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INSECT AND PEST CONTOL NEWSLETTER

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Joint FAO/IAEA Division
of Nuclear Techniques
in Food and Agriculture and
FAO/IAEA Agriculture and
Biotechnology Laboratory, Seibersdorf
International Atomic Energy Agency
Vienna

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A. TO THE READER

Letter from the Section Head

I would like to report that the USDA-supported SIT New World Screwworm, *Cochliomyia hominivorax*, eradication programme, the first and largest of its kind, is close to achieving its objective of eliminating this very damaging pest from nearly half the American continent. On October 29, 1999 a USDA-Panama sterile fly processing and release centre was inaugurated at the international airport of Panama City, by the US Assistant Secretary of Agriculture, Michael Dunn, and Ministers of Agriculture of various countries in the region.

This new release centre will receive sterile pupae from the screwworm mass rearing facility of the Mexico-USA Screwworm Commission in Tuxtla Gutierrez, Mexico, and process them for aerial release over Panamanian territory. It is of a more permanent nature than previous release centres in the region in view that it will support indefinitely a biological barrier of sterile fly releases (ca. 40 million flies per week) that will be established in the year 2000 over the narrow Darien region, covering the area between the Panama Canal and the Colombian border.

The new Panamanian release facility is the consequence of impressive progress over the last 40 years which started with a successful pilot test in Curaçao in 1954 directed by US scientists, E. F. Knipling and R. C. Bushland. This was followed by screwworm eradication in 1957-1959 in Florida, and the rest of the USA between 1962 and 1982. A co-operative agreement established between USDA and the Mexican Secretary of Agriculture and Livestock in 1972 culminated in the establishment of a barrier at the Isthmus of Tehuantepec in 1984, and complete eradication of screwworm from all of Mexico in 1991.

Similar co-operative agreements with the Central American Governments have resulted in rapid progress since then. Successful SIT campaigns that have achieved eradication of screwworm from Guatemala and Belize in 1994, El Salvador in 1995 and Honduras in 1996. Nicaragua is already free of screwworm and expected to be officially declared free in 1999. Screwworms are already well controlled in Costa Rica and an eradication program has recently begun in northern Panama. At present sterile flies are being released over southern Nicaragua, all of Costa Rica and western Panama. However, the SIT releases will soon move again southward to reach the Panama Canal. Declaration of eradication of screwworm in Costa Rica is planned for the year 2000, when it is expected that all Panamanian territory will be under sterile fly releases.

Economic assessments have conservatively estimated that eradication of screwworm represents annual direct benefits to livestock industries that amount to ca. US$ 800 million for the USA, US$ 300 million for Mexico, and US$ 80 million for Central America, not including indirect benefits and environmental impacts, as well as the elimination of all human screwworm cases (several hundred per year in each of the Central American countries). Economists estimate that these benefits have a multiplier effect on the economies as a whole between 3.5 and 7-fold.

This large investment by the livestock industries and governments of all the countries involved, however, is still at risk as long as screwworm is present in various Caribbean islands, representing a continuous threat of new outbreaks in screwworm-freed countries. Screwworm was already eradicated from the Virgin

Islands in 1972, Puerto Rico in 1975, and Curaçao in 1976 after screwworm had reinvaded. The Caribbean countries where screwworm populations are still present are Jamaica, Cuba, Haiti and the Dominican Republic, as well as Trinidad and Tobago.

Over the last years and at the request of Caribbean nations, we have increasingly become involved, together with our FAO colleagues, in extending the successful screwworm SIT programmes in Central America to address the screwworm threat in the Caribbean. We have reported in previous newsletters on the screwworm SIT programme we have initiated in Jamaica with Jamaican and IAEA funding, together with USDA in-kind and technical support. The first aerial sterile fly releases are now programmed to start in April 1999 and are scheduled to last for about 24 months. The release centre to process the 20 million sterile pupae which will be received weekly from the screwworm mass rearing facility of the Mexico-USA Screwworm Commission in Tuxtla Gutierrez, Mexico is presently being set up near the international airport in Kingston. A new modular screwworm mass rearing factory is presently being designed by USDA and Panama and construction some 10 km south of Panama City is tentatively planned to start in 2000 and to be completed in 2002/3. This facility will be available starting in 2003 to procure sterile flies for future SIT campaigns in the Caribbean.

During the last two years, FAO has taken the lead in assessing the screwworm situation in Cuba, establishing monitoring and information systems and elaborating a benefit-cost study and a strategy document for screwworm eradication. Annual incidence of screwworm in cattle in Cuba is around 60% and annual benefits of screwworm eradication are estimated at US$ 33 million per year. Following the successful model of the FAO and IAEA co-ordinated screwworm regional programme in North Africa, which achieved screwworm eradication in Libya in 1991-92, we have now initiated discussions with regional authorities including those from Cuba in preparation of a regional screwworm eradication programme throughout the Caribbean. An initial SIT programme is planned in Isla de la Juventud off mainland Cuba (a 2,200 square km island, about a quarter the size of Jamaica) which has 80,000 head of cattle. The objective is to train Cuban staff in SIT operations and to refine cost estimates for a future screwworm eradication programme in all of Cuba. Field assessments and preparatory activities, including monitoring and benefit-cost studies, again supported jointly by FAO and IAEA, are also scheduled for the Dominican Republic and Haiti during the biennium 1999-2000.

A thematic planning meeting on SIT activities for New World and Old World screwworms, sponsored by IAEA, was being held in Vienna at the time this newsletter is going to press. Representatives from the FAO, USDA, the Mexico-US Screwworm Commission, the Australian Government and CSIRO, and the Cuban National Centre for Animal and Plant Health, participated in discussions on the short and medium term research, as well as operational strategies and requirements to carry out SIT programmes against both pests. This meeting was also important since Australia has finished its Old World Screwworm pilot mass rearing facility in Malaysia, and this pest has recently invaded the Near East Region (Iraq and the Persian Gulf), and therefore represents a major threat to the whole Mediterranean region. In our next newsletter we will report on the agreements and conclusions reached during this meeting.

Jorge Hendrichs

B. STAFF

The Sub-programme staff, consisting of those in the Joint FAO/IAEA Division located in the Vienna International Centre, those in the FAO/IAEA Agricultural and Biotechnology Laboratory in Seibersdorf Laboratory and field experts, are listed below.

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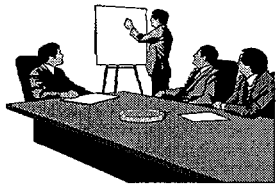


C. FORTHCOMING EVENTS

I. Research Co-ordination Meetings (RCM)

"Automation in Tsetse Mass-rearing for Use in Sterile Insect Technique Programmes", 12-16 April 1999,Vienna, Austria, 3rd RCM.

"Medfly Mating Behaviour Studies Under Field Cage Conditions", 29 June - 3 July, 1999, Guatemala City, Guatemala. 4th and final RCM.

"Molecular and Genetic Approach to Develop Sexing Strains for Field Applications in Fruit Fly Sterile Insect Technique Programmes", 12 - 16 July 1999, Tapachula, Mexico, 3rd RCM.

"Genetics Application to Improve the SIT for Tsetse Control/Eradication including Population Genetics", September 1999, Vienna, Austria. 2nd RCM.

"Evaluating the Use of Nuclear Techniques for the Colonisation and Production of Natural Enemies", autumn 1999, 1st RCM.

"Quality Assurance of Mass Produced and Released Fruit Flies", autumn 1999, 1st RCM.

II. Consultants Meetings

"Thematic planning for Old and New-World Screwworm Control", 10 - 12 November 1998, Vienna, Austria.

"Programme on African Animal Trypanosomosis", 25-27 November 1998, Vienna, Austria.

III. FAO/IAEA Training Courses

Training course on "Integrated Control of Fruit Flies, with Emphasis in the Sterile Insect Technique", 30 November - 4 December 1998, Lima, Peru.

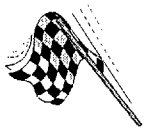
Training course on "Quarantine Procedures in Support of the Development of Fly-Free Areas", February 1999, Tacna, Peru.

Interregional Training Course on the "Use of the Sterile Insect and Related Techniques for the Area-Wide Management of Insect Pests", Gainesville, Florida, 14 April - 19 May 1999. Deadline for Nominations is **January 15, 1999.** A detailed prospectus and application form are included as a pull-out in the centre of this newsletter.

FAO/IAEA Regional Training Course on "The Sterile Insect Technique as a Component for Integrated Area-wide Tsetse and Trypanosomosis Management", 20 March to 14 April 2000.
Preliminary announcement. The course is proposed to last four weeks and will include lectures and practical work in the laboratory and the field. Emphasis will be placed on: principles of area-wide insect pest control / eradication; general introduction in the complexity of tsetse and trypanosomosis management; a refresher course in tsetse morphology and reproductive physiology relevant to SIT programmes; introduction to tsetse mass-production; overview of epidemiology and methods for parasitological and serological monitoring techniques used in intervention programmes; methods for pre-release tsetse population suppression, fly population monitoring and maintenance of barrier systems; methods for sterile male releases; use of GIS and principles of decision taking

in tsetse SIT eradication programmes; awareness of essential supportive and administrative aspects relevant to the operation of a tsetse SIT eradication campaign, including public relations activities; environmental appropriateness of tsetse control measures and of land use after intervention campaigns.

The course will be open to senior tsetse control staff, with preference to veterinarians and entomologists who are or will likely be involved in area-wide tsetse and trypanosomosis management campaigns. Full details, and instructions for applications, will be confirmed in a later Newsletter.



D. PAST EVENTS (1997-1998)

I. Research Co-ordination Meetings (RCM)

"Development of Female Medfly Attractant Systems for Trapping and Sterility Assessment", 20-24 January 1997, Madeira, Portugal. 2nd RCM.

"Automation in Tsetse Mass-rearing for Use in Sterile Insect Technique Programmes", 27 February- 4 March 1997, Tanga, Tanzania. 2nd RCM.

"Genetic Applications to Improve the Sterile Insect Technique for Tsetse Control/Eradication Including Genetic Sexing", 10-14 February 1997, Addis Ababa, Ethiopia. 1st RCM.

