *Eriocereophaga humeridens* (Col. : Curculionidae), a potential agent for the biological control of *Eriocereus martinii* (Cactaceae) in Australia.

The weevil *Eriocereophaga humeridens* O'Brien attacks the cactus *Eriocereus adscendens* in N.E. Brazil. Laboratory tests and field observations demonstrate that it will also accept *Eriocereus martinii* as a host, and does not damage plants except in the subfamily Cereanae of the Cactaceae. *E. humeridens* was approved for mass release in Queensland, Australia, for the control of *Eriocereus* spp., and field releases were made in 1976.

A.G. RASKE & H.O. SCHOOLEY, Canadian Forestry Service, St John's, Newfoundland, Canada. Parasites of *Coleophora laricella* larvae in Newfoundland (Lep. : Coleophoridae).

A total of 15 species of parasites has been reared from the larch casebearer *Coleophora laricella* (Hübner), in Newfoundland, but only 2 species, *Agathis pumila* (Ratzeburg) and *Chrysocharis laricinellae* (Ratzeburg), are common. For biological control of the casebearer, *A. pumila* appears the most promising agent present in Newfoundland.

K.L.S. HARLEY, J.D. KERR & R.C. KASSULKE, CSIRO, Long Pocket Laboratories, Indooroopilly, Australia. Effects in S.E. Queensland during 1967-1972 of insects introduced to control *Lantana camara*.

Seasonal fluctuations in populations of the introduced species *Teleonemia scrupulosa* Stal (Tingidae) and damage by this insect to common taxa of *Lantana camara* (Verbenaceae) were observed on several field sites and experimental plots. In general, attack by *T. scrupulosa* reduced fruiting and caused severe, short-term foliage damage.

M. MUSHTAQUE & G.M. BALOCH, CIBC Pakistan Station, Rawalpindi, Pakistan. Possibilities of biological control of mistletoes *Loranthus* spp., using oligophagous insects from Pakistan.

Of 27 species of insects and mites associated with *Loranthus* spp. in Pakistan, 12 insects appear to be restricted feeders. The phenology, biology and host specificity of 4 of these have been investigated and the insects found to be specific and potentially effective biocontrol agents.

C.E. KENNETT, D.L. FLAHERTY & R.W. HOFFMANN, University of California, Berkeley, USA. Effect of windborne pollen on the population dynamics of *Amblyseius hibisci* (Acarina : Phytoseiidae).

Populations of *Amblyseius hibisci* (Chant), a predator of citrus red mite, *Panonychus citri* (McGregor), exhibited varying responses to field applications of cat-tail, *Typha latifolia*, pollen in San Joaquin Valley citrus groves. The degree of response appeared to be inversely related to the levels of natural foods present during the various seasons.

C.G. JACKSON, E.G. NEEMANN & R. PATANA, USDA, Cotton Insects Biological Control Laboratory, Tucson, Arizona, USA. Parasitization of 6 lepidopteran cotton pests by *Chelonus blackburni* (Hym. : Braconidae).

When eggs of 6 species of lepidopteran cotton pests (pink bollworm, cotton bollworm, tobacco budworm, cabbage looper, beet armyworm and saltmarsh caterpillar) were offered to *Chelonus blackburni* Cameron, all were parasitized except those of the saltmarsh caterpillar, *Estigmene acrea* (Drury). However, the parasite did not distinguish between parasitized and unparasitized eggs, so superparasitization was common.

Abstracts from Acta Entomologica Sinica

ENTOMOLOGICA SINICA, volume 21 (2), 1978

GUAN XUE-CHEN, WU ZHI-XIN, WU TSIU-NGUN & FENG HUI, Institute of Zoology, Academia Sinica. Studies on rearing *Trichogramma dendrolimi* Matsumura *in vitro*.

Supplying sufficient eggs of the oak silkworm, *Antheraea pernyi*, and Eri silkworm, *Philosamia ricini*, as artificial hosts for mass rearing of trichogrammatid wasps presents problems. Alternative, artificial media for culturing the parasites were therefore studied. Media based on chicken eggs plus casein hydrolysates and nucleic acids were tested. Development periods of the immature stages were similar to those in intact silkworm eggs, but growth stopped at the larval or prepupal stages. Results suggested that, in addition to nutritional factors, the physical environment provided for the developing parasites is also of great importance.

ENTOMOLOGICA SINICA, volume 21 (3), 1978

WU ZHONG-LIN, Wu-xian Institute of Agricultural Research, Kiangsu Province. Relationships between the change of rice cropping system and the pest status of rice stem borers.

