Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Insect Pest Control Newsletter

No. 75 July 2010

http://www-naweb.iaea.org/nafa/ipc/index.html
http://www.fao.org/ag/portal/age-index.html

ISSN 1011-274X

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IAEA
International Atomic Energy Agency

Anopheles *mosquito obtaining a blood meal. IAEA Member States have been requesting the review of the potential of applying the sterile insect technique (SIT), as an additional tool for managing selected* Anopheles *vectors, as part of an integrated approach to be applied in special situations in sub-Saharan Africa.*

To Our Readers

In our last newsletter we reported that the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture is experiencing important changes as part of a major reform process that is ongoing at FAO since 2009, and which will be fully implemented by 2013, resulting in a more responsive and modern organization.

Also at IAEA restructuring is taking place as a result of IAEA's new leadership and external reviews that made positive recommendations. These changes directly affect the operations of the Joint Division. Up to the end of 2009, the IAEA Laboratories in Seibersdorf and Monaco were administratively under separate management, although programmatically they always have been part of their respective Divisions at headquarters. This double leadership in the management structure was a source of inefficiencies in what should be seamless programme operations. As of 1 January 2010, in order to streamline, simplify and harmonize lines of authority and accountability, laboratory activities and staff have been aligned with their respective programmes.

In the case of the FAO/IAEA Agriculture & Biotechnology Laboratories in Seibersdorf, this means that its five units (including the Entomology Unit) have been fully integrated into the respective subprogrammes under the Director of the Joint Division, who was given full authority and accountability for all programmatic and administrative functions regarding the management of the activities of the FAO/IAEA Laboratories. It is expected that this streamlining will lead to more opportunities for Seibersdorf staff to play a greater role in programme development and will result in improved programme delivery to our Member States. You will notice in this newsletter that, as part of the streamlining, the name of the Entomology Unit, which has been in use since the 1960s, has been officially changed to Insect Pest Control Laboratory (IPCL). Aside from the name change we do not anticipate any real changes in the implementation of the subprogramme.

As each year, we have once more issued the extensive annual Activities Report on the methods development and other entomological activities carried out at the FAO/IAEA Agriculture & Biotechnology Laboratories in Seibersdorf. You can find the 2009 report (see picture) on our website together with reports of previous years as of 1996 (http://www-naweb.iaea.org/nafa/ipc/public/newsletters-ipc.html). As it covers the year 2009 it is still entitled 'Entomology Unit Activities Report', while for the 2010 report the name will change to 'Insect Pest Control Laboratory Activities Report'.

One of the external evaluations of the Joint FAO/IAEA Programme was on 'Comparative Assessment of Nuclear Technologies'. We are pleased to report that the external panel of experts confirmed the strategic and technological direction of the Joint Division, and provided good to excellent ratings for its involvement in 82% of the 76 different combinations of nuclear technologies/applications currently supported by the Joint Divisions activities (including 8 in the area of insect pest control). They were found to be relevant and contributing to solving food and agriculture problems of Member States (MS), with strong advantages over other non-nuclear alternatives.

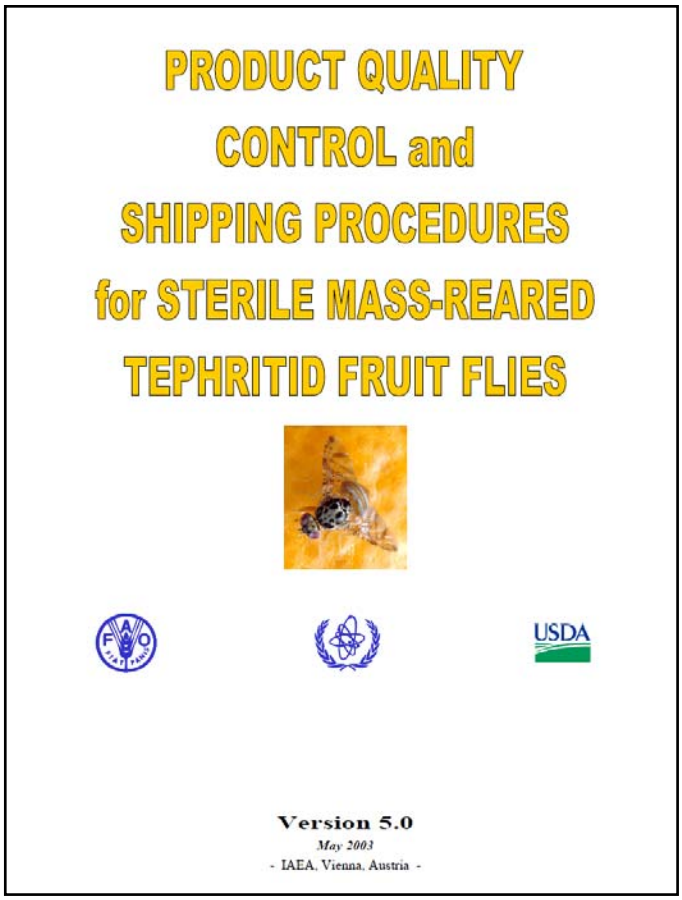
This review also strongly endorsed the role of the Seibersdorf FAO/IAEA Agricultural & Biotechnology Laboratories as a centre of excellence and commended its work as being of high visibility and quality. It also recommended, in light of the recent trend in increased regulation on radiation sources and international transport problems resulting in MS facing problems of limited access to gamma-ray sources, which have conventionally been used in food irradiation, mutation breeding and SIT projects, that other radiation methods for these applications such as X rays and electron beam need to be developed by the IAEA. Therefore the external evaluators acknowledged the importance of the work done on validating the use of an X-ray machine at the IPCL and recommended the need for future work to develop more alternatives in that area.

We would like to remind you that we will be hosting from 19-22 October 2010 in Vienna the 12th Workshop of the International Organization of Biological Control's Global Working Group on Arthropod Mass Rearing and Quality Control (see details of the meeting under http://www.tinyurl.com/amrqcreg). We expect at this international meeting ca. 100 participants, including representatives from the private sector that has been emerging significantly over the last decades in this field. It will be held in collaboration with the Association of Natural Biocontrol Producers (ANBP), the American Society for Testing and Materials (ASTM) Subcommittee on Natural Multi-Cellular Biological Control Organisms, the International Biocontrol Manufacturers Association (IBMA), and Invertebrate Biocontrols Group.

This international meeting will focus on the principles and practices of quality assurance and all issues related to moving from small scale to industrial production of high-quality entomophagous and phytophagous insects, mites and nematodes for biological control, SIT, research and other current and future applications. There are many common problems and issues when rearing natural enemies and sterile insects, particularly in the field of formalizing and standardizing quality control protocols. We hope that the meeting will lead to enhanced interaction between the leaders in natural enemies' rearing and the rearing for SIT applications. It also offers the opportunity to present to the biological control community some of the uses of nuclear techniques for the rearing of natural enemies and their deployment. For more information

please contact Andrew Parker (A.Parker@iaea,org) who is our focal point for this event.

In collaboration with USDA, and in conjunction with the above international meeting in Vienna on Arthropod Mass-Rearing and Quality Control, a consultants meeting is planned to revise version 5.0 (2003) of the widely used FAO/IAEA/USDA Manual for '*Product Quality Control and Shipping Procedures for Sterile Mass-reared Tephritid Fruit Flies*' (http://www-naweb.iaea.org/nafa/ipc/public/ipc-mass-reared-tephritid.html). There has been much advance in this field over the last seven years since version 5 was developed, and there are a number of proposals to upgrade relevant sections of this manual. We have already contacted fruit fly workers to submit suggestions and proposals for improvement. All suggestions will be compiled before the consultants meeting, at which they will be reviewed to reach consensus on all proposed changes. Experienced experts in quality management from operational fruit fly SIT programmes are welcome to participate.



In terms of new publications, I would like to call your attention to the Supplement of the Malaria Journal on 'Development of the Sterile Insect Technique for African Malaria Vectors' (volume 8, Supplement 2, Nov. 2009), which is freely available under http://www.malariajournal.com/supplements/8/S2.

It reviews the potential of applying the sterile insect technique (SIT), as an additional tool, for managing selected *Anopheles* vectors as part of an integrated approach in special ecological situations in sub-Saharan Africa.

As the efficiency of the SIT increases with decreasing vector-population densities it can effectively complement insecticide-treated bednets and indoor residual spraying, which target mainly females, but not the sterile males. Improved mass-rearing, release and monitoring methods under development as part of the SIT package will furthermore also benefit other genetic approaches being developed against mosquitoes using molecular techniques. This supplement gives mosquito researchers and public health authorities information about the state-of-the-art as well as the specific challenges and requirements for eventual successful implementation of the SIT.

Another publication to be highlighted contains the 'Proceedings of an FAO/IAEA Coordinated Research Project (CRP) on Improvement of Codling Moth SIT to Facilitate Expansion of Field Application'. Codling moth, *Cydia pomonella*, is a key pest in temperate regions of all major continents, attacking most pome fruit (apple, pears, and quince), and some walnut orchards. The proceedings present the progress made during the CRP on improving SIT application against this important pest, in particular sterile moth quality and management, and also contributed to a better understanding of the basic genetics of codling moth with the aim of eventually developing genetic sexing strains. The 12 papers of the proceedings can be found in a special issue (volume 134 (3): 163-273) of the Journal of Applied Entomology.

With respect to staffing, I'm pleased to announce that Jeremie Gilles has been appointed as research leader of the mosquito group of the Insect Pest Control Laboratory. He was previously working in the mosquito group as a consultant and the group will greatly benefit from his leadership, his experience, and his enthusiasm. Another welcome addition to the mosquito group is Hanano Yamada, who as a cost-free US-paid junior professional officer, will work on the genetic sexing strain of *Anopheles arabiensis*, the selection of potential markers, and on the mating behaviour and competitiveness of sterile male mosquitoes.

In closing I would like to remind our readers that we much value the comments we receive from them and look forward to your inputs, particularly in view that we are currently in the process of developing the programme of activities and budget for the cycle 2012-2013.

Jorge Hendrichs
Head,
Insect Pest Control Section
July 2010

Insect Pest Control Subprogramme

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Forthcoming Events (2010-2011)

I. Research Coordination Meetings (RCMs) of Coordinated Research Projects (CRPs)

Third RCM of CRP on Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens. 26-30 July 2010, Nairobi, Kenya.

First RCM of CRP on Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade. 2-6 August 2010, Vienna, Austria.

Second RCM of CRP on Increasing the Efficiency of Lepidoptera SIT by Enhanced Quality Control. 15-19 November 2010, Stellenbosch, South Africa.

Final RCM of CRP on Development of Standardized Mass-Rearing Systems for Male *Anopheles arabiensis* Mosquitoes. 7-11 March 2011, St. Denis, La Réunion, France.

Second RCM of CRP on Development of Generic Irradiation Doses for Quarantine Treatments. 11-15 April 2011, College Station, Texas, USA.

Second RCM of CRP on Development and Evaluation of Improved Strains of Insect Pests for SIT. 16-20 May 2011, Nanjing, China.

Third RCM of CRP on Biology of Male Mosquitoes in Relation to Genetic Control Programmes. 3-7 October 2011, Bologna, Italy.

Third RCM of CRP on Applying GIS and Population Genetics for Managing Livestock Insect Pests. 10-14 October 2011, Bobo Dioulasso, Burkina Faso.

II. Consultants and Expert Meetings

Technical Panel on Phytosanitary Treatments under the International Plant Protection Convention, FAO. 26-30 July 2010, Tokyo, Japan.

Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies under the International Plant Protection Convention, FAO. 4-8 October 2010, Vienna, Austria.

Consultants Meeting to Update International FAO/IAEA/USDA Manual on 'Product Quality Control and Shipping Procedures for Sterile Mass-reared Tephritid Fruit Flies' 18-22 October 2010, Vienna, Austria.

Consultants Meeting on the Role of Bacteria on Nutritional Status and Reproductive Success in Fruit Fly Pests in Support of SIT Application. 7-11 February 2011, Vienna, Austria.

Consultants Meeting on Enhancing Vector Refractoriness to Trypanosome Infection. 4-8 April 2011, Vienna, Austria.

Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies under the International Plant Protection Convention, FAO. 5-9 September 2011, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Workshop on Genotyping Analysis of Tsetse Fly Symbionts and Pathogens. 20-24 July 2010, Nairobi, Kenya.

XX Curso Internacional Sobre Moscas de la Fruta. 16-27 August 2010, Metapa de Dominguez, Chiapas, Mexico.

8th International Symposium on Fruit Flies of Economic Importance. 26 September - 1 October 2010, Valencia, Spain. (http://www.fruitflyvalencia2010.org).

FAO/IAEA National Coordinators Meeting / Workshop on Standardised Entomological Monitoring of Old World Screwworm (OWS) Flies (*Chrysomya bezziana*), (under TC Project RAS5054). 27-29 September 2010, Muscat, Oman.

12th Workshop of the IOBC Global Working Group on Arthropod Mass Rearing & Quality Control (AMRQC). 19-22 October 2010, Vienna, Austria. (http://www.tinyurl.com/amrqcreg)

Standards Committee Meeting, International Plant Protection Convention, FAO. 1-5 November 2010, Rome, Italy.

VI Curso Internacional de Capacitação em Moscas das Frutas de Importância Económica e Quarentenária, 3-12 November 2010, Juazeiro (Bahia) and Petrolina (Pernambuco), Brazil.

FAO/IAEA Workshop on Evaluation of Field Cages for Lepidoptera SIT Behavioural Assessments. 21-22 November 2010, Stellenbosch, South Africa.

FAO/IAEA Regional Training Course on Surveillance Strategies for and Diagnosis of Tephritid Fruit Fly Pest Species in the Asian and the Pacific Regions (under TC Project RAS5052). 22-26 November 2010, Brisbane, Australia.

Past Events (2009-2010)

I. Research Coordination Meetings (RCMs) of Coordinated Research Projects (CRPs)

Second RCM of CRP on Improving SIT for Tsetse Flies Through Research on their Symbionts and Pathogens. 16-20 February 2009, Bobo Dioulasso, Burkina Faso.

First RCM of CRP on Increasing the Efficiency of Lepidoptera SIT Through Enhanced Quality Control. 27 April-1 May 2009, Christchurch, New Zealand.

Final RCM of CRP on Improving Sterile Male Performance in Fruit Fly Sterile Insect Technique (SIT) Programmes. 21-25 September 2009, Pereybere, Mauritius.

Final RCM of CRP on Development of Mass-Rearing for New World (*Anastrepha*) and Asian (*Bactrocera*) Fruit Fly Pests in Support of Sterile Insect Technique (SIT). 21-25 September 2009, Pereybere, Mauritius.

Third RCM of CRP on Development of Standardized Mass-Rearing Systems for Male *Anopheles arabiensis* Mosquitoes. 21-25 September 2009, Bologna, Italy.

First RCM of CRP on Development of Generic Irradiation Doses for Quarantine Treatments. 5-9 October 2009, Vienna, Austria.

First RCM of CRP on Development and Evaluation of Improved Strains of Insect Pests for SIT. 16-20 November 2009, Vienna, Austria.

Second RCM of CRP on Biology of Male Mosquitoes in Relation to Genetic Control Programmes. 1-5 February 2010, Vienna, Austria.

Second RCM of CRP on Applying GIS and Population Genetics for Managing Livestock Insect Pests. 22-26 February 2010, Bali, Indonesia.

II. Consultants and Expert Meetings

Workshop on Suppressing the Mediterranean Fruit Fly by Integrating the Sterile Insect Technique on an Area-Wide Basis in Neretva Valley (Croatia and Bosnia and Herzegovina). 13-15 January 2009, Metković, Croatia.

Technical Panel on Phytosanitary Treatments under the International Plant Protection Convention, FAO. 26-30 January 2009, Tokyo, Japan.

Consultants Meeting to Develop a Design Concept for a Tsetse Fly Aerial Release System. 3-5 February 2009, Vienna, Austria.

Workshop on DNA Isolation and Detection of Tsetse Pathogens and Symbionts Using PCR. 9-13 February 2009, Bobo Dioulasso, Burkina Faso.

Workshop on Assessment of the Feasibility of SIT-Based Area-Wide Integrated Management of Old World Screwworm Flies in the Middle East. 17-19 March 2009, Vienna, Austria.

Planning Meeting for Coordination of Activities of IRD, CRVOI and the FAO/AIEA in Relationship to Feasibility of Mosquito Sterile Insect Technique for La Réunion. 22-24 March 2009, Vienna, Austria.

Consultants Meeting on Development of a Standard Planning and Design Format for New SIT Mass-Rearing Facilities. 20-24 April 2009, Vienna, Austria.

Consultants Meeting on Improved Understanding of *Bactrocera* and *Anastrepha* Pests Species Complexes for Enhanced SIT Application to Facilitate International Trade. 6-10 July 2009, Vienna, Austria.

Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies under the International Plant Protection Convention, FAO. 31 August-4 September 2009, Vienna, Austria.

Consultants Meeting on Development of Generic Design for Mosquito Mass-Rearing Facility. 3-7 May 2010, Vienna, Austria.

Consultants Meeting on Applications of Area-wide IPM Programmes as Part of Systems Approaches for Pest Risk Management. 7-11 June 2010, Vienna, Austria.

III. Other Meetings/Events

PATTEC/FAO/IAEA Tsetse Management Training Course. 23 February–13 March 2009, Mansini, Swaziland.

Eleventh Pacific Science Intercongress. Pacific Countries and their Ocean: Facing Local and Global Changes. 2-6 March 2009, Tahiti, French Polynesia.

Fourth Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 30 March-3 April 2009, Rome, Italy.

Standards Committee Meeting, International Plant Protection Convention, FAO. 4-8 May 2009, Rome, Italy.

Meeting of Programme Against African Trypanosomiasis (PAAT) Programme Committee Meeting. 7-8 May 2009, Smolenice, Slovakia.

Fourth Meeting of the IOBC, Working Group on Integrated Plant Protection in Olive Crops. 1-4 June 2009, Córdoba, Spain.

UN Workshop on Science and Food Security, 2 July 2009, Geneva, Switzerland.

FAO/IAEA Meeting of Asia Regional Project Coordinators on Assessing Feasibility for Area-Wide SIT-Based Control of the Mediterranean Fruit Fly in the Middle East, 4-6 August 2009, Vienna, Austria.