"Molecular and Genetic Approach to Develop Sexing Strains for Field Applications in Fruit Fly Sterile Insect Technique Programmes", July, 1997, Guatemala City, Guatemala. 2nd RCM.

"Medfly Mating Behaviour Studies Under Field Cage Conditions", September, 1997, Tel Aviv, Israel. 3rd RCM

"Evaluation of Population Suppression by Irradiated Lepidoptera and their Progeny", 26 - 30 May 1998, Penang, Malaysia. 3rd and final RCM

"Improved Attractants for Enhancing the Efficiency of Tsetse Fly Suppression Operations and Barrier Systems used in Tsetse Control/Eradication Campaigns", 26 - 30 May 1998, Penang, Malaysia. 2nd RCM

"Development of Medfly Attractant Systems for Trapping and Sterility Assessment", 26 - 30 May 1998, Penang, Malaysia. 3rd and final RCM

"Enhancement of the Sterile Male Technique Through Genetic Transformation Using Nuclear Techniques", June 1998, Penang, Malaysia. 2nd RCM

Proceedings are available on request at the Insect & Pest Control Section's office.

II. Consultants Meetings

"Use of Nuclear Techniques in Biological Control: Managing Pests, Facilitating Trade and Protecting the Environment". April 14-18, 1997, Vienna, Austria.

"International Standardisation of Quality Control Procedures and Parameters for Mass Reared and Released Fruit Flies", 5-9 May, 1997, Vienna, Austria.

"Standardisation of Quality Control in Fruit Fly Mass Rearing", 25-27 May, 1998, Penang, Malaysia.

"Co-ordination meeting for Mediterranean fruit fly SIT projects in the Near East", 13-15 October 1998, Vienna, Austria.

Proceedings are available on request from the Insect & Pest Control Section's office.

III. FAO/IAEA Training Courses

National Training Course on "Methyl Bromide Fumigation Technology for Quarantine Treatments Against Fruit Flies", Concordia, Entre Rios, Argentina, February, 1997.

National Workshop organised by SENASA/PROCEM in conjunction with the IAEA on "Advances in Research Support for the National Fruit Fly Programme", Buenos Aires, Argentina, 27-29 May, 1997.

National Training Course on "Basic Training on Integrated New World Screwworm (NWS) Control/Eradication with Emphasis on the Sterile Insect Technique (SIT)", Kingston, Jamaica, 6-27 August, 1997.

Bi-National Chile-Peru Training Course on "Quarantine Procedures and Treatments in Support of the Mediterranean Fruit Fly Eradication Campaign in Tacna and Moquegua, Peru", Lima, Peru, 24-26 September, 1997.

Regional Training Course on the "Use of SIT in Support of Integrated Area-wide Methods to Combat Tsetse and Trypanosomosis", Tanga and Zanzibar, Tanzania, Africa - November-December, 1997.

Regional Latin American Training Course on the "Use of the Sterile Insect Technique in Support of Area-Wide Integrated Fruit Fly Control / Eradication Programmes", Tapachula, Mexico and Guatemala City, Guatemala, October, 1997.

Regional Training Course on "Use of SIT and Related Methods for the integrated Area-wide Fruit Fly Control / Eradication in the Near East and the Mediterranean Basin", Madeira, Portugal, November, 1997.

Workshop in conjunction with SENASA on "Area-Wide Integrated Control of Fruit Flies in the Littoral Citrus Region", Concordia, Entre Rios, Argentina, 23-25 June 1997.

Seminar held in conjunction with INFRUITEC on "Feasibility Assessment for Fruitfly Eradication using SIT", Stellenbosch, Western Cape, Republic of South Africa, 28-29 April 1998.

National Training Course on "Integrated Area-wide Control of Fruit Flies", 8-12 June 1998, Patum Thanee, Thailand.

2nd National Workshop organised by SENASA/PROCEM in conjunction with the IAEA on "Advances in Research Support for the National Fruit Fly Programme", Buenos Aires, Argentina, August, 1998.

Group training course on "Plant Quarantine Procedures against Fruit Flies for Quarantine Inspectors and Supervisors", 17 - 21 August 1998, Lima, Peru.

IV. Other meetings

5th International Symposium on Fruit Flies of Economic Importance, 1-5 June 1998 Penang, Malaysia (see page 19).

FAO/IAEA International Conference on "Area-Wide Control of Insect Pests, Integrating the Sterile Insect Technique and Related Nuclear and Other Techniques", 28 May - 2 June 1998, Penang, Malaysia (see page 26).

E. TECHNICAL CO-OPERATION PROJECTS

Over the last four years, the Section has had technical responsibility for over 35 technical co-operation projects. They fall under four major areas, namely:

- Tsetse
- Fruit Flies
- F-1 Sterility for the Control of Lepidopteran Pests
- Screwworm and Others

Current Operational Projects (1997-1998) are:

ARG/5/005 Fruit Fly Eradication in the South Region
ETH/5/012 Integrating SIT for Tsetse Eradication
GRE/5/01 Control of the Mediterranean Fruit Fly in Crete
IRQ/5/014 Field Monitoring and Laboratory Rearing of Old World Screwworm
ISR/5/009 Feasibility Study of SIT for Medfly Eradication
JAM/5/006 Eradication of the New World Screwworm: Preparatory Phase
JOR/5/007 Feasibility of Area-wide Control of Medfly by SIT
LEB/5/013 Feasibility of Integrated Control of Medfly Using SIT
MAR/5/009 Control of Diamondback Moth by Sterile Insect Technique
PHI/5/026 Integrated Control of Oriental Fruit Fly on Guimaras Island
POR/5/005 Mediterranean Fruit Fly Programme on Madeira
RAF/5/040 SIT for Tsetse and Trypanosomosis Management in Africa
RLA/5/039 Bi-national Project Chile-Peru: Eradication of the Fruit Fly in Southern Peru
SAF/5/002 Feasibility Assessment for Fruit Fly Eradication Using SIT
SYR/5/016 Preparation for Codling Moth Management Using SIT
THA/5/044 Extension of Areas Under Integrated Fruit Fly Control
URT/5/018 Entomological and Veterinary Monitoring on Zanzibar

New projects starting in 1999-2000 are:

ALG/5/017 Control of the Date Moth using SIT/F-1 Sterility Principle
INT/5/145 Promotion and transfer of Sterile Insect Technology
IRQ/5/016 Field monitoring and rearing of old-world screwworm
JAM/5/007 New World Screw-worm Eradication
MAL/5/023 Feasibility of Old World Screw-worm control through SIT
PAL/5/002 Area-wide application of SIT for Medfly Control
RAW/5/008 Preparing to combat the old world screwworm in west Asia.
RLA/5/044 Preparing Caribbean eradication of new world screwworm.
SLR/5/002 Feasibility Study for a Mass Rearing Insect Facility.
SYR/5/019 Controlling codling moth for apple crop using SIT.
TUN/5/019 Control of the date moth using radiation sterilisation.
UGA/5/021 Integrated Tsetse Control in Buvuma Island - Phase II
URT/5/019 Support to National Tsetse and Trypanosomosis Management

In keeping with our policy to highlight activities in a few of our Technical Co-operation projects in each Newsletter the following projects are discussed in this issue.

Feasibility of Eradicating *Ceratitis* spp. Fruit Flies from the Western Cape of South Africa by the Sterile Insect Technique (SAF/5/002)

The Western Cape is the most important area for the production of deciduous fruit and table grapes in South Africa, with approximately 110,000 ha currently under production. Most fruit is produced in valley systems in about 14 different production areas which are isolated from one another to a greater or lesser extent. Two species of fruit fly infest these fruits, the Natal fruit fly *Ceratitis rosa,* and the Mediterranean fruit fly *C. capitata.* The principal control strategy consists of one to three full-cover organophosphate insecticide sprays per season. Bait sprays are used to a lesser extent. Significant trade and other benefits would accrue from one or more production areas being declared "low-pesticide" or fruit fly free.

Many production areas are sufficiently isolated to favour the use of the sterile insect technique (SIT) to control or in some cases to eradicate fruit fly populations. The Joint FAO/IAEA Division is collaborating with the Fruit, Vine & Wine Research Institute in a study to determine the feasibility of using SIT to eradicate fruit fly from one or more areas in the Western Cape. An SIT cost-benefit study has indicated that it would be economically feasible to eradicate fruit flies from the entire Western Cape in one co-ordinated operation. However, if separate SIT operations were considered in the different production areas, an integrated SIT approach may be justified in only four of these areas.

As part of the feasibility study, a pilot SIT project has been launched in the Hex River Valley, South Africa's principal table grape production and export area. Its geographical isolation renders it the most suitable area in the Western Cape for an SIT programme. Intensive monitoring is being carried out with 300 traps deployed throughout the valley. Co-ordinated bait applications are being made to reduce the fruit fly populations in anticipation of releases of sterile flies in late winter (August 1999).

Shipments of sterile flies from Guatemala (GUA/5/013) to Israel

The largest facility to date for the production of male sterile Mediterranean fruit flies, located outside Guatemala City (El Pino Facility) has been providing sterile males for the lower Jordan Valley. The El Pino facility is currently producing only sterile males, achieved through the use of a temperature sensitive lethal (*tsl*) Genetic Sexing Strain (GSS) that was developed in co-operation with the FAO/IAEA's Seibersdorf laboratories. Production through this new technology is running at about 250 million sterile males/week including shipments to SIT programme in California and Florida. The process provides 99.99% males for the releases. Two batches of four million pupae from this production are sent each week from Guatemala City to Israel. Special shipment conditions are required to ensure that the insects arrive in good condition after about 48 hrs in transit. After emergence the flies are released in the lower Jordan Valley on both sides of the Israel-Jordan border. Transportation of the insects has been successful and the quantity of flies is likely to increase with the aim of expanding the control of the Mediterranean fruit fly population in export produce areas, while reducing the use of pesticides.

MODEL PROJECTS

Tsetse Eradication in Ethiopia (ETH5/012)

Field operations are now underway, with collection of baseline tsetse distribution data. All five field teams are active in their designated areas, and the initial survey is scheduled to be completed by early in 1999. Negotiations are

underway with ILRI for the baseline socio-economic and veterinary surveys, where their considerable experience in this field will greatly assist the national team.