Changing rice management systems, from a single late crop to double or triple cropping over large areas, has led to increasing importance of the pest status of rice stem borers. The degree of borer infestation is closely related to rice plant numbers and to the coincidence of susceptible plant stages and emergence of newly hatched larvae. Field experience has shown that borer populations can be suppressed by adopting rational cropping systems, increasing uniformity of varieties in a region, improving crop husbandry to promote healthy, uniform vegetative growth, and applying insecticides only when necessary.

DIVISION OF BIOLOGICAL CONTROL, KWANGTUNG ENTOMOLOGICAL INSTITUTE EXPERIMENTAL STATION, Sa-tien Orchard, Canton. Studies on the integrated control of the citrus red mite with the predaceous mite as a principal controlling agent.

Ambiyseius newsomi (Evans) is the most common among natural enemies of *Panonychus citri* (McG.) in Canton citrus orchards. In 1975-76, integrated control using *A. newsomi*, together with small quantities of selective insecticides and cultural techniques, maintained populations of the citrus red mite below the economic threshold. *A. newsomi's* biological characters render this predatory mite an effective controlling agent, while its pesticide resistance is an advantage in integrated control systems. *Ageratum conyzoides*, which grows wild in orchards the year round, is important in maintaining populations of *A. newsomi*.

CHAO CHING-CHUAN & CHANG SHUAN-TA, Laboratory of Pest Natural Enemies, Dept of Biology, Wuhan Teachers College. Population fluctuations of green lacewings in cotton fields.

Surveys of green lacewings in selected cotton fields showed *Chrysopa sinica* Tjeder and *C. septempunctata* Wesmael to be the dominant of 5 species, the former being more numerous in the early growth stages of cotton, and the latter dominant at later stages, with 3 population peaks during one growing season. Higher lacewing densities were found in fields where clover had been the preceding crop, and where suitable shelter was available around the perimeter of the field. More lacewings were present in fields with abundant aphids, but insecticide applications reduced their numbers.

HU HE-LIN, Chekiang Institute of Forestry, CHANG SHI-MIN & YOUNG JING-KUAN, Liaoning Institute of Forestry and Pedology, CHENG YU-PO, SHAO GUI-YING & WANG FENG-YAO, Hangchow Botanical Garden. A preliminary study of *Ballia obscurosignata* Liu — an important natural enemy of the Japanese pine bast scale.

The ladybird beetle, *Ballia obscurosignata* Liu is an important natural enemy of the Japanese pine bast scale, *Matsucoccus matsumurae* Kuw. In Hangchow, it has 4 generations annually, which synchronize well with the scale. Stable populations can

build up in pine forests. Three generations occur in Liaoning Province, and this insect could be used for controlling pine scales here.

H.F. CHU, Institute of Zoology, Academia Sinica. Strategies and tactics of pest management with special reference to Chinese cotton insects.

The history, present areas of cultivation, and pests of cotton in China are reviewed. The complicated interrelationships of cotton pests, natural enemies, time, and growth and development stages of cotton are illustrated. Monitoring is an important part of cotton pest management systems widely used throughout China, incorporating integrated control systems comprising cultural, chemical and biological measures. Mass releases indoors of an indigenous wasp, *Dibrachys cavus* (Walker), which parasitizes overwintering pink bollworms, have given encouraging results. The innovative approaches of pest management offer good prospects for the future.

Announcements

Biological Control of Plutella xylostella

Entomologists engaged in research on the biocontrol or integrated control of *Plutella xylostella* and interested in forming a group to facilitate exchange of ideas and/or parasites should contact Mr A.C. Peter Ooi, Biological and Integrated Control Section, Pest Unit, Crop Protection Services, Dept of Agriculture, Kuala Lumpur, Malaysia. If there is sufficient response, it may be possible for a *Plutella* Newsletter to be regularly issued on this topic.

Center for Population Regulation of Noxious Organisms (CIRPON)

The Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), the Fundación para la Educación, la Ciencia y la Cultura (FECIC) & the Fundación Miguel Lillo (FML) de Argentina, came to an agreement in order to build a Center for Population Regulation of Noxious Organisms (CIRPON) in Tucumán, Argentina. The insectary and laboratories are built on land donated by the government of the Province. Some research projects on control of citrus pests and woody weeds are underway in buildings on temporary loan. The Director of the Center is J. Nasca. For further information, contact : Casilla de Correos (Central) No. 90, 4000-S.M. de Tucumán, Argentina.