42nd Annual Meeting of the Society for Invertebrate Pathology. 16-20 August 2009, Salt Lake City, Utah, USA.

XIX Curso Internacional Sobre Moscas de la Fruta. 17-28 August 2009, Metapa de Dominguez, Chiapas, Mexico.

First National Coordinators Meeting of TC project RLA5057 'Establishing and Maintaining Fruit Fly Free and Low Prevalence Areas in Central America, Panama and Belize, Using the Sterile Insect Technique (SIT)'. 18–21 August 2009, Guatemala City, Guatemala.

30th Meeting of International Scientific Council for Trypanosomiasis Research and Control (ISCTRC). 21-25 September 2009, Kampala, Uganda.

FAO/IAEA Regional Indian Ocean Fruit Fly Meeting. 21-25 September 2009, Pereybere, Mauritius.

VI Curso Internacional de Capacitação em Moscas das Frutas de Importância Económica e Quarentenária, 21-29 October 2009, Juazeiro (Bahia) and Petrolina (Pernambuco), Brazil.

Symposium: The Sterile Insect Technique, an Environment-Friendly Control Tactic for Preventing the Establishment of Invasive Pest Insects at International Congress on Biological Invasions. 2-6 November 2009, Fuzhou, China (www.icbi2009.org).

FAO/IAEA Regional Training Course on Area-wide Integrated Pest Management of Tephritid Fruit Flies (under TC Project RAS5052). 2-6 November 2009, Fuzhou, China.

Meeting of Programme Against African Trypanosomiasis (PAAT) Advisory Group Coordinators. 1-3 December 2009, Mombasa, Kenya.

Workshop to Develop a Detailed Action Plan for the Collection of Entomological Baseline Data for Tsetse Management in Southern Mozambique (under TC Project RAF5059), 7-18 December 2009, Maputo, Mozambique.

Symposium: The Sterile Insect Technique: Achievements and Challenges for Area-Wide Integrated Pest Management at Annual Meeting of the Entomological Society of America. 13-16 December 2009, Indianapolis, Indiana, USA (www.entsoc.org/am/index.htm).

Coordinators Meeting / Workshop on Standardised Collection, Processing and Differential Diagnosis of Old World Screwworm (OWS) Fly (*Chrysomya bezziana*) Larvae (under TC Project RAS5054). 13-16 December 2009, Muscat, Oman,

FAO/IAEA Regional Training Course on Surveillance of Tephritid Fruit Flies in Support of Planning and Implementing Area-wide Integrated Pest Management Programmes (under TC Project RAS5052). 18-22 January 2010, Bangkok, Thailand.

FAO/IAEA/PATTEC Regional Training Course on Standardised Collection and Processing of Entomological and other Relevant Geo-Referenced Data as Needed in SIT-Based AW-IPM Campaigns against Tsetse (under TC Project RAF5060). 1-19 February 2010, Bobo-Dioulasso, Burkina Faso.

FAO International Conference on Agricultural Biotechnologies in Developing Countries: Options and Opportunities in Crops, Forestry, Livestock, Fisheries and Agroindustry to face the Challenges of Food Insecurity and Climate Change (ABDC-10). 1-4 March 2010, Guadalajara, Mexico.

Fifth Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 22-26 March 2010, Rome, Italy.

FAO/IAEA National Coordinators Meeting / Workshop on Area-Wide Management of Fruit Fly Pests, (under TC Project RAS5052). 12-14 April 2010, Muscat, Oman.

31st FAO Regional Conference for Latin America and the Caribbean (LAC). 26-30 April 2010, Panama City, Panama.

Standards Committee Meeting, International Plant Protection Convention, FAO. 26-30 April 2010, Rome, Italy.

Training Course on Taxonomía, Ecología y Control de Moscas de Importancia Económica, 3-14 June 2010, Panama City, Panama.

FAO/IAEA Regional Training Course on Collection of Baseline Data for the Planning and Implementing of Tsetse Area-wide Integrated Pest Management in Southern and Eastern Africa (under TC Project RAF5059). 7-24 June 2010, Maputo, Mozambique.

XI Commissioners meeting of the Panama-United States Commission for the Eradication and Prevention of Screwworm. 8-9 June 2010, Panama City, Panama.

National Coordinators Meeting of TC project RAF5059 'Supporting the Creation of a Tsetse-Free Zone in Southern Mozambique and North-East South Africa'. 28-30 June 2010, Maputo, Mozambique.

Note: Reports available upon request

Technical Cooperation Field Projects

The Insect Pest Control Subprogramme currently has technical responsibilities for the following technical cooperation projects that are managed by the IAEA's Department of Technical Cooperation. They can be classed under five major topics, namely:

- Fruit Flies
- Mosquitoes
- Moths
- Screwworm Flies
- Tsetse Flies

Project Number	Country	Title	Technical Officer
AFG5004	Afghanistan	Enhancing Crop Productivity Through Mutation Breeding and Pest Control	Rui Cardoso Pereira
BOT5004	Botswana	Establishment of a Capacity for Integrating the Sterile Insect Technique into the National Tsetse and Trypanosomosis Control Programme	Udo Feldmann
BRA5057	Brazil	Establishment of Medfly, Fruit Fly Parasitoids and Codling Moth Rearing Facility	Rui Cardoso Pereira
BZE5002	Belize	Establishment of a Pilot Fruit Fly Free Area Using an Integrated Approach that Includes the Area-Wide Sterile Insect Technique	Jesús Reyes
CHD5002	Chad	Assessing the Feasibility of Using Sterile Insect Technique Components to Create a Tsetse-Free Zone in the Mandoul Region	Udo Feldmann
ETH5015	Ethiopia	Creating a Tsetse-Free Zone in the Southern Rift Valley	Udo Feldmann
GUA5016	Guatemala	Establishment of Fruit Fly Free or Low Prevalence Areas using the Sterile Insect Technique	Jesús Reyes
ISR5015	Israel	Strengthening the Capacity to Use the Sterile Insect Technique for the Olive Fruit Fly	Andrew Jessup
JOR5010	Jordan	Strengthening the Capacity for the Area-wide Suppression of the Mediterranean Fruit Fly Using the Sterile Insect Technique	Jesús Reyes
KEN5022	Kenya	Integrated Area-wide Tsetse and Trypanosomosis Management in Lambwe Valley	Udo Feldmann
MAG5017	Madagascar	Developing Strategies for Integrated Management of Fruit Flies Based on the Sterile Insect Technique (SIT)	Rui Cardoso Pereira
MAR5016	Mauritius	Feasibility Study for the Suppression of the Melon Fly (*Bactrocera cucurbitae*) in Selected Areas of Mauritius	Jorge Hendrichs
MEX5029	Mexico	National Prevention Campaign Against the Cactus Moth	Rui Cardoso Pereira
MOR5031	Morocco	Controlling the Mediterranean Fruit Fly Using the Sterile Insect Technique and Other Conventional Methods	Jesús Reyes
MYA5014	Myanmar	Support for a Feasibility Study on Using the Sterile Insect Technique against Diamond Back Moth	Jesús Reyes

PAK5043	Pakistan	Development of Biological Control for Cotton Pest Management Using Nuclear Techniques	Jorge Hendrichs
PAN5018	Panama	Maintaining and Operating a Medfly-Free Area, Implementing a Fruit Fly Emergency Plan, and Suppressing *Anastrepha* spp. Fruit Flies in the Azuero Peninsula Using the Sterile Insect Technique	Jesús Reyes
RAF5059	Regional Africa	Supporting the Creation of a Tsetse-Free Zone in Southern Mozambique and North-East South Africa	Marc Vreysen Rui Cardoso Pereira
RAF5060	Regional Africa	Supporting the Use of the Sterile Insect Technique for Area-Wide Tsetse and Trypanosomosis Management (Phase II)	Udo Feldmann
RAS5051	Regional Asia	Developing Integrated Control of the Olive Fruit Fly	Andrew Jessup
RAS5052	Regional Asia	Sharing Regional Knowledge on the Use of the Sterile Insect Technique within Integrated Area-Wide Fruit Fly Pest Management Programmes	Rui Cardoso Pereira
RAS5053	Regional Asia	Assessing Feasibility for Area-Wide SIT-Based Control of the Mediterranean Fruit Fly in the Middle East	Jesús Reyes
RAS5054	Regional Asia	Contributing to the Assessment of the Feasibility of SIT-Based Area-Wide Integrated Management of Old World Screwworm Flies in the Middle East	Udo Feldmann
RER5014	Regional Europe	Suppressing the Mediterranean Fruit Fly by Integrating the Sterile Insect Technique on an Area-Wide Basis in Neretva Valley of Croatia and Bosnia and Herzegovina	Rui Cardoso Pereira
RLA5057	Regional Latin America	Establishing and Maintaining Fruit Fly Free and Low Prevalence Areas in Central America, Panama and Belize, Using the Sterile Insect Technique (SIT) (ARCAL CVI)	Jesús Reyes
SAF5011	South Africa	Refining an Integrated Application of SIT Against Some Key Lepidopteran Pests of Southern African Agricultural Crops	Jorge Hendrichs
SEN5031	Senegal	Implementing the Pre-Operational Phase to Create a Zone Free of *Glossina palpalis gambiensis* Using the Sterile Insect Technique (SIT)	Marc Vreysen
SEY5003	Seychelles	Feasibility of Integrating the Sterile Insect Technique to the Ongoing Area-Wide Melon Fly Eradication Programme	Rui Cardoso Pereira
SUD5032	Sudan	Investigating the Use of the Sterile Insect Technique for Controlling Mosquitoes in Northern Sudan	Jeremie Gilles
TUN5026	Tunisia	Assessing the Use of Inherited Sterility as a Genetic Control Method against the Carob Moth	Marc Vreysen
UGA5031	Uganda	Assessing the Feasibility of Establishing a Tsetse Free Zone in Lake Victoria Basin	Jesús Reyes
ZIM5012	Zimbabwe	Feasibility Study on the Use of SIT to Eradicate Tsetse in Zimbabwe	Udo Feldmann

Highlights for Technical Cooperation Projects

Implementing the Pre-Operational Phase to Create a Zone Free of *Glossina palpalis gambiensis* Using the Sterile Insect Technique (SIT) (SEN5031)

The Government of Senegal has embarked on a programme to eradicate the tsetse fly *Glossina palpalis gambienis (Gpg)* from the Niayes in the western part of the country. This initiative is receiving technical advice from the Insect Pest Control Sub-programme and financial support through TC project SEN5031.

In NL 74, it was reported that the insectary that is located at the ISRA (Institut Sénégalais de Recherche Agricole) in Dakar was made operational in October 2009. Since then, *Gpg* flies from the target area have been maintained in the insectary with the aim to develop a local Senegal strain. Female flies collected in the target area were maintained in the insectary and all pupae produced were shipped to the Insect Pest Control Laboratory (IPCL) in Seibersdorf, Austria. Between October 2009 and May 2010, a total of 1240 *Gpg* pupae have been shipped from Dakar to Seibersdorf and on 31 May, the colony of the Senegal strain of *Gpg* contained 248 producing females. The process of colonization is very tedious and time consuming, but progress is good and the results obtained to date are satisfactory. This activity will continue to receive high priority in the coming months until a colony of 2000-3000 producing females has been reached. Then, sufficient pupae will be available that can be used for mating compatibility studies with flies from the colony that is maintained at the Centre International de Recherche-Développement Sur l'Elevage en Zone Subhumide (CIRDES) in Bobo Dioulasso, Burkina Faso. The Senegal strain will also serve as a seed colony should there be mating barriers with the flies from CIRDES or in case the CIRDES flies are not performing as expected in the Niayes.

In addition, equipment for *in vitro* rearing of the flies was installed in the insectary and made operational. There is no radiation source available in Dakar to decontaminate blood that could be collected from the slaughterhouse, and therefore, as an interim solution, blood is taken aseptically from two cows, which are kept at the ISRA. This blood is used for the *in vitro* feeding of the flies. In the current system, the flies that are collected from the field receive their first two blood meals on a goat, and are then transferred to the *in vitro* feeding system. Feeding response of the wild flies on the membrane is extremely good with over 80 % of the flies engorged. For the operational releases, other methods for blood decontamination such as the use of UV are being considered.

Efforts have been undertaken to initiate the trial releases with fly material originating from CIRDES, but some problems were encountered with the handling and irradiation protocols that were developed. The pupae were shipped with a courier service and the entire transport (Bobo Dioulasso – Dakar) time took no more than 48 hours. It appeared that the climatic conditions in the insectary of CIRDES were different from those at the IPCL, which made adherence to the developed protocols difficult. Adjustments were made to match the climatic conditions in the CIRDES insectaries with those of the IPCL, Seibersdorf. To test the validity of the proposed protocol, a trial shipment was done from Seibersdorf to Dakar. Shipping conditions were good as evidenced by a 97% emergence rate of the shipped pupae. The female flies were released in Thiès, an area where only 1 wild male was trapped during the extensive field surveys. The release of sterile females is an 'amplification method' to detect wild male populations whose densities are below the detectable level of the traps used. The sterile male flies were released in the Parc de Hann in Dakar.

Suppression trial with insecticide impregnated traps in Kayhar (top), in vitro *feeding of* Glossina palpalis gambiensis *in the insectary in Dakar (bottom, left), typical fragmented suitable tsetse habitat in the Niayes (bottom, right).*

The baseline data collection has indicated the very fragmented nature of the habitat and hence, also of the fly populations in the Niayes. It will therefore be necessary to release the sterile flies by aircraft to be able to work

area-wide. The possibility of using ULM aircraft and/or gyrocopters is being investigated. A company has been identified and discussions for collaborations are underway.

A preliminary suppression trial was initiated in October 2009 in Kayhar (i.e. most northern population of *Gpg* in Senegal) with the aim to assess the impact of insecticide-impregnated traps on the *Gpg* population in the Niayes. One polygon containing 'wet' suitable habitat of 0.7 km^2 was selected and 25 insecticide-impregnated traps were deployed. The effect of the traps on the fly population was monitored monthly. The apparent density dropped from 0.2 flies/trap/day in the first month to 0.1 fly/trap/day in the second month and has since then stabilised at 0.1 fly/trap/day.

Investigating the Use of the Sterile Insect Technique for Controlling Mosquitoes in Northern Sudan (SUD5032)

The Government of Sudan has the intention to test the feasibility of using the SIT for integration with other control tactics against *Anopheles arabiensis* mosquitoes. A project has been created that is receiving technical support from the FAO/IAEA Joint Programme and financial support under the regional TC project RAF5052 and the national TC project SUD5032. The project area is composed of a very long stretch of irrigated land along the River Nile between Dongola and Merowe in the Northern State of Sudan. The total project area is estimated at approximately 3000-5000 km^2. The Islamic Development Bank has approved a grant of USD 7.5 million for the project that includes the construction of a mass-rearing facility.

The project received a review team in February 2010, to assess the status of the project and to make recommendations for the future implementation. Over the past years, the project has focused on the collection of essential baseline data and the initiation and maintenance of a colony of *An. arabiensis*. These activities included a comprehensive survey of larval breeding sites in Dongola and Merowe, initial studies on the ecology and behaviour of *An. arabiensis*, some initial trial releases, preliminary studies on the mating behaviour of male mosquitoes, studies on the effects of rearing conditions on the lipid and glycogen reserves of male mosquitoes, studies to examine the effect of colonization on the ability of colony males to compete with wild males, and a comprehensive population genetic study to assess genetic differentiation amongst various *An. arabiensis* populations along the River Nile between Dogola and Khartoum.

The review team recommended that the project strictly adheres to the 'phased conditional approach' as was developed for tsetse and fruit fly SIT programmes. This systematic approach entails that support to a particular next phase is conditional to completion of all activities in the previous phase. The different phases are (1) Policy and strategy development, long term commitment and management structures, (2) Baseline data collection and technical feasibility assessment, (3) Preparatory and pre-operational activities and, (4) Operational implementation of AW-IPM measures. The project in Sudan is still in the phase of baseline data collection and feasibility study. Technologies that are being developed for the project in Sudan will need to be thoroughly tested and validated before becoming operational.

Semi-field cage in the project area in Dongola (top left), breeding sites in a village close to the River Nile (top right), larval rearing at the insectary in Khartoum (bottom right), and the new dam in Merowe (bottom left).

The review team also suggested that urgent action is needed to collect data on adult mosquito population densities, dynamics, ecology, behaviour, etc. In addition, adequate data need to be collected on sterile male performance (dispersal, dispersion, survival, competiveness, etc.), required overflooding ratios in relation to the rate of induced sterility in the wild female population etc. This information will be essential to properly plan the dimensions of the new mass-rearing facility and to develop an appropriate intervention strategy.

The review team likewise suggested that some of the equipment that is under development at the Insect Pest Control Laboratory (IPCL) in Seibersdorf (larval trays, tray-holding racks, new larval diet, the pupa-larva separator, oviposition cages, etc.) needs to be transferred to Sudan as soon as possible. This will allow testing this equipment under local conditions and also considerable up-scaling of the production in the current facilities up to a level of 100 000 sterile male mosquitoes per week that would allow the initiation of extensive trial releases.

Finally, the review team suggested that consideration be given to establish the new mass-rearing facility in the project area in Northern State, rather than in Khartoum, in view of the long and costly shipment of sterile males involved. It was also recommended to consider revising

the intervention strategy and to start the eventual operational release programme at the northern edge of the distribution of *An. arabiensis* north of Dongola and move the eradication front upstream towards Merowe.

Developing Integrated Control of the Olive Fruit Fly (RAS5051)

This subregional olive fly project is currently focused on Israel, Jordan and the West Bank. The pilot olive fly release in Israel is progressing well with weekly releases of sterile olive fly and monitoring and trapping studies being carried out. There are also continuous improvements being made to mass-rearing of olive fly at Bio Fly in Israel and in Seibersdorf, and these are being incorporated into the project.

Surveys are in progress to assess olive production, costs and damage incurred by olive fly, farmer questionnaires. A consultancy carried out by a Greek expert has progressed very well with authorities from Israel, Jordan and West Bank having been very cooperative in providing data, advice and assistance. The expert has obtained information on olive production in the region – areas under production, volume produced, cultivars grown, etc. in the three entities. These data will also be used to set up trapping and monitoring systems and to test different traps for the most efficient types/techniques and to make recommendations (in conjunction with the results of the TC project ISR5015: Feasibility of SIT for olive fly) for area-wide programmes with SIT for the respective production areas.