Development of the colony in Seibersdorf has been seriously hampered by problems with contaminated packaging material used for shipping the pupae from Arba Minch. Fresh packaging material has been supplied, and steps have been taken to establish a temporary membrane feeding facility in Addis Ababa to supplement the collection of pupae. Plans for a small scale rearing facility at Kaliti, near Addis Ababa, have been prepared, and work should start shortly on converting the existing building. Land for the main production facility has been secured, and preliminary designs for the production factory should be ready soon based on the prototype cage handling unit at Seibersdorf.

Continuing progress in Zanzibar URT/5/016

Two recent expert missions to Unguja Island, Zanzibar, as part of the post eradication monitoring by Dr. G. Leak and Dr. M. J. Vreysen have failed to find any evidence of either tsetse flies or trypanosomosis on the island.

Dr. Leak from ILRI visited at the beginning of September to assist with the trypanosome survey, and additional animals were bled in the areas around Kwebona, Jozani, Mungoni and Muyuni since these are the former *T. vivax* areas. By the end of October a total of 2240 animals had been bled from all areas of the island. All were found negative by the micro haematocrit centrifuge technique as was the case in all previous bleedings since September 1997.

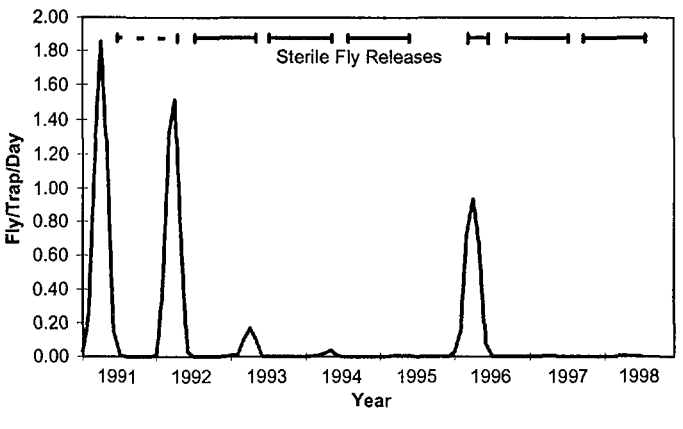
Due to the additional veterinary work tsetse monitoring was reduced during Dr. Leak's mission but was maintained in Jozani, Muyuni and Mapopwe. Dr. Vreysen visited in the second half of September to assist with the tsetse survey and visited all former tsetse hot spots including Jozani A and D, coastal and central Muyuni, Mapopwe and Mangapwani, and during his visit monitoring in the middle belt was resumed. Extra panels were added in Muyuni area to bring the total number of panels deployed to 229. All panels were visited and replaced on a weekly basis. No fly was caught, extending the period since the last fly capture to more than two years.

Tsetse monitoring will continue throughout 1999, while trypanosome monitoring will continue until the end of 2000.

Medfly control in Argentina ARG/5/005

Important results have been achieved throughout the 870,000 hectares of the project working area in which medfly eradication activities are taking place. The project covers the large fruit and vegetable producing valleys in Patagonia, Mendoza and San Juan regions in Argentina. After 5 years of technical support provided through IAEA and FAO technical co-operation projects to these Area-Wide Pest Control Programmes, Argentina is now self-sufficient in providing technical and

MEAN DAILY MEDFLY CAPTURES, MENDOZA PROVINCE, ARGENTINA



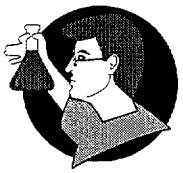
scientific support to their own fruit fly eradication activities including the Sterile Insect Technique, medfly genetic sexing technology and post-harvest quarantine treatments against fruit flies.

Over these huge areas, dedicated mainly to fruit and vegetable production and export, more than 15,000 growers (large, medium and small fruit and vegetable farmers) are benefiting from the programme. Trial releases started in Mendoza in 1991, and following the first full scale releases in 1992-3 the wild population rapidly declined. Financial problems in late 1995 as a result of the "tequila effect" (the peso crisis in Mexico), caused a late start to sterile fly releases and the wild population resurged in early 1996, but this was brought back under control the next year (see graph). Very low and in some commercial production areas almost zero detection of the pest (San Rafael and Uco Valleys in Mendoza, as well as Alto Valle in Patagonia) is adding high quality and value to the produce and better market opportunities are now available.

As a result of this progress, Argentina and Chile (which is already medfly free following a successful SIT project supported by IAEA/FAO) have signed an agreement for close co-operation on medfly control and a joint strategy for establishing a binational fruit fly free area that would bring additional benefits to both countries' international trade in fruit and vegetables.

As a result of the contribution of the FAO and IAEA, Argentina and Chile are already regional centres in South America for development and expertise in the Area-Wide Concept in fruit fly control and eradication techniques. Presently, Argentina is providing technical support (including provision of sterile medflies) to other incipient fruit fly programmes within Argentina (La Rioja, San Luis, Cordoba, Entre Rios, Buenos Aires, Corrientes, Misiones, Catamarca and Tucuman) and Chile to the on-going programme in southern Peru.

Almost 30 million dollars were invested by the government and fruit growers of Argentina in medfly control during the period from 1994 to 1998. Of this amount, around 6% was contributed by IAEA and FAO.



F. EXISTING AND PLANNED CO-ORDINATED RESEARCH PROJECTS (CRP)

Enhancement of the Sterile Insect Technique (SIT) through Genetic Transformation Using Nuclear Techniques (D4. 10.12)

Since the first Research Co-ordination Meeting (RCM) held in Vienna in late 1996, major breakthroughs have been made in the development of non-drosophilid insect transformation systems. There have been 4 published reports in peer reviewed international journals of transposable elements being used to genetically transform 2 non-drosophilid species, the medfly *Ceratitis capitata* and the yellow fever mosquito, *Aedes aegypti*. These developments make it possible now to design and execute experiments aimed at the production of genetically engineered medfly strains that can be used to augment existing SIT strategies. These developments will also result in the identification and cloning of strategic genes and/or promoters from medfly that can be incorporated into existing strains and developed into new strains for the SIT.

Expected duration: 5 years (1995-99)

Contract Holders (1) from Greece

Agreement Holders (6) from Australia, United Kingdom, United States (2) and Italy (2).

A Molecular and Genetic Approach to Develop Sexing Strains for Field Application in Fruit Fly SIT Programmes (D4.10.15)

The first and second RCM's of this CRP have now been completed. The first was in Mendoza, Argentina (March 1996) and the 2nd in Guatemala City, Guatemala (July 1997). The venues were chosen as genetic sexing strains are being reared at facilities in both of these locations and this gives the participants the opportunity to appreciate the constraints associated with the introduction of genetic sexing strains into operational programmes.

During the course of the CRP genetic sexing strains have been introduced into mass rearing facilities in Argentina, Guatemala, Chile, Madeira and Crete. In addition Hawaii and Western Australia are preparing to rear genetic sexing strains. The expertise developed in the CRP has been essential in order that this technology transfer meets the needs of the customer. In other fruit fly species, progress towards the development of genetic sexing strains has been made in the areas of polytene chromosome analysis and the isolation of genetic markers. There is also an increasing emphasis on the use of molecular techniques targeted to the cloning of sex determination genes.

A proposal has been made to extend the CRP for a further year into 2000. The next RCM will be held in Tapachula, Mexico from 12-16 July, 1999.

Expected duration: 5 years (1994-99)

Contract Holders (6) from Argentina, Bangladesh, Brazil, Greece, Guatemala, Philippines and United States of America.

Agreement Holders (3) from Australia, Italy and the United States.

Automation in Tsetse Fly Mass-rearing for Use in Sterile Insect Technique Programmes (D4.20.06)

Several stages in the mass production of tsetse have been addressed so far. Progress has been good in the automated stocking of production cages, where it is now possible to emerge flies under controlled conditions into production cages to give the desired female to male ratio of 4:1, with less than 0.5% females remaining in the un-emerged pupae, for both *G. austeni* and *G. pallidipes*. The necessary conditions for other species remain to be determined.

The automated recognition of males and females has given mixed results. A transport system has been devised that moves the flies one at a time at emergence past a camera, where high quality images can be captured. So far though the variation in light intensity and orientation of the flies is too great for the image recognition software to reliably separate males and females.

Work on an improved system to handle cages for feeding is progressing well. A first fully automated prototype proved to be too complicated and a second prototype is now undergoing trials and shows good promise of reducing the effort of cage handling by approximately ten fold. The system holds 63 large cages on a single trolley that can be moved to feed all the cages simultaneously and then returned to the larval collecting unit. After further testing and modification this version is expected in the future to be installed in Ethiopia for the mass rearing of *G. pallidipes*.

Other work has looked at the handling factors affecting flight ability in irradiated males, increasing cage holding density by the use of inserts, blood decontamination, energy saving, and colonisation of *G. longipalpis*.

The next RCM is scheduled for 12 - 16 April 1999 in Vienna.

Expected duration: 5 years (1995-00)

Contract Holders: (5) from Austria (2), Czech Republic, Burkina Faso, Tanzania and Nigeria.

Improved Attractants for Enhancing the Efficiency of Tsetse Fly Suppression Operations and Barrier Systems Used in Tsetse Control/Eradication Campaigns (D4.20.08)

This CRP was set up to address the shortcomings in attractants for a number of important tsetse species where the standard odours used for *G. morsitans* and *G. pallidipes* are poor or ineffective, and to generally try to improve effectiveness and reduce cost.

So far the Nile monitor lizard has been confirmed to be the principal host of *G. palpalis gambiensis* and *G. f. fuscipes* by blood meal analysis, but odour experiments using live lizards have been inconclusive.

A number of natural kairomones and their analogues have been synthesised, and tested in laboratory experiments or in the field. Decylaldehyde increased caches of *G. austeni*, and linoleic acid, a possible precursor of 1-octan-3-ol also proved active.

Molecular modelling of the structure of known attractants has indicated possible new synthetic attractants, and several of these have proved active in laboratory tests. This approach could lead to the identification of not only more attractive and cheaper compounds, but also attractants for the current "difficult" tsetse species.