Ladybird Beetles Wanted *

The Plant Protection Dept of the Ministry of Agriculture in Ecuador is interested in buying the ladybird beetle (*Rodolia cardinalis* Mulsant) as soon as possible, in order to destroy the cottony cushion scale (*Icerya purchasi* Maskell) that has invaded citrus orchards, ornamental acacias, and other hosts. Any information about insectaries that sell this insect, techniques for rearing, shipping, and releasing would be fully appreciated by Ing. Julio Molineros A., P.O. Box 6031, Quito, Ecuador, South America.

Canadian Biting Fly Assoc. *

In recognition of the growing interest and number of specialists involved in the biology and control of biting flies in Canada, an association is being formed, patterned after the American Mosquito Control Association. Interested persons may contact Dr R.A. Ellis (City of Winnipeg Entomologist, 2799 Roblin Blvd., Winnipeg, Manitoba, R3R 0B8), Chairman of the C.B.F.A. Formation Committee, for details.

Book Review (by Elizabeth A. Baker)

Provisional Atlas of the Nematodes of the British Isles 1)

Vol. I, Parts 1-3 (ISBN 0 904282 04 X). General editors : J. Heath, D.J.F. Brown and B. Boag (1977).

By means of dot maps, the Atlas presents the geographical distributions within Britain of 8 *Longidorus* spp., *Paralongidorus maximus* (Butschli), and 4 *Xiphinema* spp. (family Longidoridae) ; 4 *Paratrichodorus* spp. and 8 *Trichodorus* spp. (family Trichodoridae) ; 2 *Criconema* spp., *Criconemella parva* (Raski), 2 *Criconemoides* spp., 2 *Crossonema* spp., *Hemicriconemoides pseudobrachyurus* De Grisse, 4 *Hemicycliophora* spp., 10 *Macroposthonia* spp., 6 *Nothocriconema* spp., and *Xenocriconemella macrodora* (Taylor) (family Criconematidae).

The maps are based on 3 extensive surveys, involving collection and analysis of soil samples from each of 5 vegetation types (arable, permanent pasture, deciduous woodland, coniferous woodland and scrub or moorland), in addition to a detailed literature and records search.

The Atlas commences with a short preface in English, French and German, followed by a longer general introduction explaining the background, aims and methods used in compiling the maps.

Each of the 3 parts of the Atlas, devoted to the respective nematode families, opens with a brief account of the nematodes' main diagnostic features, and reference is made to their host range and economic importance in agriculture ; the nematodes' role as virus vectors is emphasized.

A general dot map is given to show the areas sampled and recorded for each of the 3 surveys. These are followed by the species maps, which give the reader a clear visualization of the individual species' distribution within the British Isles.

The incidence of these economically important nematodes can be usefully compared, and the information so provided constitutes an effective contribution to plant nematology ; the authors hope that this publication will stimulate interest in nematode surveys and encourage the formation of a European Nematode Survey Committee to organize the compilation of records on the distribution of selected plant parasitic nematode species throughout Europe.

Abstracts from Entomophaga 23 (4), 1978 - additions

W.G. HART *et al.*, USDA, ARS, Citrus Insects Research, Weslaco, Texas, USA. The introduction and establishment of parasites of citrus blackfly, *Aleurocanthus woglumi* in Florida (Hem. : Aleurodidae).

Three species of laboratory-reared parasites of citrus blackfly, *Aleurocanthus woglumi* Ashby, were released at Fort Lauderdale, Florida in 1976 following discovery of this citrus pest in residential properties there. *Amitus hesperidum* Silv. and *Prospaltella opulenta* Silv. were recovered 6 weeks after release and sharp increases in the rate of parasitism were observed throughout the season. Seven months after the initial release, 100 % parasitism of citrus blackfly pupae was observed at some release sites, and 95 % of the original release sites were found positive for the parasite. Observations after 1 year showed significant levels of parasitism over a large area. The rapid establishment and increase of these parasite species indicate that environmental conditions and the host at Fort Lauderdale are suitable for these species and that they may well provide control of the pest.

S.S. ROSENTHAL, University of California, Berkeley, USA. Host specificity of *Tyta luctuosa* (Lep. : Noctuidae), an insect associated with *Convolvulus arvensis* (Convolvulaceae).

As part of a program to find biological control agents for *Convolvulus arvensis* L., *Tyta luctuosa* (Denis & Schiffermueller), a defoliator, has been tested for host specificity in the laboratory and in field cages. While several host plants from different families are recorded in the literature, there was feeding only on members of the *Convolvulaceae*. There was complete development only on species of *Convolvulus* and *Calystegia*.

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* From April 1978 issue of Entomological Society of America Newsletter.

1) Price £2 ; available from the Scottish Horticultural Research Institute, Invergowrie, Dundee DD2 5DA, Scotland.

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