Releases of olive fruit fly in the pilot area in Israel.

The Jordanian Government and companies such as the agents for fruit fly baits are assisting olive growers because they acknowledge that olives are an important crop for Jordan (commercially and traditionally). The Government-run Olive Unit, which advises farmers and manages exports, mills, etc. is ample demonstration of its commitment. Government-organised and industry-supported field days ensure growers and the public are more aware of olive fly, organic production of olives and olive fly trapping and baiting.

It is anticipated by project workers in Jordan that olive fly SIT, as a component of area-wide integrated management, will be accepted by the community. This is so because of the increased perception of, and demand for, high quality produce that is grown with high regard to public health and the environment. There is the need to ensure that growers also see the dollar benefits of producing high quality food for both domestic and international consumption. Many farmers who grow olives for olive oil production already have seen the benefits of producing high quality as the prices for their oil in Japan, the EU and in the USA are high and returns to the growers are also very good.

Sharing Regional Knowledge on the Use of the Sterile Insect Technique within Integrated Area-Wide Fruit Fly Pest Management Programmes (RAS5052)

Under this regional project two major activities took place place in early 2010. A regional Training Course on 'Surveillance of Tephritid Fruit Flies in Support of Planning and Implementing Area-wide Integrated Pest Management Programmes' and the National Coordinators Meeting.

Group photo of the Regional Training Course participants (Bangkok, Thailand).

The Regional Training Course (RTC) was held in Bangkok, Thailand from 18 to 22 of January 2010 and was attended by 35 students from 14 Member States and consisted of lectures and laboratory and field visits, addressing the following aspects: (1) Fruit fly biology and ecology; (2) Adult surveillance systems; (3) Larval surveillance; (4) GIS as instrument for fruit fly surveillance; (5) Concept of Area-Wide Integrated Pest Management (AW-IPM); (6) Suppression techniques in an AW-IPM approach; (7) Monitoring and discrimination of released sterile flies; (8) Fruit fly activities in Thailand (by local lecturers); (9) Field visit to conduct: (a) GPS operation practice; (b) Trap placing, trap inspection and fruit sampling; (c) Local organization supporting and public information; (d) Growers cooperation in fruit flies control programme; (10) Laboratory practice in: (a) Collect the

pupae and larvae obtained from fruit sampling; (b) Practice fruit fly morphological identification of *Bactrocera* spp.; (c) Identify fruit fly species, counting, calculate to fly/trap/day and fill data sheet; (11) Exercise in groups where the participants were asked to analyse the trapping and fruit sampling data, collected in the field and laboratory, and prepare and present a short summary with the data.

The other event was a National Coordinators Meeting held in Muscat, Oman from 12-14 April 2010 that was attended by 18 participants from 15 Member States of the Asia and Pacific Region.

Group photo of the National Coordinators Meeting participants (Muscat, Oman).

The objective of the NCM was to review the national activities related to tephritid fruit flies control implemented in the participating Member States since 2007; share among participating countries methodologies and new developments, and review the work plan of RAS5052 based upon the needs of each Member State.

Each of the participating Member States presented the fruit fly activities under way in each country. The data compiled during the NCM of the previous TC project on the same subject (RAS5049) was updated and new data from the Member States participating for the first time on the NCM was added to the meeting report.

Supporting the Use of the Sterile Insect Technique for Area-Wide Tsetse and Trypanosomosis Management (Phase II) (RAF5060)

The Centre International de Recherche-Développement sur l'Élevage en zone Sub-humide (CIRDES) at Bobo-Dioulasso, Burkina Faso, has become an IAEA Collaborating Centre in 'The Use of the Sterile Insect Technique for Area-wide Integrated Management of Tsetse Fly Populations'.

From 1-19 February 2010 CIRDES hosted the FAO / IAEA / PATTEC Regional Training Course on 'Standardised Collection and Processing of Entomological and other Relevant Baseline Data'. Thirteen participants from eight T&T affected Member States benefitted from the course. The course programme addressed the following topics: Review of basic tsetse biology and taxonomy; area identification for baseline data collection; establishment of objectives for baseline data collection; design of a sampling strategy; entomological sampling devices; entomological procedures and practical exercises in a tsetse-infested habitat.

Furthermore, lectures and practical exercises were organised on the principles of geographic information systems (GIS), remote sensing (RS) and the use of global positioning systems (GPS), and the participants were introduced to GIS hard and software, the use of satellite imagery, data management; and the production of maps for day-to-day use. Other sessions dealt with tsetse population genetics and morphometrics, and with the principles of planning and implementing environmental and socio-economic baseline data surveys.

Coordinated Research Projects (CRPs) and Research Coordination Meetings (RCMs)

Project Number	Ongoing CRPs	Scientific Secretary
G3.40.01	Development of Standardised Mass-Rearing Systems for Male Mosquitoes (2005-2011)	Jeremie Gilles
D4.20.12	Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens (2007-2012)	Adly Abd Alla
G3.40.02	Biology of Male Mosquitoes in Relation to Genetic Control Programmes (2008-2013)	Jeremie Gilles
D4.20.13	Applying Population Genetics and GIS for Managing Livestock Insect Pests (2008-2013)	Udo Feldmann
D4.10.22	Increasing the Efficiency of Lepidoptera SIT Through Enhanced Quality Control (2009-2014)	Marc Vreysen
D6.20.08	Development of Generic Irradiation Doses for Quarantine Treatments (2009-2014, managed by Food and Environmental Protection Subprogramme)	Andrew Parker (co-secretary)
D4.20.14	Development and Evaluation of Improved Strains of Insect Pests for SIT (2009-2014)	Gerald Franz
	New CRP to Start in 2010	
D4.10.23	Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade (2010-2015)	Andrew Jessup

The Second RCM of CRP on *Biology of Male Mosquitoes in Relation to Genetic Control Programmes*, 1-5 February 2010, Vienna, Austria

The second RCM of this CRP was held in Vienna, Austria with the participation of scientists and observers from 14 Member States. The specific objectives of the CRP are to advance the understanding of critical (behavioural) ecological components of male mosquitoes, which is crucial to be able to produce high quality and sexually competitive sterile males in mass-rearing facilities, and to design quality control tests to assess their behaviour. Basic and applied research contributes to the foreseen implementation of mosquito SIT by studying field populations of adult male mosquitoes. This will enable establishing the specific biological and behavioural determinants that contribute to male sexual competitiveness. Many of the research activities are being expanded from the laboratory to the field.

Significant progress was reported on mosquito male premating conditions, mosquito mating systems and on the contribution of molecular/chemical approaches to better understand male mosquito mating behaviour.

Group photo of the Research Coordination Meeting participants (Vienna, Austria).

The ultimate goal of sterile male mass-releases is to succeed in the mating competition with wild males (that are adapted to their environment). Therefore, one of the most relevant indicators of males competitiveness is their mating potential. Work along this line of research will require the development of standard protocols and guidelines to explore and compare male competitiveness in the field and in the laboratory.

Source of energy as adults is also a key factor for being competitive. Work was conducted to determine what type

of food male *An. gambiae* mosquitoes use in the wild, where and when these nutrients are acquired. This work should be extended to other mosquito species (*An. arabiensis*, *Ae. aegypti*, *Ae. polynesiensis, An. sacharovi*) in a range of eco-epidemiological settings (endemic and epidemic regions). Much work remains to be done to determine the energetic status of male mosquitoes in the field and how they contribute to reproductive success. Once sources of nutrition in the field are identified, release strategies can be tailored (in space and time), to optimize male performance.

The group also stressed that the ability to study the (behavioural) ecology of male mosquitoes depends heavily on the availability of efficient sampling tools. Efficient male mosquito sampling devices (sweeping nets, resting pots, male attractants, sound trap, other) need to be developed and field validated for several species. The ability to catch males involved in sexual activity is of particular importance in order to gather specific and relevant knowledge for subsequent applications.

Mating systems encompass all the species-specific ecological, behavioural, and physiological attributes that lead to encounter, copulation, insemination and fertilization. Many lacunae remain in our understanding of mosquito mating systems. The objective of the R&D is to understand the structure of the mating systems of various mosquito species, and to correlate this to male success within these systems, which can be applied to rearing, handling and release of mass reared mosquitoes in SIT operations. The group determined 5 main research axes/goals: (1) determine the temporal and spatial characteristics of mating encounter sites of Aedine and Anopheline mosquitoes; (2) investigate the behaviours involved in courtship; (3) understand copulation, insemination and sperm storage; and (4) determine patterns of female remating, and how male performance affects this behaviour.

The molecular group agreed to contribute to the identification of the chemical nature of volatiles associated with plants that are known to be most attractive to male mosquitoes and identification of the chemical content of preferred natural diets of male mosquitoes. This knowledge could potentially enhance the ability of sterile males to locate and feed on natural sources and optimize dietary formulations for sterile males with the goal of improving survivorship, mating success or both. Follow-up studies would be needed to assess the impact of volatiles on male behaviour in olfactometers as well as the impact of dietary formulations on male survivorship and mating success.

Molecular studies based on Y chromosome molecular markers may provide important information about male population structure and male dispersal dynamics, particularly with respect to *An. gambiae* M and S forms. While several markers currently exist for *An. gambiae*, more markers are forthcoming.

The Second RCM of CRP on *Applying GIS and Population Genetics for Managing Livestock Insect Pests*. 22-26 February 2010, Bali, Indonesia

The meeting was attended by 13 researchers from 11 countries and presented the results of their research findings during the past 18 months.

With regards to myiasis flies, the presentations included reports on the Old World Screwworm fly (OWS, *Chrysomya bezziana*) situation in Yemen; OWS fly monitoring in Iraq and Indonesia; OWS fly surveillance in Australia, using methods of bulk fly trapping and molecular detection; population genetic techniques and findings applied to OWS and *Wohlfahrtia magnifica*; and spatial distribution of genetic variability in New World Screwworm flies (NWS, *Cochliomyia hominivorax*) from the Caribbean and South America.

Group photo of the Research Coordination Meeting participants (Nusa Dua, Bali, Indonesia).

Concerning the work on tsetse flies, presentations were also held on the application of GIS within the Programme Against African Trypanosomiasis Information System (PAAT-IS), with special emphasis on land cover maps and tsetse habitats, the use of global geo-spatial datasets, the mapping of human African trypanosomiasis (HAT or sleeping sickness), and GIS metadata and data sharing. Further presentations elaborated on the principles of standardised entomological baseline data collection; the distribution and response of tsetse flies to climate and landscape features in Kenya; a study of population genetics of *Glossina pallidipes* in Ethiopia; the determination of the northern distribution limit of riverine tsetse flies in Burkina Faso; an understanding of tsetse fly complexity using simulation models; and geometric morphometrics and population structure.

Two practical sessions were held on standardised application of geometric morphometrics for tsetse flies and screwworm flies, using a special digital microscope and software for 'Collection of Landmarks for Identification

and Characterization' (CLIC), downloadable from http://www.mpl.ird.fr/morphometrics/clic/clicpackage.html.

The meeting reviewed the workplans and prioritised research activities under the research contracts and research agreements for the period March 2010 through mid 2011, when the 3rd RCM under CRP D4.20.13 is scheduled to be held.

The New Coordinated Research Project on *Resolution of Cryptic Species Complexes of Tephritid Pests to Enhance SIT Application and Facilitate International Trade.*

A call to Member States to participate in this new CRP was made in October 2009. A total of 33 proposals for research contracts and research agreements were received. Of those, 22 proposals were approved (15 contracts and 7 agreements) covering the Asia-Pacific, African, European and North and South American regions. Experts in insect molecular biology, cytogenetics, morphometrics, taxonomy, ecology, behaviour and chemistry will be working together under this new CRP with the common aim to assist with the resolution of trade and SIT issues brought about by concerns over the species status of some pest fruit flies. Selected complexes of the fruit fly genera *Anastrepha*, *Bactrocera* and *Ceratitis* will be studied under this CRP.

The first RCM of this CRP will be held in Vienna, Austria (2-6 August 2010).

Proceedings of the CRP on *Improvement of Codling Moth SIT to Facilitate Expansion of Field Application*

The CRP entitled 'Improvement of Codling Moth SIT to Facilitate Expansion of Field Application' was initiated in 2001 and was completed in 2007. The CRP had the objective to improve codling moth SIT for application in orchards and nearby urban areas internationally and thereby contributing to reduce insecticide use in agriculture in general and in the rural-urban interface in particular. Also to facilitate international trade in agricultural commodities. Research focused on sterile moth quality and management and on a better understanding of the basic genetics of codling moth with the aim to develop genetic sexing strains. During the CRP, four research coordination meetings were organised and hosted by Canada, Argentina, South Africa and Brazil.

Scientists from Argentina, Armenia, Brazil, Canada, Chile, Czech Republic, Syrian Arab Republic, South Africa, Switzerland, and the USA participated in this CRP and the final research findings (12 papers) were recently published in a special issue of the Journal of Applied Entomology (volume 134 (3): 163-273), edited by M. J. B. Vreysen and A. S. Robinson, with following table of contents:

Unfortunately, the paper of I. Fukova, L. G. Neven, N. M. Barcena, N. A. Gund, M. Dalikova and F. Marec entitled 'Rapid assessment of the sex of codling moth *Cydia pomonella* (Linnaeus)(Lepidoptera) eggs and larvae', was part of the CRP but was erroneously published in an earlier issue of the Journal of Applied Entomology (133 (4): 249-261, (2009)).

Developments at the Insect Pest Control Laboratory, Seibersdorf

FRUIT FLIES

Fruit Fly Rearing Group Activities

Research and development in this group over the last six months has concentrated on streamlining production methods for a range of pest fruit fly species with a view to facilitating the transfer of insects from small-scale laboratory culture to large-scale mass-rearing colonies to be used for SIT programmes.

R&D on pest fruit fly species at Seibersdorf

- Melon fly (*Bactrocera cucurbitae*)

A consultant from Pakistan (Ishan Ul Haq) is continuing to work on melon fly. He is looking at improving sterile male performance in the field by studying the propensity for both sterile males and wild females to mate more than once. This information will have a significant impact on SIT release methods, timing of releases and the volume of sterile insects released in target areas.

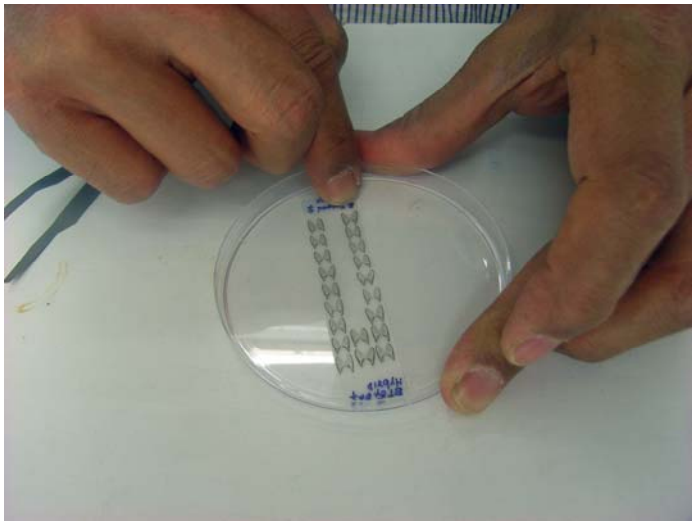
- The *Bactrocera dorsalis* cryptic species complex of pest fruit flies

The Insect Pest Control Laboratory at Seibersdorf houses laboratory-reared cultures of several pest species within this complex. They are the Oriental fruit fly *(Bactrocera dorsalis)*, the invasive fruit fly *(Bactrocera invadens)*, the Philippines fruit fly *(Bactrocera philippinensis)* and the carambola fruit fly *(Bactrocera carambolae)*.

During early 2010 wild populations of *B. dorsalis* (from Thailand), *B. carambolae* (Thailand and Suriname) and *B. papayae* (Asian Papaya fruit fly) (Thailand) and *B. correcta* (guava fruit fly, not in the *B. dorsalis* species complex but mixed in the samples of pupae received from Thailand) were received via Member State collaborators. They are now in their first generation in the laboratories at Seibersdorf.

A visiting scientist (Mark Schutze) from Australia is currently stationed at Seibersdorf and is working on various identification tools to distinguish between species within the *B. dorsalis* complex. In collaboration with the FAO/IAEA and scientists in Australia, New Zealand, South East Asia and the USA he is assessing morphometric, acoustic and behavioural differences between the species.

Experiments have shown that some of the species within the *B. dorsalis* complex can crossbreed with each other. Forced crossbreeding experiments have shown that hybrids are fertile and some are morphologically distinct from their parents (see figure).



Wings of fruit fly hybrids of the Bactrocera dorsalis *complex for wing morphometrics analysis.*

Simulated field experiments, in field cages, have shown that *B. dorsalis* will mate with *B. invadens*. More field cage experiments will be conducted in collaboration with the visiting scientist from Australia.

These studies form part of the research being carried out in support of the new Co-ordinated Research Project entitled: 'Resolution of Cryptic Species Complexes of Tephritid Pests to Enhance SIT Application and Facilitate International Trade'.

- Olive fruit fly (*Bactrocera oleae*)

Research on improving and streamlining mass-rearing of olive fly for SIT programmes continues at the Insect Pest Control Laboratory in collaboration with workers from other countries such as Greece, Israel, Italy, Jordan, Spain, the UK and the USA.

There have been marked improvements in olive fly rearing during the first six months of 2010. We are now maintaining olive flies in large cages which are demonstrating low early adult mortality and high egg production and egg fertility. The volumes of cages currently being tested are $0.17m^3$, $0.3m^3$ and $0.4m^3$ with egg collection panels measuring $0.96m^2$, $0.95m^2$ and $1.8m^2$, respectively. The costs of setting up and maintaining these large cages and of their relative productivity will be compared with currently used cages for benefit:cost assessments.

Work has progressed on the development of improved and cheaper larval diets. It has been found that unless larval diets are kept moist, but good ventilation around them is maintained and that not too many eggs per gram of diet are seeded, then studies on developing new diets are worthless.