Work is also going on to characterise the cuticular hydrocarbon sex pheromones of tsetse, for use in assessing population differences. Comparisons of conspecific populations have shown that the hydrocarbons mixtures are usually very similar.

Expected duration: 5 years (1994-99)

Contract Holders (5) from Mali, Burkina Faso, Kenya and Hungary.

Agreement Holders (3) from the United Kingdom, the United States and Switzerland.

Evaluation of Population Suppression by Irradiated Lepidoptera and their Progeny (D4.10.11)

This CRP was concluded in June 1998. Drs. F. Marec and J. Carpenter are editing the final proceedings which will be published as a special issue of the Florida Entomologist, which is available on-line. (http://www.fcla.ufl.edu/FlaEnt/feissues.htm)

Development of Female Medfly Attractant Systems for Trapping and Sterility Assessment (D4.10.13).

This CRP was concluded in mid 1998 and has resulted in an effective female medfly attractant system that was tested in 16 countries and is now commercially available and being used in many operational projects including California and Florida. Dr M. Heath is editing the final proceedings which will be available as a technical publication (TECDOC) from the IAEA. See also the extended item in Section H (page 23) summarising the outcome of this CRP.

Medfly Mating Behaviour Studies under Field Cage Conditions (D4.10.14)

Slow motion video-recordings of the sexual behaviour of wild and/or mass-produced flies have been collected from Argentina, Costa Rica, Greece, Guatemala, Israel, Kenya, Madeira, Mexico and Reunion for centralised analysis. Though a thorough quantitative analysis is still pending, preliminary results showed that no consistent qualitative difference can be found between the courtship behaviour of males from the different wild populations.

Field cage tests with host trees have been found to be the most reliable tool available to assess mating performance and sexual compatibility of mass-reared medfly males when competing with wild males for wild females. There is clear evidence from the tests and field assessment studies that some quantitative differences in term of mating performance and sexual activity between mass-reared and wild flies can be detected.

Among the most important outcomes of the CRP it was shown that, for the countries represented in the CRP with the exception of populations in Kauai, Hawaii, and Madeira, Portugal, no sexual incompatibility was encountered between mass-reared and wild medfly populations or among wild medfly populations from different geographic origins.

Expected duration: 5 years (1993 - 98)

Contract Holders (8) from Argentina, Costa Rica, Greece, Guatemala, Israel, Mexico, Reunion and Kenya.

Agreement Holders (1) from the United States.

Genetic Applications to Improve the SIT for Tsetse Control/Eradication Including Genetic Sexing (D4.20.05)

The first RCM was held in Addis Ababa, Ethiopia in February, 1997. It was held in Ethiopia to acquaint the participants with the preparations for the future SIT programme in the Southern Rift valley and to focus the work of the CRP on *Glossina pallidipes* populations, the target for the SIT programme. A report of the meeting is available from the Section.

During this first meeting detailed research goals were elaborated and they focused on the development of PCR based analytical tools which will be used to

investigate the degree of population isolation of the target population in the Southern Rift valley. It was also decided to develop polytene chromosome analysis for tsetse. Other work that will be carried out in the CRP includes the analysis of refractoriness in tsetse and the possible use of genetic incompatibilities between different taxa of tsetse.

The next meeting will be in Vienna in September 1999.

Expected duration: 5 years (1997-02)

Contract Holders (3) from Greece, Kenya and Italy.

Agreement Holders (5) from Greece, Kenya and Belgium, Canada, United States, Italy

Reports of the RCMs are available upon request from the offices of the Section.

The following two Co-ordinated Research Projects are scheduled to be initiated in 1999 subject to approval and availability of funding. We still encourage applications for participation:

Evaluating the Use of Nuclear Techniques for the Colonisation and Production of Natural Enemies

Objective: The proposed CRP has the objective of evaluating the use of nuclear techniques in improving the production, shipping and deployment of biological control agents to manage pests, facilitate trade and protect the environment.

Considerable technological advances have been made in mass-rearing of parasitoids and predators for augmentative biological control. The large scale availability of natural enemies of key insect pests opens the way for totally biological systems of pest control, where mass releases of natural enemies can suppress pest densities in the field and so act synergistically with sterile insect releases to control wild insect populations within the context of area-wide integrated pest management programmes. Nuclear techniques can also play an important role in the production of natural enemies, as recent research has shown that parasitisation rates are increased in irradiated host larvae. Irradiation can also prevent the escape of fertile prey or unparasitised adult pest insects and artificial diets for mass-rearing of natural enemies can be decontaminated using irradiation.

Expected duration: 5 years (1999 - 04)

There has been a good response to this initiative and a number of proposals are under consideration. Further submissions are still welcome.

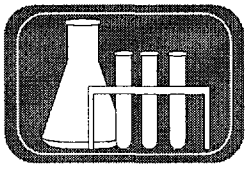
Quality Assurance of Mass Produced and Released Fruit Flies

Objective: To improve and standardise internationally quality control and assurance procedures for mass produced fruit flies. There are now over ten fruit fly mass rearing facilities in the world that produce sterile flies for SIT programmes. With international trade in sterile insects becoming a reality, it is important that producers and users apply internationally standardised quality control procedures. A CRP involving behaviourists, physiologists and mass rearing specialists will allow fine-tuning of the internationally accepted standards and procedures as well as developing new tests measuring more representative parameters. A Consultants Group Meeting on the International Standardisation of Quality Control Procedures for Mass Reared and Released Fruit Flies was held in May 1997 in Vienna. It produced an updated international manual of standard QC

procedures (see Section H, page 28) and recommended implementing this CRP to address those technical issues that require fine-tuning and those that could not be resolved and therefore require a co-ordinated R&D approach to develop new or better QC tests.

Expected duration: 5 years (1999-04)

We strongly encourage behaviourists, physiologists and mass rearing specialists from the relevant countries rearing facilities and research institutions or universities to put forward proposals for this co-ordinated research project.



G. DEVELOPMENTS AT THE ENTOMOLOGY UNIT, SEIBERSDORF

MEDFLY

Genetic Sexing

The use of genetic sexing strains (GSS) in operational SIT programmes continues to increase. To ensure that this transfer of technology is providing a satisfactory product to the end-user, R and D support in the form of provision of current strains or the development of new ones, remains a high priority. Strains are developed, tested under mass rearing conditions and their mating behaviour evaluated before being transferred to operational facilities.

The widespread acceptance of male only strains as an important component of operational SIT programmes requires increasing attention from the Unit to ensure that the appropriate support is provided on a continuing basis, and that strain transfer is not a "one off" event.

GSS Vienna 7-97

This new strain was chosen for mass rearing evaluation as the position of the translocation breakpoint was predicted to improve stability and mass rearing characteristics. The strain was not back-crossed to any field strain before testing its mass rearing characteristics. The mass rearing characteristics of this strain have proved to be excellent with no build up of recombinants, even in the absence of a filter (see below), after 19 generations of mass rearing.

There is concern however about the mating behaviour of this strain, especially when mating with wild flies from Madeira. VIENNA 7-97 was tested in the greenhouse against wild populations from Israel, South Africa and Madeira. The mating competitiveness of VIENNA 7-97 males was found satisfactory when tested with wild Israel and South Africa flies (VIENNA 7-97 males achieved about 25% of wild female mates). However, tested under the same conditions, VIENNA 7-97 males do not compete successfully with wild Madeira flies and achieve only 7% of wild female mates. Similar results were also found on site in Madeira during field cage tests. Despite the fact that mass rearing quality control data was very satisfactory, the unexplained poor mating behaviour of VIENNA 7-97 with Madeira flies is giving some concern. The strain is being back-crossed to field material and the tests will be repeated to assess whether the mating effect is due to the translocation or to the genetic background.

Filter Technology for Mass Rearing

The maintenance of long term stability during mass rearing of genetic sexing strains is essential if these strains are to gain wide acceptance. To help in this regard a filter system has been developed together with colleagues at Moscamed, Guatemala, in which a small colony of the genetic sexing strain is maintained by removing recombinants by hand. This colony is then used to feed eggs into the mass rearing system which then multiplies these eggs over a limited number of generations to produce the required numbers of flies for release. This filter principle can also be used for conventional strains in order to rear colonies under low stress conditions to maintain important components of courtship and mating behaviours.

Inversions

Chromosomal inversions can be used in two ways in combination with genetic sexing strains. They can reduce instability and they facilitate the introduction of wild

genetic material into the strains. In collaboration with Antigone Zacharopoulou in Patras and Carlos Caceres in Guatemala, a series of 8 inversions has been isolated and characterised cytogenetically. Although none of the inversions covers all the required markers the mating procedures are now so efficient that additional inversions can now be routinely isolated. Although the need for inversions to stabilise genetic sexing strains has somewhat reduced due to the success of the filter system, they are still very important to ensure the easy transfer of wild genetic material into the strains.

Mating Behaviour

An exhaustive study of mating compatibility between medfly populations from different parts of the world has now been completed. This study also included mating studies between genetic sexing strains and wild populations. Wild populations from 9 countries, covering most of the geographical range of medfly, were tested as well as 4 genetic sexing strains.

The study demonstrated for the first time that there appear to be no pre-mating isolation barriers for medfly over its whole geographic range and this indicates that if a particular genetic sexing strain shows good mating competitiveness with one population there is a good chance that it will be effective against others. In practical terms this means that a single well characterised strain, regularly refreshed with wild genetic material, could be used in many facilities world wide.

Transgenic flies

As reported in the previous Newsletter genetic transformation was achieved using a particular genetic vector named *piggy bac*. Stable transformed lines are now being maintained and analysed. A second vector, *Hermes*, has now been shown to be able to transform medfly. The current rapid progress in medfly transformation and the increasing demand for the facilities at Seibersdorf has required the refurbishment of part of the Unit into a transgenic facility. This facility will enable the work to be carried out in a biologically responsible manner and with more space available.

TSETSE

Mass Rearing Developments

The implementation of the tsetse SIT programme in the Southern Rift valley in Ethiopia will require extensive R and D in terms of fly production and handling. The scale of the operation will require new procedures and concepts to be developed. Two aspects will be highlighted here.