The Fruit Fly Rearing group has collaborated with the Mosquito group to test some of the cheaper protein

sources used in their work and found that some proteins sources are at least equal to the standard mixture in terms of egg production, egg hatch rate and egg to pupa recovery rate. Substitution of protein hydrolysate and egg yolk with some of these ingredients is proving to be a real possibility for mass-rearing olive fly. The laboratory now has strains of olive fly originally from different geographical origins reared up to 3 or 4 generations on these ingredients liver with no reduction in egg to pupa recovery rates.

Collection of olive fruit fly eggs from the adult oviposition cage.

In addition, a new hybrid strain developed by crossing the very old Demokritos laboratory-adapted strain with wild olive flies reared from French olives has proven to be very highly productive in the laboratory. We are currently carrying out tests to determine the reasons for this and whether or not these flies are capable of competing with wild flies in the field.

- Mediterranean fruit fly (*Ceratitis capitata*)

The Insect Pest Control Laboratory continues to supply the VIENNA 8 temperature sensitive lethal (*tsl*) genetic sexing strain of the Mediterranean fruit fly to mass-rearing facilities around the world for testing and use in SIT programmes.

- Examination of fruit fly eggs

A fellow from Myanmar (Ms Nwe Nwe Yin) is currently carrying out studies on fruit fly egg size and shape. The reason for interest in this is that the number of eggs per ml of egg suspension is necessary to be exact for optimal seeding rates of fruit fly eggs on SIT larval diets for correct quality control procedures. It has been found, on reviewing international literature that the number of eggs/ml varies considerably between SIT facilities even within a single species. This figure impacts heavily on such quality assessment tests as the calculation of egg to pupa recovery. Egg shape and dimensions, too, vary between species but not within species (i.e. there is insignificant variation in egg size and shape between individuals within a fruit fly species). This phenomenon may be a useful species identification tool for international trade purposes.

Shipments of fruit flies and rearing materials to other researchers and/or SIT programmes

The Fruit Fly Rearing group of the Insect Pest Control Laboratory is considered by Member States and other countries as a valuable resource for fruit fly species and for its experience in rearing fruit flies of various species in the laboratory.

During the first six months of 2010 one to several shipments of Olive fruit fly were made to Italy and Spain; of Mediterranean fruit fly to Argentina; of South American fruit fly to Germany; *Bactrocera dorsalis*, *B. papayae* and *B. carambolae* to the USA; melon fly to Mauritius and of insect feed and equipment to Croatia, Spain and the UK. Flies were imported from France (olive fly), Suriname (carambola fruit fly), Thailand (Oriental fruit fly, carambola fruit fly, Asian papaya fruit fly, guava fruit fly) and the Philippines (Philippines fruit fly).

Visiting Scientists and Fellows

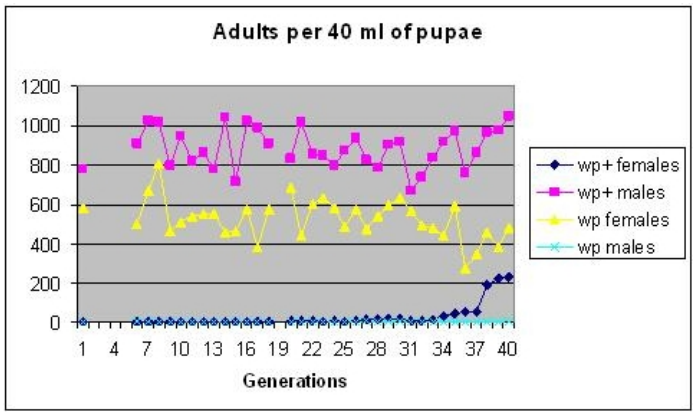
The fruit fly rearing group is an excellent place for fellows, visiting scientists, scientists on sabbatical and others for two-way development and exchange of knowledge and ideas on improving fruit fly research and development. During the first half of 2010 several visiting scientists and fellows worked with the technicians in fruit fly rearing. They came from Australia, Brazil, Myanmar, and Pakistan.

Fruit Fly Genetic Sexing Group Activities

Evaluation of the genetic stability of a *Bactrocera dorsalis* genetic sexing strain

For the oriental fruit fly (*Bactrocera dorsalis*) a genetic sexing strain (GSS) based on the selectable marker white pupae (*wp*) was developed by USDA in Hawaii. This strain was subjected to a long-term analysis to evaluate the stability of the sexing system. The strain was reared under the same standard rearing conditions as the GSS for the Mediterranean fruit fly, i.e. 34 mL of pupae were used to set up the cages for the next generation and a parallel sample of 40 mL of pupae was analysed. Also the same adult and larval diets were used. Only the egg collection was not done with egging nets but with bottles. The strain was reared in total for 40 generations without removing any recombinant flies. During the evaluation

roughly 50 000 adults were screened. The strain produces 1450 adults per 40 mL of pupae. The sex ratio is strongly biased in favour of males, i.e. on average 1.7 times more males are produced than females. Until generation 19 the strain was very stable, i.e. the number of recombinants was low and the overall recombination frequency stayed below 0.25%. From generation 32 onwards a rapid degeneration of the stability was observed, i.e. the frequency of wp^+ recombinant females reached 14% in generation 40. The breakdown pattern is very typical and is equivalent to that observed with Mediterranean fruit fly GSS. The number of recombinant females with wp^+ phenotype starts to accumulate rapidly while the number of recombinant males with *wp* phenotype stays low. These two types of recombinants represent the reciprocal products of type-1 recombination and occur initially at the same frequency. However, the wp^+ recombinant females have a selective advantage over their non-recombinant sisters with *wp* phenotype and that leads to a selective accumulation in the colony. In case of the recombinant males the situation is reverse. In conclusion, under the relatively relaxed rearing conditions used here the strain stays stable for over 1.5 years. For a practical application in SIT programmes larger volumes have to be produced under less favourable conditions. To avoid degeneration of the strain a Filter Rearing System should be used.



Number of recombinants of Oriental fruit fly during 40 generations of rearing in the laboratory.

TSETSE FLIES

The tsetse group continues to concentrate its efforts on solving practical problems for the Ethiopian (ETH5015) and Senegalese (SEN5031) projects. For Senegal, the main issues are related to the transportation of males under chill conditions from the rearing facility in Bobo Dioulasso, Burkina Faso, to Dakar, Senegal and the release of males from the air. For Ethiopia, the main issue remains management and control of the salivary gland hypertrophy virus infection.

Effect of chill holding of male pupae on mating performance

Field cage tests were carried out with *Glossina palpalis gambiensis* to assess the impact of delaying male adult emergence by chilling to simulate the procedure needed to transport male pupae from Burkina Faso to Senegal. For the control, normal colony emergence of males was used. For the chilled treatment male pupae were chilled at 12.5°C for seven days to inhibit emergence after female emergence was completed. After incubation, they were returned to normal colony conditions for emergence. Competitiveness tests were carried out between untreated control males and males from the chilled treatment of the same post emergence (PE) age, i.e. 3 days PE (untreated) vs. 3 days PE (chilled treatment), 6 days PE (untreated) vs. 6 days PE (chilled treatment), and 9 days PE (untreated) vs. 9 days PE (chilled treatment). The males competed for mating opportunities with 3 day-old females that emerged under normal colony conditions. Observations were carried out in a field cage erected in the insectary building under fluorescent lights, temperature 24°C, relative humidity 60%. The observation time was 09h00 to 12h00 on each day.

Results indicate that there were significantly more mating pairs recorded for older males than the younger males irrespective of whether they were chilled or not. Premating time was slightly shorter on average for 3 day-old males of the chilled treatment group (63 minutes) compared to untreated males (88 minutes), whereas it was longer for 6 and 9 day-old males of the chilled group (56 minutes and 32 minutes respectively) compared to the control males (51 and 25 minutes respectively). Overall the 9 day-old males mated earlier than the 3 and 6 day-old males. The mating duration was on average similar for 6 and 9 day- old males for both treatments (87 to 89 minutes for control and 75 to 83 minutes for chilled males) and slightly shorter for 3 day-old males, 69 minutes for the control and 59 minutes for the chilled males.

Half of the mating pairs involving 9 day-old males were initiated within the first ten minutes of observations, whereas it was up to thirty minutes and up to one-and-half hours for 6 day- and 3 day-old males respectively. Mating duration was nearly the same for control and chilled flies and when insemination occurred, it was frequently maximum for both treated and control flies at each age.

The test was repeated with the pupae chilled at 10°C for seven days to inhibit emergence and then returned to normal colony conditions for emergence. Again, there were significantly more mating pairs recorded for older males than the younger males irrespective of whether they were chilled or not. Premating time was slightly shorter on average for 6 (54 minutes) and 9 (36 minutes) day-old males (chilled group) as compared to control males (65 and 43 minutes respectively). Overall the 9 day-old males mated earlier than the 3 and 6 day-old males. The mating duration was on average similar for 3 and 6 day-old males for both groups (75 to 76 minutes) and slightly longer for 9 day-old males, 80 minutes for the control and 89 minutes for the chilled males.

In five replicates the proportion of mating pairs involving 9, 6 and 3 day-old males were 0.47, 0.37 and 0.25 (con-

trol) and 0.38, 0.28 and 0.14 (chilled at 12.5 ºC) respectively. When pupae were chilled at 10 ºC the proportion of mating pairs involving 9, 6 and 3 day-old males in five replicates were 0.42, 0.41 and 0.25 (control) and 0.42, 0.24 and 0.17 (chilled) respectively.

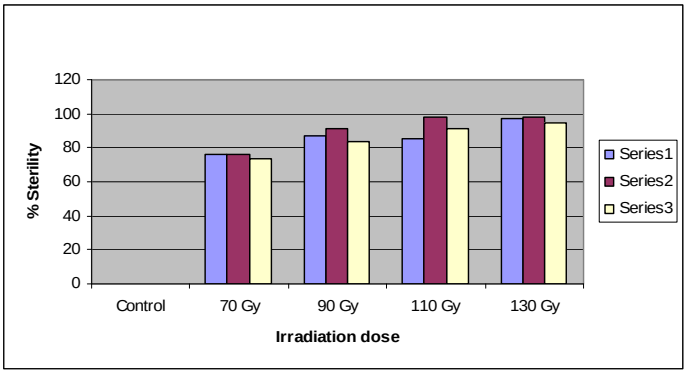
Controlled environment room for field cage

The field cage tests in the constant environment room confirmed the suitability of the selected temperature and humidity levels for mating competitiveness tests with *G. p. gambiensis*. Although the fluorescent light was of lower intensity than natural light the tsetse fly activity in the cage was similar to that observed in the green house. The flies responded to movement by the observer and the preferred landing sites were the darker areas of the cage, for instance the PVC frame, the junction of the roof with the side wall and the ground with the side wall. However, fewer flies landed on the tree in the constant environment room (insectary) than when the cage was in the green house. The proportions that mated were also similar in both environments.

Pupa irradiation

In order to achieve efficient sex separation, and to provide adequate time for the transport of the sterilized males from Burkina Faso to Senegal, the tsetse group has been developing the use of near infrared spectroscopy (SKNIR) to separate pupal sexes five days before first female emergence. Although this is not yet ready for operational use, we anticipate its introduction soon.

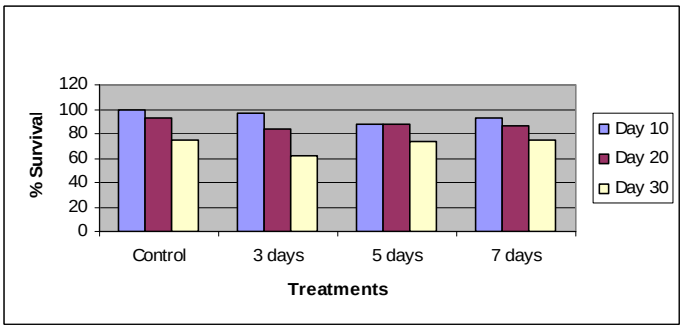
In anticipation of having male pupae five to seven days before emergence available for handling and shipping, the tsetse group has been investigating handling procedures for late stage pupae. The radiation sensitivity to gamma rays of *G. p. gambiensis* in the late pupal stage was completed with an irradiation test at day 29 post larviposition (PL) as first female emergence occurs about day 33 PL (see figure below). The results, in particular the induced sterility, were similar to those previously observed by irradiation of pupae on day 25 and 27 PL (see figure below).



Induced sterility of Glossina palpalis gambiensis *at various doses of gamma radiation in the late pupal stage.*

The size of our *G. p. gambiensis* colony from Burkina Faso has been slightly increased to 12 000 producing females in February 2010 to meet the requirement of material for experimental work *in situ* and in Member States institutions and laboratories. A total of 1884 pupae, composed of 4 different batches at 6, 5, 4 and 3 days before emergence, but all irradiated on day 25 PL, were sent through airfreight to Dakar, Senegal. This test was successful confirming the efficiency of the protocol communicated to CIRDES, Burkina Faso for the shipment of pupae to Senegal under TC project SEN 5031.

Further evaluations on the effect of cooling on male pupae after female emergence, as previously reported, have confirmed 10ºC and 12.5ºC as efficient cooling temperatures for *G. palpalis*. Experiments were pursued by combining gamma irradiation and chilling of the pupae. Preliminary results with pupae irradiated at 110 Gy at day 34 PL and chilled at 10ºC up to 7 days were encouraging. Work is now concentrated to find the optimal cooling system during the irradiation of pupal batches (see figure below).



Post emergence adult survival of Glossina palpalis gambiensis *males chilled at 10°C during the late pupal stage for various periods.*

The establishment of reared *G. p. gambiensis* originating from Senegal is progressing with a colony size of more than 260 producing females in May 2010.

Salivary gland hypertrophy virus

As reported in the last newsletter (January 2010), attempts are continuing to develop a strategy to manage the salivary gland hypertrophy virus (SGHV) that is hampering colony development of *Glossina pallidipes* due to reduced productivity. The virus management strategy is based on four approaches, (1) blocking virus replication using commercial antiviral drugs, (2) inhibiting virus infection by silencing virus specific genes using RNAi technology, (3) neutralizing the virus infection using virus specific antibodies and (4) modifying the feeding system to control horizontal transmission.

Work is continuing to assess the impact of two antiviral drugs on the viral infection in *G. pallidipes* and to assess their toxicity for tsetse flies. The drugs acyclovir and valacyclovir, were selected for further work. *G. pallidipes* flies fed on blood diet with valacyclovir for three generations showed a lower mortality and higher productivity compared to flies fed with blood diet that contained acyclovir. Quantitative PCR analysis was used to assess the effect of the antiviral drugs on viral DNA replication. The results indicate that using valacyclovir leads to a slight reduction in virus copy number in F0 and F1

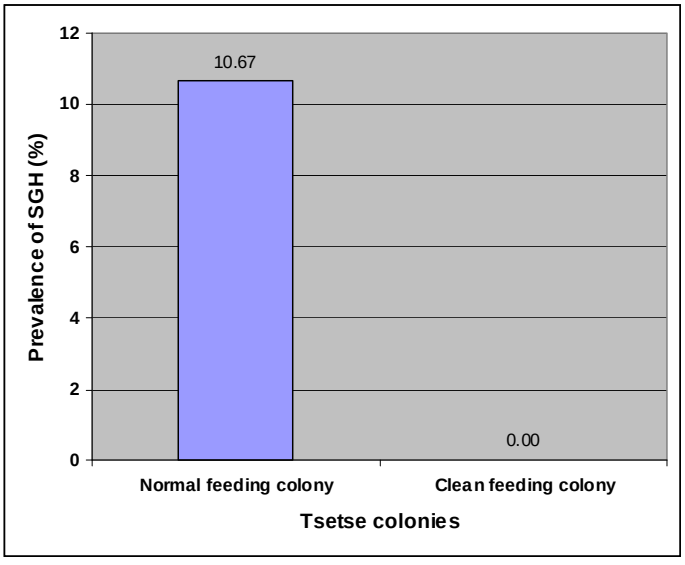
whereas adding the acyclovir did not reduce the virus copy number in F0 but caused significant reduction in virus copy number in F1. In F2 no difference in virus copy number was observed between the treatment and control due to a marked reduction in the control virus level. The quantitative PCR results did not show significant differences in virus copy number between male and female flies, but the results showed significant reduction in virus copy number over generations regardless of the treatment (including control). Due to this observation some modifications were made in the antiviral drugs experimental protocol to ensure a virus contamination source in the experiment. The use of valacyclovir and acyclovir with the normal colony feeding system for 6 months shows two interesting observations (i) the flies fed on acyclovir drug were reduced over time due to the low productivity and the treatment had to be discontinued, while the flies fed on blood supplemented with valacyclovir still maintained acceptable productivity. (ii) the virus load in the flies treated with valacylovir was not stable and increased slightly with time which could indicate a development of virus resistance against the drug, but this observation needs to be confirmed. To overcome the resistance development problem, another 15 antiviral drugs were selected to test their effect on virus replication.

An experiment has been started to assess the effect of suppressing the expression of p74 by RNAi on virus infectivity. Three regions of the gene were amplified by PCR covering the N-terminal region, the C-terminal region and the whole length of the gene sequence. The PCR product was cloned into a 28i and 38i LITMUS vector, after which the recombinant plasmid was checked by restriction enzyme pattern and transformed into HT115 (DE3) bacteria. The transformed bacteria were added to the blood diet used to feed the flies and their effects on the virus copy number were monitored by quantitative PCR. The results indicate that while there was no clear difference between the treatment and the negative control in F0, a significant reduction in the virus copy number was observed between two treatments and the negative control in F1. No significant difference in the virus copy number was observed between male and female. The results also indicate a significant reduction in the virus copy number between generations as observed in the antiviral drug experiment. As in the antiviral drugs experiment some changes were made in the RNAi experimental protocol to ensure a virus infection source and to focus on the promising treatments. The results of fly productivity and mortality and the prevalence of the SGH between the RNAi treated and non-treated flies did not show a significant result. Moreover, the qPCR results did not support a significant difference between treated and untreated flies. Attempts to develop efficient methods to initiate a virus infection by oral infection or injection and the assessment of the impact of RNAi on DNA replication in the infected flies are underway. Also, preparation of the RNAi for other virus genes is in process

For neutralization of the virus infection using virus specific antibodies, five antibodies were produced. Two antibodies against the p74 protein were produced by a commercial company, and one antibody against each protein expressed by the open reading frame (ORF) 10, 17 and 96 were produced in collaboration with Prof. Just Vlak from Wageningen University, The Netherlands and Prof. Max Bergoin from Montpellier University, France. Experimental work to assess the efficacy of the antibodies to neutralize and block virus infection has been started.

Several experiments were carried out to better understand the mode of virus transmission. The results confirm that symptomatic infected flies release large numbers of virus particles into the blood during feeding. Injecting virus into flies leads to increasing virus copy numbers with time, the injected females produced progeny with a high virus copy number, but the injected flies themselves did not develop hypertrophy.

After demonstrating the role of horizontal transmission through the membrane feeding system used in the tsetse fly laboratory colony, it was recommended to initiate a new tsetse fly colony using the clean feeding system. A clean feeding colony was established by feeding the cages first on a fresh membrane and blood. The remainder of the blood was used for the normal feeding colony. The clean feeding colony was maintained separately from the other colony and samples were taken regularly to assess the virus load and the prevalence of SGH. The qPCR results indicate a significant decrease in the virus load in the clean feeding colony in comparison with the normal feeding colony. Fly dissections indicate that after three months of clean feeding this colony became SGH free (i.e. symptom-free, but not virus-free) while the normal feeding colony still showed 10% SGH prevalence (see figure below).



Effect of clean feeding on the prevalence of SGH in tsetse colonies.

Prototype aerial release machine for chilled tsetse adults

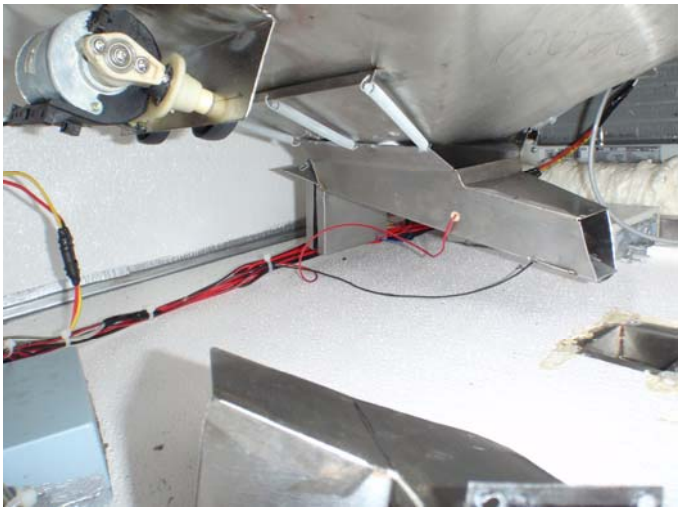
In the 1990s, *Glossina austeni* was eradicated from Unguja Island (Zanzibar) using an area-wide integrated pest management approach with an SIT component. The sterile flies were released from the air in bio-degradable cardboard boxes. Whilst this technique worked well, it is relatively expensive to supply the boxes, and it becomes too labour intensive for larger areas. We have, therefore, been working for some time on a chill adult release system similar in principle to the ones used for the release of screwworms and fruit flies in Mexico and Central America. Following a Consultants' Group Meeting last year, the company Mubarqui in Mexico has been developing a prototype release machine for tsetse and initial test releases with surrogate fruit flies have recently started.

Fly holding cylinder showing the mechanism to release the flies into the main funnel lowered. The cylinder is perforated to permit chilled air circulation.

The important factors that were taken into consideration in this development work are the much lower release rates required for tsetse, and the much higher cost of the individual flies. Due to this high cost, fly mortality in the machine must be minimized and no crushing or squeezing action can be employed. The prototype consists of 36 individual cylinders (see figure opposite column) to hold the flies with minimum compaction, which are loaded into the chill release system (see figure below).

Chill release machine mounted in a Cessna 206 with the top open to show 30 of 36 cylinders mounted. The cylinders on the left side have released their flies to the main funnel below.

The flies are released from one cylinder at a time and drop through a larger funnel to a smaller one below (see figure below). This lower funnel vibrates to move the flies to the exit hole. The release rate is adjustable by changing the amplitude, frequency and duration of the vibration.



View of lower part of release machine, showing the upper larger funnel that feeds into the lower smaller funnel, with the vibration system to release the flies.

The initial tests showed that a release rate of 6 flies per second was achieved at the mid point of the vibration settings. Whilst a number of additional issues to be addressed were identified, it is anticipated that the system will be ready for field testing with live tsetse in Senegal by the end of the 2010.

MOSQUITOES

Mass-rearing mosquito technology: tray, rack, larvae-pupae separator, larval food mixer and dispenser

After testing and improving several prototypes during the last two years, a new version of the larval tray, a rack to hold up to 50 larval trays, a larva-pupa separator and larval food dispenser have been developed.

The stainless steel rack has a jack endless screw system for tilting the shelves holding the larval trays. In order to collect the larvae and pupae, a vertical plastic panel has been added in the back together with a stainless steel collector at the bottom of the rack. The plastic panel fixed on the frame rack structure on the draining side allows the larvae-pupae mixture to gently slide down toward the stainless steel collector. A stainless steel slide guides the flow of water into the collector that is supported by the bottom rack frame and a new transversal bar has been added. The collector (dimensions of 600 x 400 x 100 mm) has a compact bottom and 3 walls made out of stainless steel (see figure below). Three handles are present on three sides of the collector to permit an easy handling from the side.

Mosquito rack system. The plastic panel, the slide and the collector of the immature stages from the larval trays on the right.

A stainless steel version of the larvae-pupae separator has been manufactured based on an earlier prototype version. This machine uses the vortex effect created by a 15°C water flow circulating in the main chamber for the separation of a larvae-pupae mixture introduced in the two dedicated outlets. The separator has on top a box that can hold the collector of the rack. The general shape of this box offers the possibility to slide inside two collectors, rinse them and guide larvae and pupae in the outlet positioned at the bottom towards the separator chamber. A supporting structure with stairs permits easy loading of the pupae-larvae mixture (see figure below).

Larvae-pupae separator made of stainless steel.

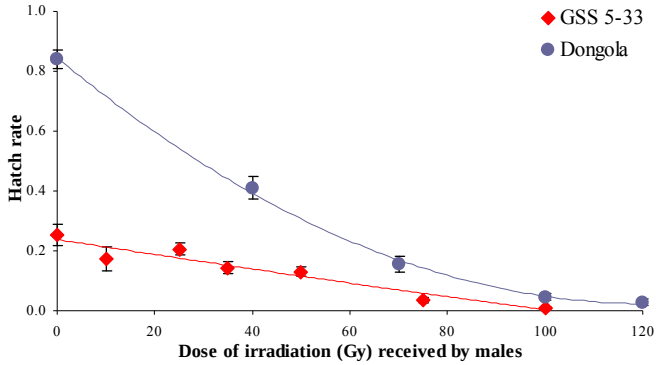
A mixer for larval mosquito diet preparation has been developed. This machine will be used to dissolve the powdered diet in water in order to provide to the immature stages a liquid solution fully homogenised for a rapid and more efficient nutrition. A dispenser feeder will be connected to the diet machine and allow distribution of the right amount of food in the trays. The mixer has a capacity of 400 litres that will allow the supply of about 4000 trays (see figure next page).

This new equipment is currently being tested for *Anopheles arabiensis* and will be transferred to Sudan for further validation and testing in the coming months. In the context of a strong collaboration with Italy, this mass-rearing equipment will be also tested and improved for *Aedes albopictus*.

Larval diet mixer machine with the dispenser feeder.

Effect of irradiation on *Anopheles arabiensis* male sterility - Dose response studies

The establishment of the sterility curve for the *An. arabiensis* genetic sexing strain (GSS) 5-33 is the first step in the study on sexual competitiveness and male mating parameters of sterilized and wild males. The GSS 5-33 strain has a very low natural fertility (27% on average). However when subjected to irradiation, the rate of reduction of male fertility with increasing dose was less drastic than for the wild type 'Dongola' strain (see figure next column) and full sterility was reached with a dose of radiation > 75 Gy. When irradiating pupae at high doses, few eggs hatched and these tended to die early. The development of some hatched eggs until the pupal stage will be further investigated in order to determine the minimum radiation dose that results in no viable larvae. Reduction of the sterilizing dose as low as possible will avoid deleterious effect on the capacity of the male mosquitoes to fly, mate and transfer sperm.

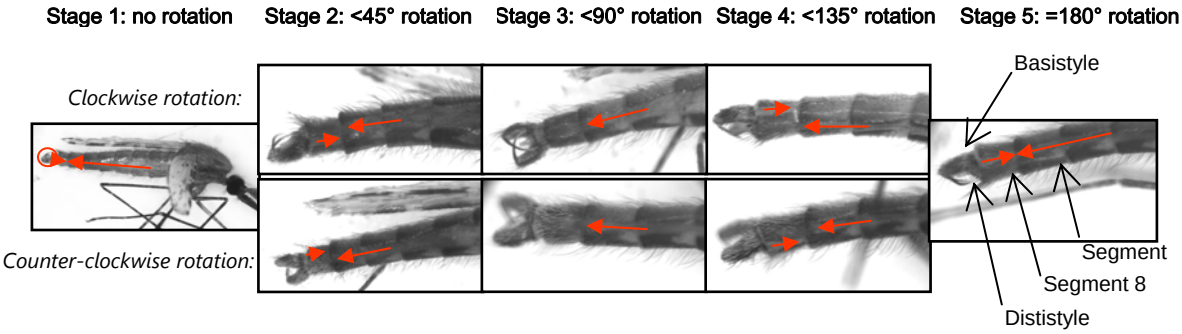


Effect of irradiation on mean fertility of the Dongola strain of Anopheles arabiensis *and the genetic sexing strain (GSS) 5-33, when males are irradiated at the pupal stage (>20 h old) with Cobalt 60.*

Sexual behaviour - Precocious mating

Males and females from the laboratory-reared strain of *An. arabiensis* Dongola were observed to reach sexual maturity much earlier than previously described. In most mosquito species newly emerged males and females are not able to successfully mate: females' receptivity is usually low after emergence and males need to undergo a sexual maturation during which the genitalia part rotates 180°. It was previously assumed that males and females of the species *An. arabiensis* were only able to mate 24 h post-emergence.

We have found that after 5 years of laboratory culture, mosquitoes from the Dongola strain already mated successfully only 11 h after emergence. This suggests that an inadvertent selection occurred in the rearing process that favours those that reach sexual maturity earliest. Indeed, the management of the colony in the insectary occurs with no overlap of generations, and newly produced pupae are put in a cage with no adults, and this would favour such a selection. This new observation is of high importance to use terminalia rotation to determine the age of males collected on the field and in particular for experiments involving virgin females. This outcome has been presented as a poster for the International Conference EDEN 2010 (Emerging Vector-borne Diseases in a Changing European Environment) in Montpellier, France.



Different stages of terminalia rotation, occurring clockwise (upper pictures) or counter-clockwise (lower pictures), when the specimen (species Anopheles arabiensis*) is observed on the right side view. Arrows indicate the position of the pleuron 7 and 8.*

Reports

Symposium: The Sterile Insect Technique: Achievements and Challenges for Area-Wide Integrated Pest Management at Annual Meeting of the Entomological Society of America, 13-16 December 2009, Indianapolis, Indiana, USA

As part of the 57th Annual Meeting of the Entomological Society of America, the symposium 'The Sterile Insect Technique: Achievements and Challenges for Area-Wide Integrated Pest Management' was organized by FAO/IAEA and USDA.

The symposium included the following presentations:

- Recent advances on Tephritid fruit fly research and development for improved sterile insect technique application (by Pereira R, Parker A, Jessup A, Hendrichs J, Teal PEA, Yuval B, Liedo P, and Shelly T)
- The use of SIT to prevent exotic fruit fly establishment in the United States (by Hoffman K, Dean D, and Gersabeck E)
- The medfly programme in Guatemala and Mexico: Multiple uses of the sterile insect technique in a successful area-wide control programme (by Cáceres, C, McGovern T, Lira E, and Rendón P)
- The sterile insect technique as a component of area-wide integrated pest management against selected tsetse fly populations in Africa: past successes and future prospects (by Vreysen MJB, Feldmann U, and Parker A)
- Networks of habitat patches in tsetse fly control: implications of metapopulation structure on assessing local extinction probability (by Peck, SL)
- Pest eradication with sterile insect technique: Approach and components of the screwworm eradication programme (by Mangan RL, Thomas DB, Courtois R, and Rojas J)
- Application of the sterile insect technique as part of the eradication programme against the cactus moth (*Cactoblastis cactorum* Berg.) in Mexico (by Gutierrez-Moreno R and Sánchez-Anguiano H)
- The role of the sterile insect technique for eradication of pink bollworm in North America: Achievements and remaining challenges (by Simmons G, Tate C, and Sims M)
- Fast-tracking sex to gain control: development of SIT as a tool against light brown apple moth *Epiphyas postvittana* (Walker) (by Bloem K and Simmons G).

Fifth Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO, 22-26 March 2010, Rome, Italy

Agreements with two new Contracting Parties to the IPPC entered into force during 2009: Botswana and Montenegro, bringing total membership to 173 parties .

The session was opened by FAO's Assistant Director-General, Mr Modibo Traoré. He noted the importance of the work of the CPM and the IPPC in contributing to food security. He noted that the gap between standard development and implementation was growing, and mentioned that areas of particular importance for IPPC activities are phytosanitary capacity building and surveillance and monitoring of the emergence of plant pest. He also noted that FAO placed significant emphasis on the work of the IPPC and this is reflected in the appointment of the first full-time secretary to the IPPC, Mr. Yukio Yokoy.

The Secretariat of the IPPC thanked the IAEA for hosting and funding the TPFF meeting held in Vienna, Austria in August 2009, and the support given to the development of post-harvest irradiation treatments, including through participation in the IPPC *Technical Panel on Phytosanitary Treatments* (TPPT).

In terms of the TPFF, the CPM added to the IPPC standard setting work programme the development of a new draft ISPM *Establishment and Maintenance of Regulated Areas upon Outbreak Detection in Fruit Fly Free Areas*, for inclusion as Annex 1 of ISPM 26 *Establishment of Pest Free Areas for Fruit Flies* (*Tephritidae*). The CPM also sent back to the Standards Committee (SC) the draft Appendix 1 to ISPM 26 on *Trapping Procedures for Fruit Flies*, and recommended to the TPFF to review the formal objections received from Contracting Parties for presentation to the November 2010 SC. These drafts are of much relevance to the activities the Insect Pest Control Subprogramme and its stakeholders in FAO and IAEA Member States.

Regarding the development of 14 treatments on the use of irradiation as phytosanitary treatment, that had been subject to much discussion and continuous technical support during the last three years, the CPM last year adopted as annexes to ISPM No. 28 '*Phytosanitary Treatments for Regulated Pests*' eight specific irradiation treatments. During the 2010 meeting the CPM adopted additional irradiation treatments for *Conotrachelus nenuphar*, for *Grapholita molesta* with and witouth hypoxia. The drafts for the weevils *Cylas formicarius elegantulus*, and *Euscepes postfasciatus* received formal objections; therefore, they were forwarded to the SC for further review. The draft for the moth *Omphisa anastomosalis* had been previously deleted by the SC in 2009.

Standards Committee Meeting, International Plant Protection Convention, FAO, 26-30 April 2010, Rome, Italy

There were 25 officially nominated members representing the FAO's seven regions. Mrs. Jane Chad was elected as new Chairperson of the Standards Committee (SC).

In relation to the Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies (TPFF), the previously approved draft International Standard for Phytosanitary Measures (ISPM), 'Systems Approaches for pest risk management of fruit flies (Tephritidae)' and the Treatment 'Irradiation treatment for *Ceratitis capitata'*, were cleared and sent for country consultation.

The revised specification 'Protocol to determine host status of fruits to fruit flies (Tephritidae)' was approved to be developed as a draft ISPM by TPFF. The approved text of the specification includes most of the suggestions and comments by the Member States during the country consultation phase and minor changes proposed by the SC. Other comments by Member States were not incorporated due the nature of the specification (short guideline), but will be taken into consideration during the development of the draft ISPM. The draft ISPM will be developed during the next TPFF meeting (Vienna, October 2010).

31st FAO Regional Conference for Latin America and the Caribbean (LAC), 26-30 April 2010, Panama City, Panama

The twin crises of drastic food price rises and world financial and economic crisis have significantly affected food and nutritional security in the LAC region. Nearly two decades of progress in combating hunger in the region, during which LAC countries had succeeded in reducing the number of hungry people from 53 million to 45 million, were largely erased and undernourished people are expected in 2010 to reach the same level as in 1990-1992: 53 million out of the current 600 million people in the region (and ca. 5% of the estimated 1,020 million undernourished in the world).

It was stressed that it is paradoxical that a region that has a surplus of food and is a net exporter should have 53 million hungry people. While in some countries there is insufficient production, in many others there is a disjunction between increased production and reduced poverty, with the extreme poor experiencing difficulties in accessing food. In spite of positive rates of sectoral economic growth, rural poverty has not declined in proportion. The conditions of wage labour in the rural sector, and in particular for temporary farm workers are considered among the main structural causes of this disjunction.

The introduction in many countries, both before and after the crisis, of safety nets such as 'Conditional Cash Transfer' schemes to the absolute poor and other social programmes, as well as subsidies, public credit, greater attention to small-scale agriculture and the production of basic food-stuffs, and other measures such as grain reserves and agricultural insurance, are helping to reduce inequalities and boosting food demand from the lowest-income sector for basic food staples produced by small farmers, and have been buffering the effects of the two crises.

The year 2015 is only 5 years away, and the Millennium Development goal of halving global hunger has become more distant and appears currently unrealistic. Nevertheless, as a result of these global events food and agriculture are now much more visible on the political and public agenda of many countries and subregional and regional fora, with countries making increasing commitments to boost legislation on the human right to food. The ongoing revalorization of the importance of agriculture and rural development in the region has culminated in renewed efforts by governments to try to achieve within one generation the eradication of hunger in the region ('2025 Hunger-Free LAC Initiative').