TPU2

The "tsetse production unit 2" (TPU2) is a conceptually simple set of equipment which is used to hold and feed large numbers of flies and to collect pupae from them. A prototype is now under evaluation which carries 63 large cages containing in total about 15,000 female flies. Aspects of fly density, mating efficiency and production are being tested using *Glossina pallidipes*, the target species in Ethiopia. The TPU2 is robust, simple, easily constructed and can be manufactured and assembled in Ethiopia.

Self stocking of cages

Using a difference in the emergence time of male and female *G. pallidipes* a system has been developed whereby adult flies of the right sex ratio and number can be added to cages without handling the flies. This procedure has been developed based on the observations that a ratio of 1 male to 4 females is acceptable in the cage and that flies of both sexes can be placed in the cage immediately after emergence. This cage stocking system will now be used to stock the cages for the TPU2.

G. pallidipes Colony from Arba Minch

For the SIT release programme in Ethiopia it will be essential that a mass reared colony of *G. pallidipes* is established from the target area. Until a rearing facility is constructed in Ethiopia the responsibility for building up the colony is at Seibersdorf. Pupae are received at regular intervals from Ethiopia and the emerging flies fed directly on the membrane feeding system. Problems have been encountered in obtaining viable adults from Ethiopia although once the flies have survived the first 24 hours in Seibersdorf their survival and productivity are acceptable. Recent changes have been made to the pupal collection procedure in Ethiopia and it is hoped that this will now improve. The colony currently stands at 2000 females.

Other Areas of Interest

1) *Radiation studies*: There is no data on the radiation sensitivity of *G. pallidipes* and a series of experiments has been set up to identify the correct dose to use for effective sterilisation of males.
2) *Freeze dried blood*: A large test on the long term effects of feeding freeze dried blood to tsetse, as opposed to fresh frozen blood, is coming to a conclusion. The test shows that blood can be stored for an extended period under ambient conditions without significant loss of quality after freeze drying, and although fecundity is slightly reduced, mortality is no higher than normal. The utilisation of freeze dried blood would give a large programme the ability to switch diets for a limited period if an emergency occurred with the supply of fresh frozen blood without jeopardising the colony. The effects of feeding freeze dried blood over several generations are now being evaluated.
3) *New colonies*: A colony of *G. morsitans centralis* from Botswana is now being successfully established in the event that an SIT programme for this species in the Okavango Delta becomes a reality. A colony of *G. swynnertoni* derived from that in the laboratory of Dr. R. Gooding in Canada will also be established.
4) The Unit continues to supply an increasing number of researchers in many parts of the world with tsetse material. The closure of tsetse rearing laboratories in many parts of the world has dictated that the Unit take over the support for many tsetse R and D projects.

H. SPECIAL NEWS AND REPORTS

5th International Symposium on Fruit Flies of Economic Importance, 1-5 June 1998 Penang, Malaysia

The Minister of Agriculture for Malaysia, Datuk Amar Dr. Sulaiman Haji Daud, opened the 5th International Fruit Fly Symposium on the 1st of June 1998. In a brief ceremony, Patrick Gomes, Chairperson for the International Steering Committee, provided opening remarks followed by a presentation of the Universiti Sains Malaysia, which served as sponsors and convenors of the symposium. Professor Tan Keng Hong, School of Biological Sciences, Universiti of Sains Malaysia, served as the local organiser of the symposium.

A total of 194 participants from 45 countries met for 4 days to discuss progress in the development of new technologies and the implementation of projects to better control fruit fly pests. A total of 12 sessions were held that included presentation and poster discussions. Topics covered included Area-wide Fruit Fly Action Programmes; Area-wide Approaches to Fruit Fly Management; Quarantine and Post-Harvest Treatments; Biotechnology, Genetics, and Molecular Biology; Genetic Sexing and the Sterile Insect Technique; Rearing, Quality Control and Nutrition; Ecology and Demography; Biochemistry and Physiology; Semio-chemicals and Field Monitoring; Behaviour; Biosystematics, Biodiversity and Evolution; and Natural Enemies and Beneficial Fruit Flies. A total of 31 papers and 202 posters were presented. A joint proceedings with the FAO/IAEA International Conference will be published in the coming year.

South Africa was selected as the venue for the 6th International Symposium on Fruit Flies of Economic Importance to be held in four years time, in 2002.

3rd Annual Exotic Fruit Fly Symposium, Riverside, California, 14-16 September 1998

This event is becoming a very important meeting as it brings together many people and organisations involved in area-wide control of fruit flies. Most of the presentations during the symposium dealt with aspects of medfly SIT to which the FAO/IAEA programme has made significant contributions and this was repeatedly recognised. The Symposium covered both field implementation of SIT, mainly in California, and reports of R and D projects which the California Department of Food and Agriculture (CFDA) and the Citrus Research Board (CRB) are funding. Both organisations are currently funding several R and D projects which have direct relevance to the Insect and Pest Control sub-programme. The CDFA have already funded a project at the University of Hawaii which contains funds earmarked for support of the R and D programme at the FAO/IAEA Seibersdorf laboratories. The key points made during the symposium included:

Field Implementation

- In California the medfly Preventative Release Programme (PRP) is successfully preventing the establishment of new medfly infestations.
- For new outbreaks outside the PRP area the temperature sensitive lethal *(tsl)* genetic sexing strain (GSS) from Guatemala is now being used.
- In Florida, there are currently four infestations in various stages of eradication with the *tsl* from Guatemala being used where possible.

- The CDFA medfly rearing will be remodelled to mass rear the *tsl.*
- Considerable progress was demonstrated in the development of improved female trapping systems for medfly. When used in combination with male only release these will greatly increase the effectiveness of SIT. The key role that the CRP (D4.10.13 - see pages 13 and 23) has played in this development was repeatedly acknowledged.
- Molecular analysis continues to show that California and Florida are subject to medfly invasions from different geographical areas but it is currently not possible to unequivocally determine the precise geographical origin of a single trapped medfly.

R and D

- Genetic transformation of fruit flies has now been accomplished in several laboratories, including Seibersdorf, using different genetic vectors.
- Medfly has now been transformed with a gene expressing a green fluorescent protein (GFP) which might be useful for the identification of released flies.
- PCR primers have been designed which can differentiate male and female individuals at any stage of development, including eggs.
- The role that symbiotic bacteria might play in nutrition and hence survival of mass reared flies is being recognised.

The sterile insect technique for commercial control of the onion fly

The Sterile Insect Technique has been applied commercially for the control of the onion fly, *Delia antiqua,* (Diptera: Anthomyiidae) in the Netherlands since 1981. About 15% of the total Dutch onion crop is treated representing about 2600 hectares. Flies are mass reared on an artificial diet and a new strain is regularly collected from the field. Continuous rearing can be carried out as the pupae can be stored for up to one year at 3°C. The ability to store pupae is extremely important for the implementation of the programme.

Grower uptake of the programme has been problematical due mainly to a lack of confidence in the technology but also to the selfish behaviour of a minority of growers. This means that a key condition for the optimal use of this technique, i.e. an area-wide approach in which all growers of a region participate has not been achieved and effective population suppression is not possible.

Many growers who use chemical control for this pest view SIT as a convenient insurance policy in the event that the fly develops resistance to the insecticides. However, should resistance develop then only a strict and regional management of onion production could provide the right environment for the utilisation for this technology.

SIT for codling moth eradication in British Columbia, Canada

For the past 5 years orchardists and homeowners in the Okanagan Valley of British Columbia, Canada have joined forces with the Okanagan-Kootenay Sterile Insect Release (SIR) Program to do battle with the codling moth (CM), *Cydia pomonella,* (Lepidoptera: Tortricidae). Eradication of the pest is being achieved through the release of sterile CM throughout the area from mid-April to mid-September. In order to provide the needed overflooding ratios, a mass-rearing facility is being operated in Osoyoos, BC with a current production of 14.2 million sterile moths per week.

Prior to the start of the Program, control of this pest was based on 3-5 cover sprays of the organophosphate insecticide azinphosmethyl per season. By eradicating CM the industry will decrease its reliance on these sprays, creating expanded opportunities for integrated management of other orchard pests.

The SIR Program became a reality in 1992 following 20 years of research and development at the Agriculture and Agri-Food Canada Research Centre in Summerland, BC. Area growers and all 3 levels of government agreed to share the Program's costs. In 1997 the operating budget was $3.2 million CAD, with growers paying $80 per acre of apples and pears and homeowners $0.195 per $ 1,000 of assessed land value.

Lack of a co-ordinated clean-up effort prior to the release of sterile CM in 1994 resulted in excessive damage in the initial year. These results began to change in 1995, when growers were persuaded to combine an aggressive spray program with the release of the sterile moths to reduce the wild population to a manageable level. Since then, the resulting decline in the wild population has been dramatic. The average trap catch has been reduced from 13.0 moths/trap/week during peak first brood spring emergence and 3.0 moths/trap/week during peak second brood emergence in 1995, to an average of 1.0 and <0.5 CM/trap/week for first and second brood, respectively, in 1997. The majority of growers sprayed only once for CM in 1997, 91 % of the orchards had no CM injury at harvest, and it is likely that growers will not have to spray for CM in Zone 1 in 1998 and future years.

The treatment area has been divided into 3 zones - South, Central and North Okanagan - with approximately 8,250, 6,250 and 3,500 acres of apples and pears, respectively. The schedule in each zone involves 3 years of pre-release sanitation to reduce wild populations, followed by 3 years of sterile moth releases to achieve eradication. Eradication in Zone 1 is anticipated by the end of 1999, Zone 2 by the end of 2002 and the entire SIR treatment area by 2005.

Use of Sterile Insect Technique in Mediterranean Fruit Fly Eradication in Florida

The Mediterranean fruit fly (medfly) is a quarantine pest for the USA and is established only in Hawaii. It has invaded Florida, Texas and California several times this century and always been eradicated.

Increased tourist travel, changes in demographics with the concurrent desire to obtain familiar fruits, often medfly hosts, and increased trade in fruit and vegetables all contribute to the increasing risk of accidental medfly infestation in Florida.

The Florida fruit and vegetable industry cannot live with the medfly because of direct losses caused by the pest, losses of export markets because the medfly is a quarantine pest and increased production costs resulting from insecticide treatments to produce quality fruit. Extensive insecticide treatments to control the pest would result in major environmental concerns.

The medfly was detected in Florida in 1997 following a 6 year period during which it had not been detected. An eradication campaign was immediately initiated utilising eradication technology similar to the Federal and State manuals/protocols developed several years ago. This includes delimitation of the infestation by intensive trapping with Trimedlure baited traps, multiple aerial and/or ground bait sprays of malathion treatments at about weekly intervals, stripping and destruction of host fruit to remove larval populations, soil treatments to kill immature medflies in the soil under host trees, mass trapping to catch as many males as possible to reduce the adult medfly population and finally the release of sterile flies (if available) to eliminate any wild populations of flies that escaped the insecticide treatments. Apparent eradication was achieved in 1997. However new infestations were detected in 1998 which are believed to have resulted from failure to eradicate in 1997. A new

campaign was initiated in 1998 utilising more SIT releases and renewed insecticide treatments. Elimination of the 4 infestations detected in 1998 seems imminent (October 98). The program, based primarily on the SIT, must be vigorously continued for several months to ensure eradication.

Since the programme became operational in 1997, the use of the SIT has increased gradually until it has become the predominate eradication tool at the present time. This increased use is partly because of environmental concerns with wide usage of bait sprays and partially because of increased confidence in the SIT. Sterile males of the temperature sensitive lethal (*tsl*) genetic sexing strain, shipped from the El Pino facility in Guatemala, are being used in conjunction with the medfly female attractant in SIT release areas.

Mediterranean Fruit Fly Preventative Release Program in Southern California

The Joint FAO/IAEA Division has been an advisor to the Preventative Release Program (PRP) which is a major component of on-going efforts to keep Mediterranean fruit fly (medfly) out of California. This program uses continuous releases of sterile flies to interfere with medfly colonisation in 5,581 km^2 of contiguous urban areas of Los Angeles, Orange, Riverside, and San Bernardino Counties. The program began in July 1996 and will run for five years. The program components are sterile fly release, trapping, larval survey, and fly identification.

Sterile medflies are supplied by medfly rearing facilities in Hawaii and Guatemala. The sterile fly release facility incubates and emerges 450 million sterile medfly pupae per week and evenly disperses the sterile adult flies over the release area at a density of not less than 49,000 sterile medflies per km^2, per week. Some 30 billion sterile medflies have been released between July 10, 1996, and May 31, 1998.

Two Jackson traps baited with Trimedlure and two McPhail traps baited with yeast are deployed per square kilometre throughout the project area to detect the presence of wild medflies. These traps are relocated to new host plants with fruit every six weeks. The traps are serviced weekly during the warmer months and every other week during the winter.

Larval survey involves a focused survey of high risk areas, i.e., wholesale fruit markets, fruit importers, and exotic fruit markets. Host fruits are sampled, cut, and inspected for the presence of medfly larvae. Over 2,722 kilograms of fruit were inspected and no medfly larvae were found in this general survey

Fly identification determines the status of the adult medflies (sterile or wild) trapped throughout the release area. The sterile medflies are marked with a fluorescent pink dye. Over 20 million dyed sterile medflies were examined in 1997.

Between 1986 and 1994, California was subjected to over 60 discrete medfly introduction events as indicated by the capture of over 800 wild medflies during the same years. The Basinwide Program and its successor the PRP have reduced the captures of wild medflies to a single infestation discovered in the SIT area. Twenty-three flies were trapped in this small 1997 infestation. No flies were detected in 1998 in the PRP area, whereas several outbreaks outside of the PRP confirm the increasing rate of medfly introductions from abroad. Viewed in this context, it is believed that the current release rate of 49,000 sterile medflies per km^2 is effective at reducing significantly the rate at which medfly introductions become established in California.

It is concluded that unlike the previous bait-spray eradication activities, the PRP is effectively protecting California's high risk area for medfly introductions in an environmentally friendly way and at less than half the cost.

Eradicating *Bactrocera papayae* from northern Queensland

An outbreak of the Asian Papaya fruit fly (PFF), *B. papayae,* was detected near Cairns, Australia, in October 1995. In response to this incursion, the Queensland Department of Primary Industries established an eradication campaign, with support from the federal and other state governments. Road blocks were installed to prevent fruit movement and trapping was intensified to determine the extent of the infestation. Ten days after the initial detection, a pest quarantine area was declared covering an area of 76,000 km^2 in northern Queensland. Eradication was based on male annihilation, supplemented by strategic foliage baiting.

From an initial catch of 0.8 PFF/trap/week in October 1995, fly numbers declined to less than 0.001 flies/week by June 1997 and none have been detected since then. All quarantine restrictions were removed in August 1998. Successful eradication of *B. papayae* in this campaign is attributed to a combination of area-wide coverage with blocks and foliage baiting.

Final results of the Co-ordinated Research Programme "Development of Female Medfly Attractant Systems for Trapping and Sterility Assessment" (CRP D4.10.13)

The practical application of the Sterile Insect Technique (SIT) is continuing to expand at an increasing rate as the continuous use of insecticides becomes more of a recognised environmental problem. To improve the efficacy of the SIT, reduce costs, and more effectively utilise sterile males, a female attractant system to trap females in the wild population is required. The main objective of this Co-ordinated Research Programme (CRP) was to develop a female medfly targeted detection and trapping system that would result in simplified and more accurate methods for following the progress of the SIT programmes.

It was envisioned that the development of a synthetic female food attractant by USDA ARS and APHIS scientists could be combined with the male only sterile fly programme to reduce the number of males captured. The capture of females would enhance the programme since most of the females captured would be wild and removal of them provides an indication of the programme's success and simultaneously reduces the female population.

The second objective of the CRP was to develop a system to capture live female flies to access the sterility of a wild female medfly population. By knowing precisely the extent of sterility induced the sterile males can be more strategically utilised, increasing efficacy and reducing programme costs.

The participants consisted of research teams from Argentina, Costa Rica, Greece, Guatemala, Honduras, Mauritius, Mexico, Portugal, South Africa, Turkey, United Kingdom and United States. The CRP began in January 1994 with the final Research Co-ordination meeting in Penang in May, 1998.

Initial experiments were conducted to evaluate the new female trapping systems for medflies. The combination of two female attractants (ammonium acetate and putrescine) was tested in different types of traps and comparisons of female capture with the new synthetic lures were made with standard aqueous proteinaceous baits. The male specific parapheromone Trimedlure (TML) was used to provide additional information on population densities. In addition to several standard traps provided by the Agency many of the research teams also tested the female attractant in traps designed by them or known to be used in their country. In addition to obtaining comparisons of medflies captured, host availability and environmental conditions were also recorded. Preliminary success was obtained in the capture of live wild females

that was needed to develop systems for female sterility assessments. In 1996 it was discovered that the addition of a third chemical (trimethylamine) was a potential synergist for the capture of female medflies. Based on the early success of the project it was recommended by the participating scientists that the last part of CRP should focus on comparisons of using the synthetic lures in traps that were dry versus those that contained water in round bottom plastic McPhail type traps. Additional recommendations were made to begin trapping in low density populations, continue to improve systems to capture wild female flies or collect eggs deposited within egging devices contained in the traps and determine the potential for fly suppression by mass trapping of female flies. Based on the efforts prior to 1997 a cohesive protocol was developed that resulted in significant advances in female trapping systems for use in SIT programmes. Some of the significant results are as follows:

- The two component lure consisting of ammonium acetate and putrescine was approximately equal to protein baits for capture of medflies.
- The addition of the trimethylamine lure to ammonium acetate and putrescine lures significantly improved trap capture of female medflies.
- The commercial formulation of the three component lure has a field life of 6 - 8 weeks compared to protein baits that should be replaced every week.
- Traps baited with the synthetic lure capture few non target insects. Protein baits capture 4 to 50 times more non target insects, including beneficial insects, then the synthetic lure.
- Traps baited with the three component lure captures 5 - 40 times less sterile male flies then TML baited traps.
- Traps baited with the synthetic lure captured approximately 75% female medflies. Protein baited traps captured 77% female medflies. TML captured < 1% females.
- Based on results from all countries, the plastic McPhail type traps baited with synthetic lures and insecticide captured 2.2 times more medflies than protein baited plastic McPhail type traps, (N = 60, equivalent to 7,280 trap days or approximately 20 trap years).
- Based on results from countries having very low medfly populations, the plastic traps baited with synthetic three component lure catch approximately 4 times more medflies then protein baited plastic traps.
- In low populations the female food attractant synthetic lures detected the presence of wild Mediterranean fruit flies before the TML baited traps.

The international network of distinguished research scientists co-ordinated by the FAO/IAEA Research Contract Programme has resulted in a major contribution to the male only SIT program to suppress and eradicate medfly. The use of the three component synthetic female food attractant is now globally accepted for use in supporting programme efforts. The results obtained are indicative of the enthusiasm and dedication of the scientists that were involved in this highly successful CRP. The research teams were lead by Enrique Vattuone, Argentina; Hernan Camacho, Costa Rica; Byron I. Katsoyannos, Greece; Felipe Jeronimo, Guatemala; Yoav Gazit, Israel; Abdeljelil Bakri, Morocco, Aydin Zümreoğlu, Turkey; Pablo Montoya, Mexico; Pedro J. Ros, Spain; Robert R. Heath, U. S. A.; Luis Vásquez, Honduras; Philip Howse, U. K.; Rui Pereira, Portugal; Swarnalata Indira Seewooruthun, Mauritius; Brian Barnes, South Africa.

C. capitata Parasitoid Rearing Facility, Brazil.

In Brazil, a pilot field test will take place to control fruit flies using SIT and

parasitoids. A small mass rearing pilot facility is nearing completion and a medfly genetic sexing strain from Argentina will be introduced. This sexing strain is based on the slower development of female larvae which will be used to rear parasitoids with the male larvae being allowed to complete their development for sterilisation and release. Dr. Julio Walder is in charge of the programme under the CRP on "A Molecular and Genetic Approach to Develop Sexing Strains for Field Application in Fruit Fly SIT Programmes (D4.10.15)"

ANNOUNCEMENT

3rd Symposium on Fruit Flies of Economic Importance of the Western Hemisphere, July 1999.