Meeting on Programme Against African Trypanosomiasis (PAAT) Advisory Group Coordinators, 1-3 December 2009, Mombasa, Kenya

The 15th meeting PAAT's Advisory Group Coordinators was held in Mombasa, hosted by the International Centre for Insect Physiology and Ecology (ICIPE). Four national representatives of projects under PATTEC (Pan-African Tsetse and Trypanosomosis Eradication Campaign), i.e. from Ghana, Kenya, Mali and Uganda, participated at the meeting and presented progress relevant to their work against the tsetse and trypanosomosis problem. Staff members of the mandated specialised UN agencies (FAO, WHO and IAEA) and of regional, international and national institutions, i.e. Centre International de Recherche-Développement sur l'Élevage en zone Subhumide (CIRDES) in Bobo-Dioulasso, Burkina Faso, ICIPE, the International Livestock Research Institute (ILRI) in Nairobi, Kenya and the Institute for Tropical Medicine (ITM) in Antwerp, Belgium, summarised their activities relevant to dealing with the tsetse and trypanosomosis problem.

The meeting reviewed two project concept notes, one for East and one for West Africa, which had been drafted at the 13th meeting of the PAAT Programme Committee, Smolenice, Slovakia, 7–8 May 2009, and assessed which support PAAT and collaborating partner institutions could provide to such projects. Using PATTEC-Kenya as an example, the meeting also reviewed the support that PAAT can provide to the national PATTEC projects regarding data management and data sharing.

FAO, with the technical concurrence of the IAEA and WHO, had organised an external review of PAAT in late 2009. The review team paid visits to national PATTEC projects and interacted with various other stakeholders,

including AU, international and regional institutions and PATTEC. It reported the stakeholders' high appreciation of PAAT as source of policy advice and of information relevant to the T&T problem. The review team also underlined that the working relationship between PATTEC and PAAT needs further harmonisation.

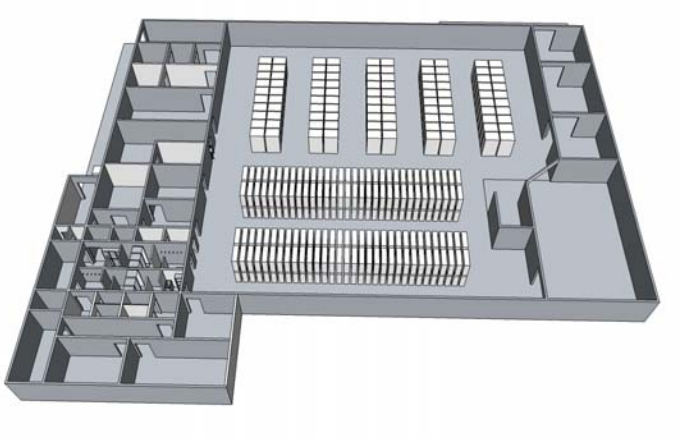
Consultants Meeting on the Development of Generic Design for Mosquito Mass-Rearing Facility, 3-7 May 2010, Vienna, Austria

At the request of the Centro Agricoltura Ambiente 'G. Nicoli' (CAA), Bologna, Italy and the Italian Permanent Mission, the IAEA hosted a consultants meeting on the 'Development of Generic Design for Mosquito Mass-Rearing Facility'. The meeting was co-funded by the CAA and the IAEA and attended by representatives of 10 Member States who benefitted from the outputs. The objective of the Consultants Meeting was to discuss the requirements for an adequate design for a mosquito pilot mass-rearing facility, which is required in support of feasibility studies and pilot projects in preparation (French Polynesia, Italy, La Réunion and Sudan) to further develop cost effective SIT technology for mosquito species.

During the first day of the meeting, the participants gave 12 presentations related to their experience with mass-rearing, mass-rearing facility design and equipment, and mosquito rearing. The following days, mosquito, fruit fly experts and observers shared their experience and knowledge and developed a draft design for a mosquito facility.

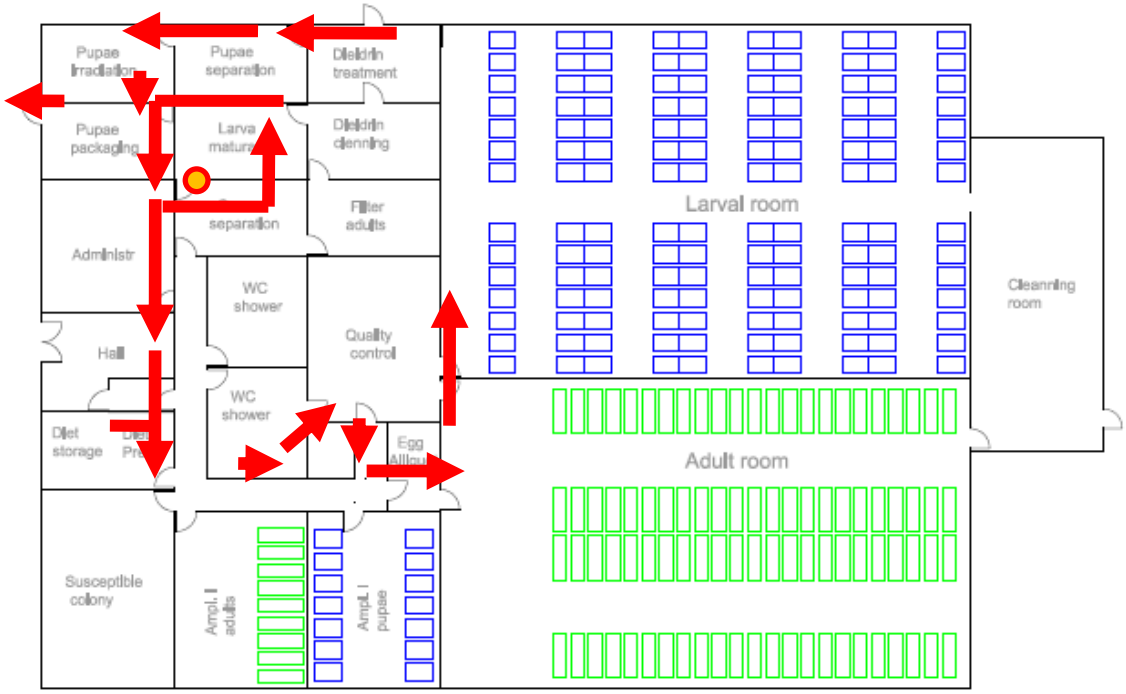
A visit to the Insect Pest Control Laboratory in Seibersdorf was included to show the experts the progress in the development of mass-rearing equipment for mosquitoes.

After discussions and exchanges, participants decided to elaborate two drafts, i.e. based on the availability (or not) of a genetic sexing strain and the requirement of a filter colony. A list of general recommendations was developed and another with specific aspects related to the mosquitoes species and countries (policy, climate, etc.).



Draft design for Aedes albopictus *mass-rearing facility (bisexual strain). The design does not include a filter colony due to the unavailability of a genetic sexing strain and the capacity to separate sexes based on pupal dimorphism.*

To assist with the planning and designing new SIT facilities for fruit flies, the FAO/IAEA Excel spreadsheet was used, that contains all physical variables related to the construction and operation of a fruit fly mass-rearing facility. However, due to the difference in biology of fruit flies and mosquitoes, this spreadsheet developed mainly for fruit flies can only be used as a guide to develop a spreadsheet specific to a mosquito facility. It was recommended to contract a technical expert with mosquito knowledge to accomplish this task.



Draft mosquito mass-rearing design that includes the use of a genetic sexing strain and a filter colony. Red arrows indicate the staff flow in the facility.

Announcements

12th Workshop of the IOBC Global Working Group on Arthropod Mass Rearing & Quality Control (AMRQC). 19-22 October 2010, Vienna, Austria

The Arthropod Mass Rearing and Quality Control (AMRQC) Global Working Group of the International Organization of Biological Control (IOBC) will hold its 12th workshop in cooperation with the Joint FAO/IAEA Division. The objective of this international workshop is to address the audacious goal of moving from 'bug farms' to industrial production of high-quality insects, mites and nematodes for biological control, SIT, research and other current and future applications. The workshop will focus on all issues related to the rearing of entomophagous and phytophagous insects and mites, and entomopathogenic nematodes, and to principles and practices of quality assurance.

The programme will consist of invited papers presenting an overview of selected topics and contributed presentations on the different aspects of arthropod rearing as it relates to quality control. Papers will serve as a basis for discussion and exchange, with the final aim of improving collaboration among scientists and practitioners. There will be a session on quality control in relation to the use of nuclear techniques in natural enemy rearing and mass-rearing for the SIT.

The meeting will be held at the IAEA headquarters in Vienna and ca 100 participants are expected. Further details are available at: www.tinyurl.com/amrqcreg.

Announcement of FAO/IAEA Regional Training Course

Surveillance Strategies for and Diagnosis of Tephritid Fruit Fly Pest Species in the Asian and the Pacific Regions (under TC Project RAS5052). 22-26 November 2010, Brisbane, Australia.

Application procedure: Nominations should be submitted on the standard IAEA application form for training courses/workshops (downloadable from: http://www-tc.iaea.org/tcweb/participion/astrainee/default.asp). Completed forms should be endorsed by and submitted through the official channels established (namely the Ministry of Foreign Affairs, the National Atomic Energy Authority, the Office of the United Nations Development Programme, or the office of the FAO Resident Representative or the Ministry of Agriculture). The completed forms must be received by 31 August 2010 at the International Atomic Energy Agency, P.O. Box 100, A-1400 Vienna, Austria. Advance nominations by facsimile (+43-1-26007), or e-mail (official.mail@iaea.org) are welcome.

Development of the Sterile Insect Technique for African Malaria Vectors

This supplement of the Malaria Journal reviews the potential use of the sterile insect technique (SIT) as one additional tool as part of an integrated approach to combat the problem of malaria in Africa. The supplement, edited by Mark Benedict, Alan Robinson and Bart Knols, who along with other colleagues have been leading efforts to develop this technology at the FAO/IAEA Agriculture & Biotechnology Laboratories in Seibersdorf, Austria assesses how and where the SIT may be used to complement efforts against some *Anopheles* vectors of malaria in sub-Saharan Africa.

Introducing this supplement, which is freely available under http://www.malariajournal.com/supplements/8/S2, the editors explain that the SIT has proven highly effective when applied against some other insect pests as part of an integrated area-wide approach. The supplement was produced because of the believe by experts that the technique has been overlooked as a complementary anti-mosquito method. Its efficiency in low vector-population settings precisely complements insecticide-treated bednets, indoor residual spraying and larval control: when they are at their weakest, SIT is at its strongest.

This supplement gives researchers and public health authorities information about the state-of-the-art as well as identifying specific challenges and requirements for

eventual successful implementation of the SIT. The table of contents of Malaria Journal 8: Supp. 2 (2009) is:

W. Klassen**.** Introduction: development of the sterile insect technique for African malaria vectors.

A. S. Robinson, B. G. J. Knols, G. Voight, J. Hendrichs. Conceptual framework and rationale.

D. V. Dame, C. F. Curtis, M. Q. Benedict, A. S. Robinson, B. G. J. Knols. Historical application of induced sterilisation in field populations of mosquitoes.

B. B. E. Sayed, C. A. Malcolm, A. Babiker, E. M. Malik, M. A. H. E. Tayeb, N. S. Saeed, A. H. D. Nugud, B. G. J. Knols. Ethical, legal and social aspects of the approach in Sudan.

M. Q. Benedict, B. G. J. Knols, H. C. Bossin, P. I. Howell, E. Mialhe, C. Caceres, A. S. Robinson. Colonisation and mass-rearing: learning from others.

P. A. Papathanos, H. C. Bossin, M. Q. Benedict, F. Catteruccia, C. A. Malcolm, L. Alphey, A. Crisanti. Sex separation strategies: past experience and new approaches.

M. E. H. Helinski, A. G. Parker, B. G. J. Knols. Radiation biology of mosquitoes.

F. Catteruccia, A. Crisanti, E. A. Wimmer. Transgenic technologies to induce sterility.

P. I. Howell, B. G. J. Knols. Male mating biology.

C. A. Malcolm, B. E. Sayed, A. Babiker, R. Girod, D. Fontenille, B. G. J. Knols, A. H. Nugud, M. Q. Benedict. Field site selection: getting it right first time around.

H. Towson, SIT for African malaria vectors: Epilogue.

Principles and Procedures for Rearing High Quality Insects

This excellent book provides an in-depth presentation of every major element comprising professional insect rearing programmes, from small-scale, tabletop rearing to industrial-scale, mass-rearing. It focuses on the use of artificial rather than natural diets. In addition, procedures are presented to either prevent or to diagnose and solve many of the problems that may arise in insect rearing.

The impetus for this book came from the five-day, insect rearing workshop, 'Principles and Procedures for Rearing High Quality Insects' held at least annually since 2000 at the Department of Entomology and Plant Pathology, Mississippi State University. This workshop has provided the first comprehensive, university-level training course available in insect rearing.

Regardless of size, any comprehensive insect rearing programme should encompass all of the major areas illustrated as parts of the rearing puzzle (Health and Safety, Nutrition and Diet, Microbiological Management, Facility Management, Production System, Quality Control, Facility Design, Environmental Biology, and Populations Genetics).

The book is organised in 11 Chapters that cover all the puzzle pieces:

1. Introduction (by N. C. Leppla, F. M. Davis & J. C. Schneider)
2. Insectary Design and Construction (by W. R. Fisher)
3. The Insect Manager (by W. R. Fisher)
4. Health and Safety Issues in Rearing Arthropods (by J. P. Reinecke)
5. Genetic Considerations and Strategies for Rearing High Quality Insects (by M. A. Caprio)
6. Environmental Biology of Insect Rearing (by J. C. Scheider)
7. Insect Nutrition, Feeding and Artificial Diets (by M. F. Chaudhury)
8. Microbial Contamination and Insect Rearing (by G. D. Inglis & P. P. Sikorowski)
9. Entomopathogens and Insect Rearing (by G. D. Inglis & P. P. Sikorowski)
10. The Basics of Quality Control for Insect Rearing (by N. C. Leppla)
11. Insect Rearing Production Systems, A case Study: The Southwestern Corn Borer (by F. M. Davis).

To order or obtain more information about this book, please visit: http://www.irc.entomology.msstate.edu/

News

Fruit Fly Mass-Rearing Centres in Peru

Peru has a long history of implementing the SIT as part of an AW-IPM approach against the Mediterranean fruit fly (*Ceratitis capitata)* and more recently the South American fruit fly (SAFF) *Anastrepha fraterculus*. The Animal and Plant Health Service (SENASA) of the Ministry of Agriculture achieved in 2007-08 the eradication of these pests in several regions of southern Peru contiguous to Chile, and is currently expanding these fruit fly-free areas northwards.

Mediterranean fruit fly mass-rearing facility in La Molina, Lima.

Since 2004, the Mediterranean fruit fly (medfly) mass-rearing centre in La Molina, Lima, uses the *tsl* VIENNA 8 strain and has a capacity for mass-rearing 400 million sterile males per week. Sterile males produced are being released in southern Peru, Lima, and Lambayeque, but also as a preventive measure in Tacna and Moquegua, which are medfly-free since 2007.

Fruit fly centre team at mass-rearing facility in La Molina, Lima.

In Piura, northern Peru, the mass-rearing centre for the SAFF is ready to start a production of 30 millions per week. These flies will be released in the Olmos valley (Lambayeque region) and other areas in northern Peru, where mango orchards for export are common.

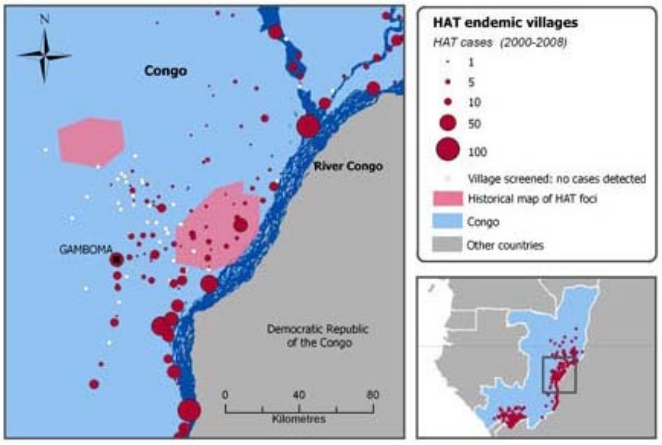
In addition, these mass-rearing centres have a Method Development Unit, which has been developing the system for mass-rearing, irradiation, handling and releasing of the SAFF, including the quality control tests for competitiveness and dispersion. This unit is also working with *A. obliqua*, *A. serpentina,* and *A. distincta*.

The mass-rearing centre in La Molina, Lima has a panoramic multi-use irradiator Type II, which has enough capacity for irradiation of the pupae and food commodities. Since 2005, this centre has provided services to irradiate spices, seeds, organic colorants, medicinal herbs and dry plant products. It has processed over 140 tons of products and foresees to quintuplicate this amount in the near future.

Source: Pedro Molina, Orlando Lucas, Liz Villanueva, Mónica Alburqueque, Yesika Velarde, Norma Nolazco, Edgardo Ortíz, and Juan Araujo, Centros de Producción de Moscas de la Fruta.

The Atlas of Human African Trypanosomiasis. A WHO/FAO Initiative in the framework of the Programme against African Trypanosomiasis (PAAT)

Accurate up-to-date information on the spatial distribution of diseases is of paramount importance to maximize impact and effectiveness of control measures. This is a particularly true for Human African Trypanosomiasis (HAT), a parasitic disease unique to sub-Saharan Africa. HAT, like many other neglected tropical diseases, affects some of the poorest populations often living in remote rural areas, or in conflict-shaken zones.



Example of focus-level map of HAT distribution, Gamboma, Congo.

An 'Atlas of Human Africa Trypanosomiasis' is being developed that will greatly contribute to streaming ongoing efforts to control sleeping sickness. Highly accurate, village level information on disease occurrence will help plan and implement surveillance operations in a more efficient way. Calculation of up-to-date, evidence-based estimates of population at risk and disease burden will become possible. Georeferenced, GIS-

compatible data on HAT will also allow a range of studies to be undertaken by combining accurate epidemiological information with satellite-derived environmental data. It is believed that the Atlas will represent an indispensable tool along the way towards the elimination to the public health problem posed by HAT.