After a successful meeting between fruit fly researchers and action programme personnel from the Americas (Viña del Mar, Chile, 1996), a follow up meeting is scheduled for Guatemala City during the first week of July 1999.

This meeting is a unique opportunity to exchange information with participants from both research and action programmes, to observe the progress made in both arenas and to determine the needs for future research to solve the action programmes' most pressing problems.

For the meeting, simultaneous translation will be provided with the aim of increasing participation from both English and Spanish speaking countries.

The first announcement of the meeting has already been sent to those individuals included in the e-mail list of the previous meeting. Individuals wishing to participate for the first time and those whose e-mail address has changed, can request information from Pedro Rendon at ppq@guate.net.

ANNOUNCEMENT

XIVth International Plant Protection Congress, Jerusalem, 25 - 30 July, 1999

The XIVth International Plant Protection Congress will be held in Jerusalem, Israel, from 25 - 30 July 1999. The theme of the Congress is "Plant Protection Towards the Third Millennium - Where Chemistry Meets Ecology" to symbolise the need to incorporate all aspects and approaches to pest control including biotechnology and environmentally compatible chemical and non-chemical methods, and will include nine main sessions. During the first of these, "IPM Towards the 3rd Millennium - Progress in Strategies and Technology" there will be a symposium on "The Sterile Insect Technique, Past, Present and Future". Details of this symposium can be obtained from the joint organisers, Jorge Hendrichs (j.hendrichs@iaea.org) or Yoram Rössler (rossler@netvision.net.il)

For information on the International Congress visit their web site at http://www.kenes.com/IPPC, or contact the Secretariat at P.O. Box 50006, Tel Aviv 61500, Israel, Fax: +972 3 514 0077, e-mail: IPPC@Kenes.com

Jordanian - Israeli - Palestinian Joint Communiqué

Following the Co-ordination Meeting for SIT projects in the Near East, held from 13-15 October 1998 at the IAEA headquarters, Vienna, Austria, the delegations from the Hashemite Kingdom of Jordan, the State of Israel and the Territories Under the Jurisdiction of the Palestinian Authority signed a joint communiqué affirming their common interest in medfly control, and their mutual intent to co-operate to this end.

The communiqué listed the following fields of co-operation, amongst other:

- Control of medfly on an area-wide basis integrating SIT and other appropriate technologies

- Co-ordination of the planning and execution of surveillance and control activities aimed at suppressing medfly populations more effectively
- Open exchange of technical data and information in a timely manner regarding the incidence and severity of medfly infestation
- Co-ordination of efforts to train personnel on better approaches to detection and control of medfly

Gracian Mutika Joins Staff

Gracian joined the staff of the Entomology unit in Seibersdorf in October 1998. He graduated in Biological Sciences from the University of Zimbabwe in 1990 and gained his MSc in Tropical Entomology from the same university in 1993. Since then he has worked as a research officer in the Tsetse and Trypanosomiasis Control Branch, Zimbabwe, on trap oriented behaviour of tsetse flies in the field and use of cattle as live baits in tsetse control.

His assignment at Seibersdorf will cover various aspects of the development of post production handling of sterile male tsetse (both pupae and adults), and the measurement of behavioural parameters for quality control of released sterile flies.

J Wendell Snow joins Jamaica Screwworm Eradication field project.

Wendell has many years of experience in Screwworm control and sterile insect programmes. He was instrumental in getting the Jamaican New-world Screwworm Eradication project (JAM/5/006) off the ground. He is now counterpart to the National Project Director, Dr. George Grant, and is based in Kingston.

The project is scheduled to last three years. Releases of about 15 million sterile flies per week from the Mexico-US facility in Tuxla Gutierrez, Mexico, giving about 1,200 sterile flies per square kilometre for two years will start in April 1999. The sterile fly releases will be supported by prevention, control and quarantine measures. The total cost will be about US$9 million, whilst losses to the livestock industry are estimated at US$5.5 to 7.7 million annually.

In the past Wendell has frequently worked with the section as a consultant on various projects.

The following is taken from the Press Release issued in connection with the FAO/IAEA International Conference in Penang

FAO/IAEA International Conference on "Area-Wide Control of Insect Pests, Integrating the Sterile Insect Technique and Related Nuclear and Other Techniques", 28 May - 2 June 1998, Penang, Malaysia

Recent advances and the potential for applying innovative and more environmentally-friendly methods to manage key insect pests were the focus of the International Conference, organised by the Joint FAO/IAEA Division, in co-operation with the University Sains Malaysia, in Penang, Malaysia. The Conference brought together 280 experts, including some of the world's best and most knowledgeable pest control scientists, animal and plant protection specialists, and representatives of regulatory authorities and the private sector from over 70 countries and six international organisations.

Major progress was reported in the development of the Sterile Insect Technique (SIT) and its successful large scale application in eliminating insect pests such as the fruit fly in parts of Latin America, Japan, USA and Australia, the screwworm from North and Central America and parts of North Africa and most recently the tsetse fly from Unguja Island, Zanzibar, Tanzania. The Agency's Laboratory in Seibersdorf, Austria, has played a leading role in developing SIT.

The conference also agreed that an area-wide approach to pest control, in which the entire population of a pest in an area or region is managed in a co-ordinated way, often across political boundaries, is considerably more effective and economical than uncoordinated field-by-field, or orchard-by-orchard control measures now practised by a majority of growers who rely on pesticide applications. The area-wide concept of pest control also contributes to alleviating environmental concerns and is central to the effective application of SIT.

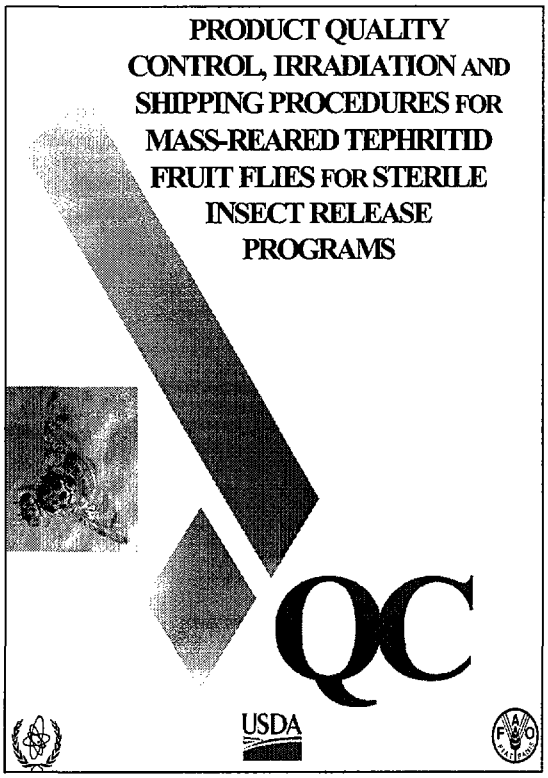
A group of participants from 16 African countries concluded that Africa can only be freed of the tsetse fly by an area-wide approach integrating SIT with other environment-friendly methods, and in a concerted effort with long-term political commitments of the countries concerned. Tsetse flies are responsible for unproductive agricultural systems in almost 11 million km^2 of sub-Saharan Africa. New advances in mass-rearing tsetse flies achieved at the Agency's Seibersdorf Laboratory have reduced costs of fly production to a tenth, making the large scale use of SIT on mainland Africa a realistic prospect. These new methodologies will be applied in a large eradication campaign to free the Southern Rift Valley in Ethiopia of tsetse.

Fruit flies are among the economically most harmful insects, severely hindering world trade in agricultural products. The Mediterranean fruit fly (medfly), for example, attacks over 250 species of fruit and vegetables in many parts of the world. So great is the potential damage that many countries impose strict trade barriers and prohibit import of fresh, potentially infested produce from endemic countries. However, research & development in SIT technologies for area-wide medfly control and eradication is among the most advanced in insect pest management. IAEA and FAO have supported successful SIT projects in Argentina, Chile, Costa Rica, Guatemala, Mexico, Peru and Portugal.

Moths are also among major pests damaging food and fibre crops, forests and stored products throughout the world. Several species have developed resistance to even high doses of insecticides. SIT programs that have successfully overcome pesticide-related problems, have been operated to control the cotton pink bollworm in California and, most recently, the codling moth of apples in British Columbia, Canada.

The Conference also addressed new developments in biotechnology, genetics and molecular biology related to insect pests.

Newly Revised Manual on International Standards for Product Quality Control of Sterile Fruit Flies for SIT Programmes



During a meeting convened by the Joint FAO/IAEA Division in 1997 in co-ordination with experts from the USDA/APHIS, international consensus was reached among 19 consultants and national experts from 12 countries representing 13 fruit fly mass-rearing facilities on the objectives, procedures, and interpretations of each quality control test.

The manual entitled "Product Quality Control, Irradiation and Shipping Procedures For Mass-Reared Tephritid Fruit Flies For Sterile Insect Release Programs" is now available upon request from the Insect & Pest Control Section. Managers of SIT programs need to be concerned with ensuring that, once in the field, sterile insects can compete effectively with wild insects and mate successfully. This is especially critical for insects that have a complex mating system like tephritid fruit flies. Effective methods for monitoring and providing feedback on the quality and competitiveness of sterile fruit flies are critical to the success of SIT programs.

New Manual to Replace Older One

The newly revised and updated manual will provide end-users of sterile fruit flies that are used in pest control projects & programs with routine, periodic and ancillary tests for assessing their overall quality and competitiveness. This manual is designed to replace an earlier QC manual published by the Animal & Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) in 1986 for assessing product quality of only medflies that are used in SIT release programmes.

Changes Made to Improve QC Assessment

A major impetus for revision of this manual was to reach international consensus on and include *required* tests of mating competitiveness and compatibility so that tests of these crucial behavioural components are not neglected. In addition, tests have been added to provide better information on survival and dispersal of sterile flies in the field. Specifications and methods have been expanded to include genetic sexing strains of *C. capitata* and additional species, including *Anastrepha* and *Bactrocera.* In some cases, standard values have not been cited for species known to be in mass production. In these instances, readers are encouraged to submit data for inclusion in future revisions of the manual.