A poster describes input data and methodology that are being used to generate the 'Atlas of Human African Trypanosomiasis'. For more information please visit the poster at: http://www.who.int/trypanosomiasis_african/resources/HAT_Atlas_A3poster.pdf.

Source: WHO website.

ARS Scientists Help Fight Damaging Moth in Africa

Agricultural Research Service (ARS) scientists have launched a preemptive strike to combat the false codling moth, a major pest in its native Africa.

If the moth enters the USA, it will damage citrus, corn, cotton and a wide range of nuts and fruits, according to entomologist James Carpenter, at the ARS Crop Protection and Management Research Unit in Tifton, Ga. He is working to control the moth in Africa, thereby reducing the risk of its arrival in the USA and ensuring a future weapon if it does show up.

Carpenter and an international team of scientists have turned to a tried-and-true method of pest control: the sterile insect technique (SIT). Using this technique, both male and female insects are irradiated. The female insects are left sterile by the irradiation and are unable to produce offspring. The males are completely or partially sterilized; if they are able to produce offspring, the offspring are sterile. By repeating the process, the target insect population eventually declines.

Originally developed by ARS scientists to control screwworms, SIT is now used to control Mediterranean fruit flies, pink bollworms and a number of other moths and pests.

Adult of faulse coddling moth (Thaumatotibia leucotreta).

Carpenter began working with South African scientists several years ago to develop SIT to control false codling moths and to test the methods in South Africa's citrus groves. In a series of studies, Carpenter and his colleagues found that irradiating adult false codling moths sterilized the females and ensured that males produced only sterile offspring. The research has been largely funded by the Food and Agriculture Organization and the International Atomic Energy Agency, which is dedicated to finding peaceful uses for nuclear energy.

Carpenter also helped South African scientists establish a mass-rearing facility in Citrusdal where codling moths are reared, chilled, irradiated and transported for release in the orchards. In a year of operations, sterilized moths released aerially and by hand drastically reduced moth populations in South Africa's Western Cape region. The sterile moths also are available for shipment to the USA if they are needed here. A report on this work was recently published in *Area-Wide Control of Insect Pests. From Research to Field Implementation* (Ed, by M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs). Springer, Dordrecht, The Netherlands (2007).

Source: USDA-ARS (10 December 2009)

First Record of *Drosophila suzukii* Reported in Italy

The National Plant Protection Organization of Italy recently informed the European Plant Protection Organization (EPPO) Secretariat of the first record of *Drosophila suzukii* (Diptera: Drosophilidae) on its territory. In September 2009, numerous larvae of an unknown drosophilid were found in ripening raspberries (*Rubus idaeus*) collected from a field near Pergine Valsugana (province of Trento – Trentino-Alto Adige region) in the northeast of Italy. The insect was identified as *D. suzukii*, an Asian pest of fruit crops which has recently been found damaging small fruit and fruit tree crops in North America. In Italy following its initial discovery, *D. suzukii* was detected during the autumn 2009 in a few areas of the province of Trento, in the municipali-

ties of Pergine Valsugana (Canzolino), Trento (Vigo Meano), Imer, Segonzano, and Vigo Cavedine. Damage has been observed on the following crops: *Vaccinium* spp. (blueberries), *Rubus idaeus* (raspberries), *Fragaria ananassa* (strawberries), *Rubus* spp. (blackberries). It is noted that small fruit crops are economically important in the province of Trento (covering approximately 600 ha, mainly in the eastern valleys of the province), and it is feared that the pest may attack other major fruit crops (e.g. cherries, peaches, nectarines, plums, grapes and apples) in Italy. In Trentino, all fruits from infected crops were collected and destroyed. In 2010, surveys will be intensified to determine the extent of the infestation (inspection of fruit crops, trapping programmes etc.) and fruit growers will be informed of this new pest introduction.

Spotted Wing Drosophila (Drosophila suzuki).

Drosophila suzukii originates from Asia. The species was first described in Japan in 1931 (although its presence was first registered in Yamanashi Prefecture, Honshu, in 1916). In Japan, *D. suzukii* is reported to cause damage to several fruits crops (including cherries and blueberries). In the USA, the presence of *D. suzukii* has been reported in Hawaii since the 1980s, but apparently without any particular damage to fruit crops. In continental USA, unusual damage caused by a *Drosophila* fly was first observed in September 2008 in a raspberry field in Santa Cruz County, California (USA).

Spotted Wing Drosophila-infested blueberry fruit with pupae (source: www.agf.gov.bc.ca).

At first, the pest was misidentified as *D. biarmipes* but with additional samples being collected from other locations in Santa Cruz County and cherry growing areas of the Central Valley, the identity of the pest could be confirmed as *D. suzukii*. At the end of 2009, the insect was considered to be established in many Californian counties. During 2009, *D. suzukii* spread to other US States (Florida, Oregon and Washington) and to British Columbia in Canada (Fraser and Central Okanagan Valleys).

Because *D. suzukii* is currently spreading and causing damage to fruit crops in North America, and how has been introduced into Europe, the EPPO Secretariat decided to add it to the EPPO Alert List.

Source: EPPO (1 January 2010)

Codling Moth Sterile Insect Release Programme Showing Benefits

The money Okanagan communities are investing in the Codling Moth Sterile Insect Release programme is paying off. That was the message from the programme's vice chair, Allan Patton, who made a presentation to the Vernon council. He says the initiative has made apples more valuable on the world market, and reduced chemical use in orchards by 97 000 pounds since 1992. “Years ago when we had to deal with the codling moth problem, we basically filled up the valley with organophosphate sprays all summer long, and if you notice that just isn't happening anymore. It's been a huge benefit that way.” Patton says the programme has reduced codling moth damage to under one percent (0.2 %), in 90 percent of Okanagan orchards. Patton says SIR's budget last year was three million dollars, adding the amount funded through property tax fell from C$2.3 million to C$1.6 million. He says the goal is to eventually have farmers paying as much as residents, adding their budget has been declining for a ‘long time’. Vernon homeowners pay anywhere from C$6 to C$20 a year for the programme, which Patton says amount to “a couple of lattes a year”. The initiative applies nature-friendly technology to the control of codling moth, the British Columbia tree fruit industry's most damaging and costly pest.

Source: Peter McIntyre (107.5 KissFM, 26 November 2009)

Peach Fruit Fly (*Bactrocera zonata*) Eradication Programme in Egypt

With approximately 2500 employees, the fruit industry and the Government of Egypt are carrying out the world’s largest fruit fly eradication programme attempting to eradicate the peach fruit fly (*Bactrocera zonata*) from the whole country.

The main technology used is the Male Annihilation Technique (MAT). This method is based on the massive use of bait stations saturated with a specific mix of Methyl-Eugenol (male attractant) and Malation. The toxic bait is exposed to the flies in the field in compressed wood blocks (stations). The bait stations are distributed on an area-wide basis, every 50 meters, covering all the fruiting areas (rural and urban) throughout the country. Initial support from FAO/IAEA through a technical cooperation project during the early 2000's was very important to transfer and establish the technology. Today, the programme is funded mostly by the fruit industry and complemented with the Government funds. In addition to the MAT, the programme is using state of the art technologies, such as Geographic Information and Monitoring Systems.

In 1924, *B. zonata* was declared present in Egypt based on the detection in an intercepted consignment of fruits in Port Said in 1912. For a long period, the pest was no longer mentioned. In the 1980s, an intensive Tephritid fruit fly survey, supported by FAO/IAEA, did not detect *B. zonata.*

Adult male of peach fruit fly (Bactrocera zonata).

In 1998, *B. zonata* was identified for the first time on infested guavas collected in Agamy and Sabahia, near Alexandria. In 1999, the first traps were set up and showed high capture rates in Alexandria and Cairo. In October 2000, *B. zonata* was detected in North Sinai (District of El Arish). Monitoring and a pilot eradication project was set up in the North Sinai Governorate and 45,000 bait station MAT blocks were distributed. At present, it is considered that *B. zonata* is present and widespread in Egypt.

The MAT programme was initiated all over the country in 2008 by contracting field and professional personnel, providing intensive training and specific expertise, implementing 34 Eradication Zones (which correspond to the Governorates of the country) with infrastructure and equipment, establishing 160 Eradication Units equivalent to the Districts of the country and considered the programme evaluation units.

The programme has been very successful in suppressing *B. zonata* throughout the country from a general average of 1.195 flies/trap/day (FTD) in 2008 to 0.313 FTD in 2009. Good experience has been gained in the last year to solve the weaknesses and to overcome the constraints found, and full eradication is expected to be achieved by 2012.

Blocks loaded with Methyl-Eugenol and Malathion.

For more detailed information please visit the National Area-Wide Peach Fruit Fly Eradication Programme website: http://www.peachfly-eg.com/ph13a.htm (ar). The English version is under construction (www.npffepeg. com).

Source: Gerardo Ortiz, consultant of the Egyptian Peach Fruit Fly Project

Biotech Advance May Yield Genetically Sterile Screwworms

Transgenic screwworms developed by Agricultural Research Service (ARS) scientists could set the stage for new, improved methods of eradicating the pest based on the sterile insect technique (SIT).

Pioneered by ARS entomologists nearly 55 years ago, the SIT is a cornerstone of eradication programmes implemented worldwide to control not only the screwworm, *Cochliomyia hominivorax,* but also the Mediterranean fruit fly, tsetse fly and other insect pests. By one estimate, screwworm eradication efforts today save USA livestock producers at least $900 million annually in potential losses.

The SIT involves sterilizing adult male flies with irradiation and releasing them into the wild to mate with females. Their eggs' failure to hatch diminishes the size of the next generation. Fewer flies, in turn, mean fewer insecticide applications to protect livestock, especially those with open wounds, where screwworm larvae feed.

But irradiating screwworms is costly. Irradiated male flies are also less competitive than wild-type males. So, starting in 2004, the ARS team—entomologists Margaret Allen and Steven Skoda and geneticist Alfred Handler—began research aimed at developing geneti-

cally sterile, male-only screwworms using transformation technology first applied on Mediterranean fruit flies. Allen is at the ARS Biological Control of Pests Research Unit in Stoneville, Mississippi.; Skoda is a research leader with the ARS Livestock Insects Research Laboratory at Kerrville, Texas; and Handler works at the ARS Insect Behavior and Biocontrol Research Unit in Gainesville, Florida.

Using a genetic element called a '*piggyBac* transposon' as a vector, the researchers introduced a green fluorescent protein (GFP) gene into the genomes of eight screwworm strains. When viewed under ultraviolet light, the transgenic screwworms emitted a fluorescent glow, helping confirm GFP's activation. Caged mating experiments showed transgenic male flies were as competitive as wild-type males, the team reports in the journal Medical and Veterinary Entomology (Volume 23, Supp. 1, June 2009, Pages: 98-105).

Sterile male screwworm fly marked with a numbered tag to study fly dispersal, behaviour, and longevity (Photo by Peggy Greb).

The next step is to develop male-only screwworms strains using the same transformation method as that used for the GFP strain. A further phase would explore inducing genetic sterility in the flies, which theoretically would eliminate the need for irradiation. The field release of transgenic flies, however, would hinge on an environmental impact assessment and regulatory approval.

Source: USDA-ARS (29 December 2009)

The Mediterranean Fruit Fly Facility of the Moscamed Programme in Mexico was Awarded a National 'Clean Industry' Certificate

The Mexican Federal Attorney for Environmental Protection, a division of the Ministry of Environment and Natural Resources, designated in December 2009 the Moscamed mass-rearing facility, in Metapa, State of Chiapas, as 'Clean Industry'. This award is recognition that the Moscamed facility achieved full compliance with Mexican environmental laws.

This is a major achievement considering that all the measures and infrastructure were implemented while the facility has been in uninterrupted operation since 1979, providing the sterile medflies required to prevent the establishment in Mexico of the *Ceratitis capitata* through the Mexican southeastern border with Guatemala.

Moscamed mass-rearing facility (front) and Moscafrut mass-rearing facility (left back) in Metapa, Chiapas, Mexico.

The certificate demonstrates that all processes to produce sterile flies do not pose a risk for the human population and environment, reinforcing in this way the favorable image of SIT as an environment friendly technology.

Source: Luis Silva and José M. Gutierrez, Moscamed Programme, Mexico

Mexican Moscamed Programme Authorized to Carry out Official Radiation Protection Courses.

The Mediterranean fruit fly mass-rearing facility of the Moscamed Programme in Mexico has recently received permission from the Mexican National Commission of Nuclear Safety and Safeguards to carry out officially recognized radiation protection courses and it is expected to extend the courses to participants from other countries in the Latin America and Caribbean region.

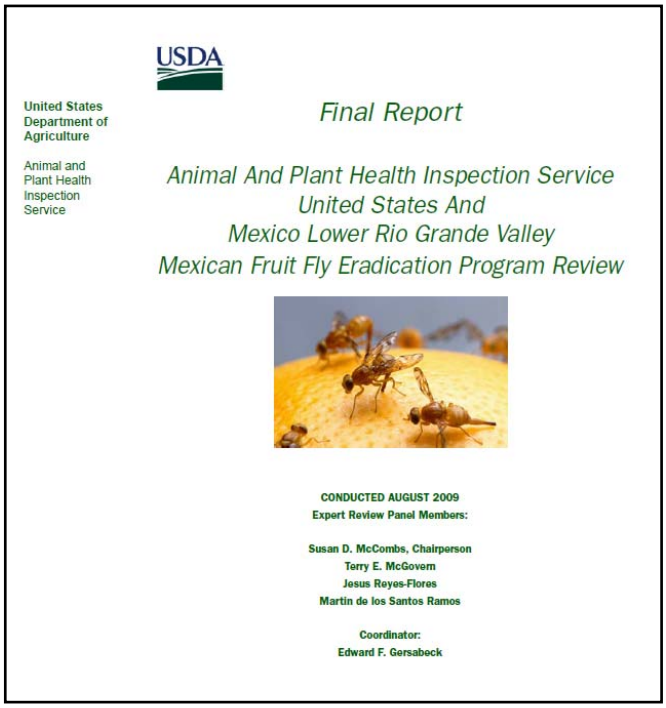
Considering that the Moscamed Programme has three different irradiators in their facilities, the organizers of the courses are also planning, in collaboration with the Joint FAO/IAEA Programme, to incorporate topics such as dosimetry and irradiation process control.

Source: Yeudiel Goméz and José Luis Zavala, Moscamed Programme, Mexico

Lower Rio Grande Valley Mexican Fruit Fly Eradication Programme Review

A review of the current status and performance of Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) and International Services (IS) Mexican fruit fly (*Anastrepha ludens* Loew) eradication activities in Texas and seven municipalities in northern Tamaulipas, Mexico is provided in this report. It is based on site visits and discussions with operational staff and programme managers in Texas and Mexico. The review contains recommendations for each component of the operational programme, strategic planning, and support activities. An international expert panel conducted site visits to Edinburg and Harlingen, Texas and Reynosa, Tamaulipas, Mexico in August 2009.

The threat from exotic fruit fly (Diptera: Tephritidae) entry and establishment in the USA remains high due to a number of factors. APHIS responds to exotic fruit fly risks with an integrated system incorporating off-shore risk mitigation, surveillance, control, prevention, and regulatory activities.



To eradicate the Mexican fruit fly from the Lower Rio Grande Valley (LRGV) of the state of Texas and the northern Mexican States of Tamaulipas and Nuevo Leon, APHIS and their cooperators operate surveillance, regulatory, insecticide applications, and sterile insect technique (SIT) programmes in high risk areas of these states.

The review concluded that the LRGV Mexican Fruit Fly Eradication Programme operated by APHIS and its cooperators requires the following:

- Fully integrated programme operations with a well-defined management structure to coordinate activities among APHIS agencies and cooperators.
- An eradication strategy that includes tactical operations applied in a systematic manner to achieve eradication from east to west across three counties of Texas and seven municipalities of Tamaulipas.
- A long-term strategy for declaration and maintenance of Mexican fruit fly free areas.

The goal of the review was to enhance programme efficacy and operational efficiencies through implementation of technical and tactical changes. The panel reviewed the strategy, tactical operations, and status of the LRGV Mexfly eradication programme in formulating their recommendations. A total of 90 recommendations were put forth by the expert panel.

The complete report can be found at the USDA website (http://www.aphis.usda.gov/plant_health/plant_pest_info/fruit_flies/downloads/LRGV_Final_Report.pdf).