Rationale for Updating Previous Manual

Previous manuals were intended to provide standardised procedures for routine

checks of the product of the rearing process. The tests that they outlined were, accordingly, designed to assess emergence, flight ability, mating propensity and indices of the basic viability of the mass-reared flies. In particular, the tests were not intended to address mating competitiveness and compatibility or post-mating factors, although the authors noted the need to run regular tests in those areas.

In the years that followed, results of the tests became equated with overall fly quality and competitiveness, at least for Mediterranean fruit fly SIT programs in the United States. Recent research suggests that lapses in mating compatibility are a likely cause of poor performance by sterile males in the field and, when severe, can result in the failure of SIT programs.

The most important part of the QC program is to assure that the mass reared sterile males interact successfully with the wild females of the target population. To assure that the sterile males are competitive and compatible with the wild females, field evaluations must be conducted routinely. These tests should include, if possible, wild flies collected from the area where releases are to occur or conducted in the location which is a likely source of introductions. Because this activity is critical to program success, sufficient funding and other resources must be allotted for this purpose. The full-time staff dedicated to conducting field evaluations should include personnel trained in behavioral and ecological aspects of fruit fly biology.

Future Plans to Update This Manual

In response to the recommendation made by the experts in 1997, updates to this manual are anticipated as improvements are made. In this regard a Cooperative Research Project sponsored by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture will begin in 1999 and continue through 2003 to standardize and improve quality control (QC) tests, data management and information exchange on a global level.

This manual and future revisions will soon become available through the Joint FAO/IAEA Division Home Page on the Internet at the following URL: http:// www.iaea.or.at/ programmes/ rifa. Plans have been made in the coming year to distribute the manual on CD-ROM. At this time, no cost information is available.

For further information and copies of the manual on paper or CD-ROM, please contact Patrick Gomes, Insect & Pest Control Section, Joint FAO/IAEA Division at P.Gomes@iaea.org.

I. PUBLICATIONS (1997-98)

Special Items

The South American Fruit Fly *Anastrepha fraterculus* (Wied.); Advances in artificial rearing, taxonomic status and biological studies. IAEA TECDOC-, 206pp (in press)

Franz, G., Willhoeft, U., Kerremans, Ph., Hendrichs, J., Rendon, P. Development and application of genetic sexing systems for the Mediterranean fruit fly based on a temperature sensitive lethal mutation. In: Evaluation of genetically altered medflies for use in sterile insect technique programmes (Ed: IAEA) Proceedings of the final Research Co-ordination Meeting, Clearwater, Florida, 11-13 June, 1994, IAEA, p85-95. (1997)

Genetic engineering technology for the improvement of the sterile insect technique 78pp. (IAEA TECDOC-993) (1997)

Control of the Mediterranean Fruit Fly in the Near East Region Using the Sterile Insect Technique. 76pp. (STI/PUB/ 1020) (1997)

Publications in Scientific Journals and Conference Proceedings (1997-98)

Bakri, A., Hadis, H, Epsky, N. D., Heath, R. R., Hendrichs, J. Female *Ceratitis capitata* (Diptera: Tephritidae) capture in a dry trap baited with a food-based synthetic attractant in an argan forest in Morocco. Part I: Low population field test. Can. Entomol. 130 (1998) in press

Cáceres, C., Fisher, K., Rendon, P. Mass rearing of the medfly temperature sensitive lethal genetic sexing strain. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Cayol J.P., Changes in behaviour and some life traits of tephritid species caused by mass rearing. In: M. Aluja & A. Norrbom (Eds.). Fruit Flies (Tephritidae): Phylogeny and evolution of behavior. CRC Press. (in press)

Cayol J.P., World-wide sexual compatibility in medfly and its implications for SIT. In Area-Wide Management of Fruit Flies and Other Major Insect Pests. (in press)

Cayol J.P., J. Vilardi, E. Rial and M. T. Vera, New indices and method to measure the sexual compatibility and mating performance of medfly (Diptera: Tephritidae) laboratory reared strains under field cage conditions. J. Econ. Entomol. (1999) (in press)

Cayol J.P. & Zarai M. Field releases of two genetic sexing strains of the Mediterranean fruit fly in two isolated oases of Tozeur Governorate, Tunisia. J. Appl. Entomol. (in press)

Epsky, N. D., Hendrichs, J. , Katsoyannos, B. I., Vásquez, L. A., Ros, J. P., Zümereo□lu, A, Pereira, R., Bakri, A., Heath, R. R. Field evaluation of female-targeted trapping systems for *Ceratitis capitata* (Diptera: Tephritidae) J. Econ. Entomol. (1998) in press

Fisher, K. Genetic sexing strains of Mediterranean fruit fly (Diptera: Tephritidae): Optimizing high temperature treatment of mass-reared temperature-sensitive lethal strains. J. Econ. Entomol. 91 (in press).

Fisher, K., Cáceres, C. A filter rearing system for mass reared medfly. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Franz, G., Fisher, K. Modifications of the genetic sexing strains based on the experience gained in the mass rearing of such strains. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Gomes, P. J., Ravins, E., Bahdousheh, M. Area-wide control of medfly in the lower Jordan rift valley. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Grant, G. H., Snow, J. W., Vargas, M. A screwworm eradication programme for Jamaica and other Caribbean nations. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Heath, R. R., Epsky, N. D., Hendrichs, J., Bakri, A., Barnes, B., Camacho, H., Jeronimo, F., Katsoyannos, B. I., Montoya, P., Pereira, R., Ros, J. P., Rössler, Y, Seewooruthun, S. I., Vásquez, L. A., Vattuone, E. M., Zümereo□lu A. Evaluation of female Mediterranean fruit fly (*Ceratitis capitata*) synthetic attractant system for trapping and sterility assessment in thirteen countries. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Kabayo, J. P., Feldmann, H. U. Potential for area-wide control or eradication of tsetse in Africa. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Katsoyannos, B. I., Papadopoulos, N. T., Hendrichs, J., Wornoayporn, V. Comparative response to citrus foliage and citrus fruit odour by wild and mass-reared sterile Mediterranean fruit fly males of a genetic sexing strain J. Appl. Entomol. (1998) in press.

Katsoyannos, B. I., Papadopoulos, N. T., Kouloussis, N. A., Heath, R., Hendrichs, J. A method of assessing the fertility of wild *Ceratitis capitata* (Diptera: Tephritidae) females for use in Sterile Insect Technique programmes. J. Econ Entomol. (1998) in press

Mebrate, A., Feldmann U. Integrating the Sterile Insect Technique to eradicate tsetse from the southern rift valley of Ethiopia. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Msangi, A. M., Saleh, K. M., Kiwia, N., Mussa, W. A., Mramba, F., Juma, K. G., Dyck, V. A., Vreysen, M. J. B., Parker, A. G., Feldmann, H. U., Zhu, Z-R., Pan, H. Success in Zanzibar: Eradication of tsetse. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press).

Opiyo, E., Luger, D., Kubelka, H., Robinson, A. S. New systems for the large scale production of male tsetse flies. In: Area-Wide Management of Fruit Flies and Other Major Insect Pests (in press)

Yuval, B., Hendrichs, J. Behavior of flies in the genus *Ceratitis*. In: M. Aluja & A. Norrbom (Eds.) Fruit Flies (Tephritidae): Phylogeny and Evolution of Behavior. CRC Press (in press)

Bailey, S. Tsetse fly eliminated on Zanzibar. Nucl. News, p56-61 (January 1998)

Hendrichs, M. A., Hendrichs, J Perfumed to be killed: Interception of Mediterranean Fruit Fly (Diptera: Tephritidae) sexual signalling by predatory foraging wasps (Hymenoptera: Vespidae). Ann. Entomol. Soc. Am. 91(1998): 228-234.

Willhoeft, U., Mueller-Navia, J., Franz, G., Analysis of the medfly sex chromosomes by microdissected DNA probes, Genome 41(1998):74-78

Cayol J.P., Buyckx E.J., Loussaief F., Zaraï M., Boukhari M. & Arfaoui T. Control of Mediterranean fruit fly with Vienna 43/44 *tsl* sterile males only in Tunisian oases. In: Proc. IOBC/WPRS Int. Open Meet. - Working group "Fruit flies of economic importance", Lisbon, Portugal, 22-24 Sept. 1997. IOBC/WPRS Bull., 20(8) (1997): 219-232.

Dyck, V.A., Juma, K.G., Msangi, A.R., Saleh, K.M., Kiwia, N., Vreysen, M.J.B., Parker, A. G., Hendrichs, J., Feldmann, U. Eradication of the tsetse fly *Glossina austeni* by the Sterile Insect Technique (SIT) in Zanzibar - could South Africa be next? In: Insects in African Economy and Environment. (Proceedings of the Joint Congress of the Entomological Society of Southern Africa (11th congress) and the African Association of Insect Scientists (12th congress)) Robertson, H. G. (Ed.) Entomological Society of Southern Africa, Pretoria, South Africa (1997) (abstract)

Gomes, P Can Area-Wide Control of the Mediterranean Fruit Fly Using Sterile Insects Lead to Establishing Pest Free Areas in the Near East? Arab J. Plant Prot. 15(2) (1997) 134-139.

Fisher, K. Irradiation effects in air and in nitrogen on Mediterranean Fruit Fly (Diptera: Tephritidae) pupae in Western Australia. J. Econ. Entomol. 90 (1997): 1609-1614.

Gooding, R. H., Feldmann, U., Robinson, A. S. Care and maintenance of tsetse colonies. In: The molecular biology of insect disease vectors: a methods manual. Ed Crampton, J. M., Beard, C. B., Louis, C. London, UK, Chapman & Hall Ltd. (1997)

Mansour, M., Franz, G. Gamma radiation as a quarantine treatment for the medfly, *Ceratitis capitata* (Wied) (Diptera: Tephritidae). J. Econ. Entomol. 89 (1997): 1175-1180

Robinson, A.S. The potential role of the International Atomic Energy Agency in the development of a sterile insect programme for mosquitoes. In: 2nd Global Meet on Parasitic Diseases, Hyderabad (1997), (abstract).

Willhoeft, U., Fluorescence *in situ* hybridization of ribosomal DNA to mitotic chromosomes of tsetse flies (Diptera: Glossinidae: Glossina), Chromosome Res. 5 (1997):262-267.

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