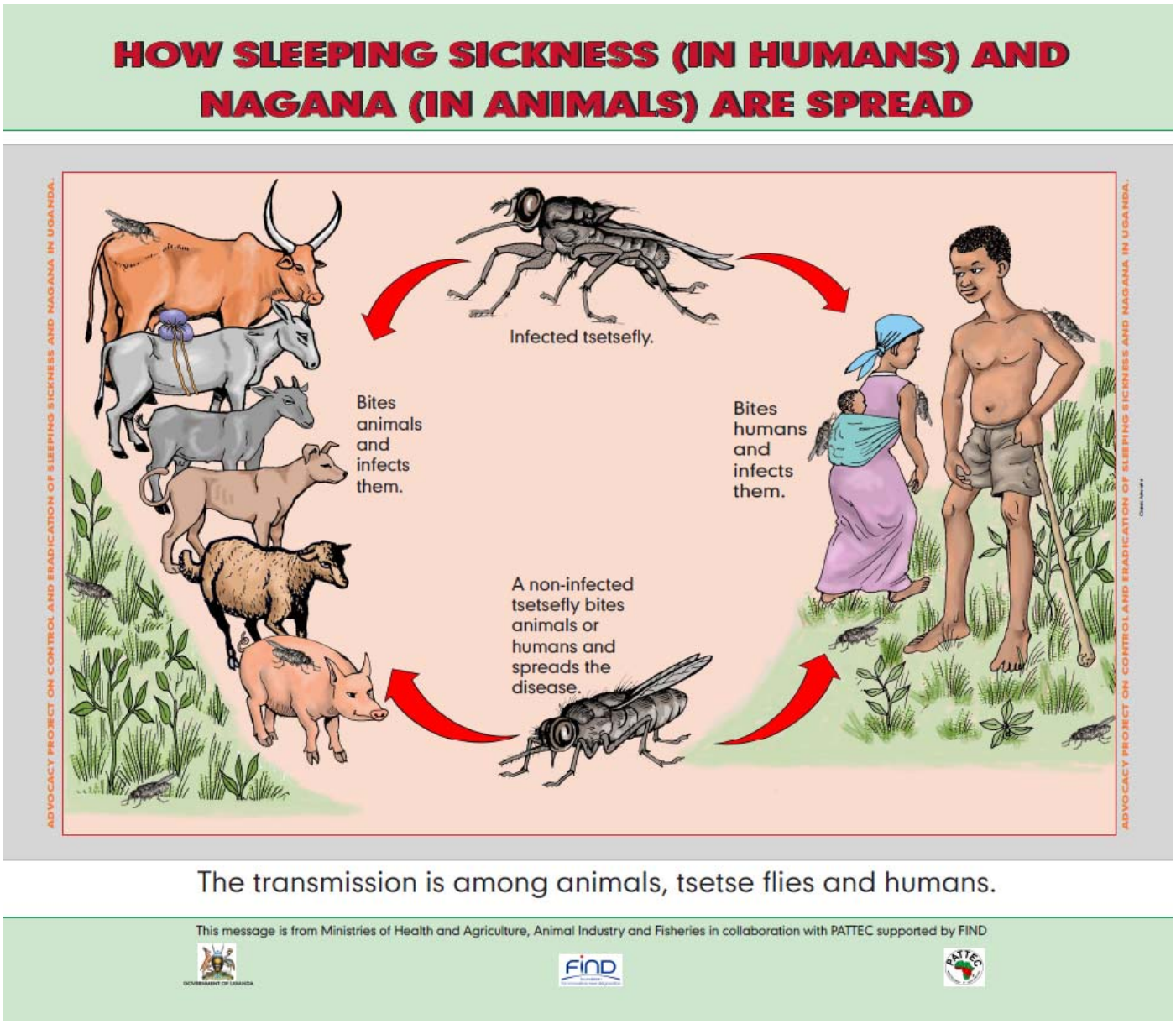
Source: USDA-APHIS-PPQ

Release of Calendar and Posters for the Ocasion of the Celebration of 10 Years of PATTEC

The Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) of the Africa Union (AU) will celebrate its 10th Anniversary in June/July 2010. We can use these 10 years of experience on PATTEC implementation as a platform to exchange and share your views and experiences on this continental initiative and to seek your kind constructive contribution on the way forward.

To celebrate the date, a Calendar and Poster were developed for farmers, students and other members of the community on African Trypanosomiasis Advocacy. It was developed by our African Trypanosomiasis Advocacy officer in Uganda. You may all wish to share such new innovations that will help strengthen the implementations of PATTEC in future. The Calendar 2010 (http://www.sendspace.com/file/k1of3y) and the Tsetse Posters (Spread of the disease and the prevention poster) (http://www.sendspace.com/file/x1aeib), can be downloaded.

Source: PATTEC



PATTEC poster on spread of the human and animal trypanosomiasis.

Interesting Published Articles

Give us the tools and we will do the job: symbiotic bacteria affect olive fly fitness in a diet-dependent fashion

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Abstract

Olive flies (*Bactrocera oleae*) are intimately associated with bacteria throughout their life cycle, and both larvae and adults are morphologically adapted for housing bacteria in the digestive tract. We tested the hypothesis that these bacteria contribute to the adult fly's fitness in a diet-dependent fashion. We predicted that when dietary protein is superabundant, bacterial contribution will be minimal. Conversely, in the absence of protein, or when only non-essential amino acids are present (as in the fly's natural diet), we predicted that bacterial contribution to fitness will be significant. Accordingly, we manipulated diet and the presence of bacteria in female olive flies, and monitored fecundity, an indirect measure of fitness. Bacteria did not affect fecundity when females were fed a nutritionally poor diet of sucrose, or a protein-rich, nutritionally complete diet. However, when females were fed a diet containing non-essential amino acids as the sole source of amino nitrogen, egg production was significantly enhanced in the presence of bacteria. These results suggest that bacteria were able to compensate for the skewed amino acid composition of the diet and may be indispensable for wild adult olive flies that subsist mainly on nitrogen-poor resources such as honeydew.

The full paper was published in: Proceedings of Royal Scociety B: Biological Sciences 277:1545-1552 (2010)

Radiation sources supporting the use of natural enemies for biological control of agricultural pests

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Abstract

Augmentative biological control as a component of integrated pest management programmes involves the release of natural enemies of the pest, such as parasitoids and predators. Several potential uses for nuclear techniques have been identified which can benefit such programmes; these benefits include facilitating trade, protecting the environment and increasing the overall efficacy of the programmes. This may involve sterilising feed material, hosts or even the control insects. Radiation is currently the most favoured sterilising agent, although availability and cost of radiation sources are considered as limiting the use of radiation in support of biological control. This paper reviews various radiation sources that may be used for this purpose, including a comparison of several key parameters such as cost estimates of these radiation sources that should assist in making a judicious selection of a suitable irradiator.

The full paper was published in: Biocontrol Science and Technology 19(S1):335-362 (2009).

A new generation of X ray irradiators for insect sterilization

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Abstract

Recent fears of terrorism have provoked an increase in delays and denials of transboundary shipments of radioisotopes. This represents a serious constraint to sterile insect technique (SIT) programmes around the world as they rely on the use of ionizing radiation from radioisotopes for insect sterilization. To validate a novel X ray irradiator, a series of studies on *Ceratitis capitata* (Wiedemann) and *Anastrepha fraterculus* (Wiedemann) (Diptera: Tephritidae) were carried out, comparing the relative biological effectiveness (RBE) between X rays and traditional γ radiation from ^{60}Co. Male *C. capitata* pupae and pupae of both sexes of *A. fraterculus*, both 24-48 h before adult emergence, were irradiated with doses ranging from 15 to 120 Gy and 10-70 Gy, respectively. Estimated mean doses of 91.2 Gy of X and 124.9 Gy of γ radiation induced 99% sterility in *C. capitata* males. Irradiated *A. fraterculus* were 99% sterile at ~ 40-60Gy for both radiation treatments. Standard quality control parameters and mating indices were not significantly affected by the two types of radiation. The RBE did not differ significantly between the tested X and γ radiation, and X rays are as biologically effective for SIT purposes as γ rays are. This work confirms the suitability of this new generation of X ray irradiators for pest control programmes that integrate the SIT.

The full paper was published in: Journal of Economic Entomology 103: 85-94 (2010).

Papers in Peer-Reviewed Journals

In Press

ABD-ALLA, A.M.M., D.G BOUCIAS and M. BERGOIN. Hytrosaviruses: Structure and Genomic Properties, in: Asgari S., Jonasson K., (Eds.), Insect Virology. Horizon Scientific Press (in press).

BARCLAY, H.J., and M.J.B VREYSEN. A dynamic population model for tsetse (Diptera: Glossinidae) area-wide integrated pest management. Population Ecology (in press).

BOUYER, J., B. SALL, M.T. SECK, L. GUERRINI and M.J.B VREYSEN. Stratified entomological sampling of an area-wide integrated pest management programme: the example of *Glossina palpalis gambiensis* in the Niayes of Senegal. Journal of Medical Entomology (in press).

GILLES, J., R.S. LEES, S.M. SOLIBAN and M.Q.BENEDICT. Density dependence effects in experimental larval populations of Anopheles arabiensis (Diptera: Culicidae) can be negative, neutral or overcompensatory depending on density and diet levels. Journal of Medical Entomology (in press).

HAQ I., C. CÁCERES, J. HENDRICHS, P.E.A. TEAL, V. WORNOAYPORN, C. STAUFFER and A.S. ROBINSON. Effects of the juvenile hormone analogue methoprene and dietary protein on on male melon fly *Bactrocera cucurbitae* (Diptera: Tephritidae) mating success. Journal of Insect Physiology (in press).

LIETZE, V., A.M.M. ABD-ALLA, M.J.B. VREYSEN, C. GEDEN, and D.G. BOUCIAS. The salivary gland hypertrophy viruses (SGHVs): a novel group of insect pathogenic viruses. Annual Review of Entomology (in press).

PEREIRA, R., J. SIVINSKI, P.E.A. TEAL and J. BROCKMANN. Enhancing male sexual success in a lekking fly (*Ananstrepha suspensa* [Loew]: Tephritidae) through a juvenile hormone analog has no effect on adult mortality. Journal of Insect Physiology (in press).

SOLANO, P., D. KABA, S. RAVEL, N. DYER, B. SALL B., M.J.B. VREYSEN, M.T. SECK, H. DARBYSHIR, L. GARDES, M.J. DONNELLY, T. DE MEEÛS and J. BOUYER. Population genetics as a tool to select suitable pest management strategies: suppression or eradication of *Glossina palpalis gambiensis* in the Niayes of Senegal. PLOS Neglected Tropical Diseases (in press).

2010

ABD-ALLA A., H. KARIITHI, A. PARKER, A. ROBINSON, M. KIFLON, M. BERGOIN and M. J. VREYSEN (2010). Dynamics of the salivary gland hypertrophy virus in laboratory colonies of *Glossina pallidipes* (Diptera: Glossinidae). Virus Research 150:103-110.

ALPHEY, L., M.Q. BENEDICT, R. BELLINI, G.G. CLARK, D.A. DAME, M.W. SERVICE and S.L. DOBSON (2010). Sterile-insect methods for control of mosquito-borne diseases – an analysis. Vector-Borne and Zoonotic Diseases 10: 295-311.

BOUYER, J., S. RAVEL, J.P. DUJARDIN, I. SIDIBÉ, M.J.B. VREYSEN, T. DE MEEÛS and P. SOLANO (2010). Population structure of *Glossina palpalis gambiensis* (Diptera: Glossinidae) in Burkina Faso and its consequences for area-wide integrated pest management. Infection, Genetics and Evolution, 10: 321-328.

FELDMANN, U. and A. PARKER (2010). Using a pest to attack itself – Tsetse SIT can make a difference. Public Health Journal 21:38-42.

GABRIELI, P., A. FALAGUERRA, P. SICILIANO, L.M. GOMULSKI, F. SCOLARI, A. ZACHAROPOULOU, G. FRANZ, A.R. MALACRIDA and G. GASPERI (2010). Sex and the single embryo: early development in the Mediterranean fruit fly, *Ceratitis capitata*. BMC Developmental Biology 10:12.

HAQ I., C. CÁCERES, J. HENDRICHS, P.E.A. TEAL, C. STAUFFER and A.S. ROBINSON. Methoprene modulates the effect of diet on male melon fly *Bactrocera cucurbitae* performance at mating aggregations. Entomologia Experimentalis et Applicata 136: 21-30.

MASTRANGELO, T., A.G. PARKER, A. JESSUP, R. PEREIRA, D. OROZCO-DÁVILA, A. ISLAM, T. DAMMALAGE and J.M.M. WALDER (2010). A new generation of X ray irradiators for insect sterilization. Journal of Economic Entomology 103:85-94.

PEREIRA, R., J. SIVINSKI and P.E.A. TEAL (2010). Influence of a juvenile hormone analogue and dietary protein on male *Anastrepha suspensa* (Diptera: Tephritidae) sexual success. Journal of Economic Entomology 103:40-46.

SIMMONS, G.S., J. CARPENTER, M. SUCKLING, M. ADDISON, A. DYCK and M.J.B. VREYSEN (2010). Improved quality management to enhance the efficacy of the sterile insect technique for lepidopteran pests. Journal of Applied Entomology 134:261-273.

TARET, G., M. SEVILLA, V. WORNOAYPORN, A. ISLAM, S. AHMAD, C. CACERES, A.S. ROBINSON and M.J.B. VREYSEN (2010). Mating compatibility among populations of codling moth *Cydia pomonella* Linnaeus (Lepidoptera: Tortricidae) from different geographic origins. Journal of Applied Entomology 134:207-215.

VREYSEN, M.J.B., and A.S. ROBINSON (2010). Ionizing radiation and area-wide management of insect pests to

promote sustainable agriculture: a review. Agronomy for Sustainable Development doi: 10.1051/agro/20100009.

VREYSEN, M.J.B., J.E. CARPENTER and F. MAREC (2010). Improvement of codling moth *Cydia pomonella* (Lepidoptera: Tortricidae) SIT to facilitate expansion of field application. Journal of Applied Entomology 134:165-181.

2009

ABD-ALLA, A., F. COUSSERANS, A. PARKER, M. BERGOIN, J. CHIRAZ and A. ROBINSON (2009). Quantitative PCR analysis of the salivary gland hypertrophy virus (GpSGHV) in a laboratory colony of *Glossina pallidipes*. Virus Research 139:48-53.

ABD-ALLA, A.M.M., J.M. VLAK, M. BERGOIN, J.E. MARUNIAK, A.G. PARKER, J.P. BURAND, J.A. JEHLE and D.G. BOUCIAS (2009). Hytrosaviridae: a proposal for classification and nomenclature of a new insect virus family. Archives of Virology 154:909-918.

AGEEP, T.B., J. COX, M.M. HASSAN, B.G.J. KNOLS, M.Q. BENEDICT, C.A. MALCOLM, A. BABIKER and B.B. EL SAYED (2009). Spatial and temporal distribution of the malaria mosquito *Anopheles arabiensis* in northern Sudan: influence of environmental factors and implications for vector control. Malaria Journal 8:123.

ALUJA, M., F. DIAZ-FLEISCHER, E.F. BOLLER, J. HURTER, A.J.F. EDMUNDS, L. HAGMANN, B. PATRIAN, and J. REYES (2009). Application of feces extracts and synthetic analogues of the host marking pheromones of *Anastrepha ludens*, significantly reduces fruit infestation by *A. obliqua* in tropical plum and mango backyard orchards. Journal of Economic Entomology 102:2268-2278.

BAQUERIZO-AUDIOT, E., A. ABD-ALLA, F.-X. JOUSSET, F. COUSSERANS, P. TIJSSEN and M. BERGOIN (2009). Structure and expression strategy of the genome of *Culex pipiens* densovirus, a mosquito densovirus with an ambisense organization. Journal of Virology 83:6863-6873.

BENEDICT, M.Q., R.C. HOOD-NOWOTNY, P.I. HOWELL and E.E. WILKINS (2009). Methylparaben in *Anopheles gambiae s.l.* sugar meals increases longevity and malaria oocyst abundance but is not a preferred diet. Journal of Insect Physiology 55:197-204.

BENEDICT, M.Q., B.G.J. KNOLS, H.C. BOSSIN, P.I. HOWELL, E. MIALHE, C. CÁCERES and A.S. ROBINSON (2009). Colonization and mass rearing: learning from others. Malaria Journal 8(Suppl 2):S4.

BRICEÑO, R.D., and W.G. EBERHARD (2009). Experimental demonstration of possible cryptic female choice on male tsetse fly genetalia. Journal of Insect Physiology 55:989-996.

BRICEÑO, R.D., and W.G. EBERHARD (2009). Experimental modifications imply a stimulatory function for male tsetse fly genitalia, supporting cryptic female choice theory. Journal of Evolutionary Biology 22:1516-1525.

CANCINO, J., L. RUÍZ, J. HENDRICHS and K. BLOEM (2009). Evaluation of sequential exposure of irradiatiated hosts to maximize the mass rearing of fruit fly parasitoids. Biocontrol Science and Technology 19(Suppl 1):95-109.

CÁCERES, C., D.F. SEGURA, M.T. VERA, V. WORNOAYPORN, J.L. CLADERA, P. TEAL, P. SAPOUNTZIS, K. BOURTZIS, A. ZACHAROPOULOU and A.S. ROBINSON (2009). Incipient speciation revealed in *Anastrepha fraterculus* (Diptera; Tephritidae) by studies on mating compatibility, sex pheromones, hybridization, and cytology. Biological Journal of the Linnean Society 97:152-165.

DAME, D.A., C.F. CURTIS, M.Q. BENEDICT, A.S. ROBINSON and B.G.J. KNOLS (2009). Historical applications of induced sterilisation in field populations of mosquitoes. Malaria Journal 8(Suppl 2):S2.

EL SAYED, B.B., C.A. MALCOLM, A. BABIKER, E.M. MALIK, M.A.H. EL TAYEB, N.S. SAEED, A.H.D. NUGUD and B.G.J. KNOLS (2009). Stakeholders first: ethical, legal and social aspects of the approach in Sudan. Malaria Journal 8(Suppl 2):S3.

GARCÍA-MARTÍNEZ, V., E. HERNÁNDEZ-ORTÍZ, C.S. ZEPEDA-CISNEROS, A.S. ROBINSON, A. ZACHAROPOULOU and G. FRANZ (2009). Mitotic and polytene chromosome analysis in the Mexican fruit fly, *Anastrepha ludens* (Loew) (Diptera: Tephritidae). Genome 52(1):20-30.

GARCÍA-MARUNIAK, A., A.M.M. ABD-ALLA, T.Z. SALEM, A.G. PARKER, M.M. VAN OERS, J.E. MARUNIAK, W. KIM, J.P. BURAND, F. COUSSERANS, A.S. ROBINSON, J.M. VLAK, M. BERGOIN and D.G. BOUCIAS (2009). Two viruses that cause salivary gland hypertrophy in *Glossina pallidipes* and *Musca domestica* are related and form a distinct phylogenetic clade. Journal of General Virology 90:334-346.

HELINSKI, M.E., and B.G. KNOLS (2009). Sperm quantity and size variation in un-irradiated and irradiated males of the malaria mosquito *Anopheles arabiensis* Patton. Acta Tropica 109:64-69.

HELINSKI, M.E.H., and B.G.J. KNOLS (2009). The influence of late-stage pupal irradiation and increased irradiated: un-irradiated male ratio on mating competitiveness of the malaria mosquito *Anopheles arabiensis* Patton. Bulletin of Entomological Research 99:317-322.

HELINSKI, M.E., A.G. PARKER and B.G.J. KNOLS (2009). Radiation biology of mosquitoes. Malaria Journal 8(Suppl 2):S6.

HENDRICHS, J., and A. ROBINSON (2009). Sterile Insect Technique, pp. 953-957. *In* Resh, V.H. and R.T. Cardé (eds.), Encyclopedia of Insects. 2nd Edition, Academic Press, Burlington, MA.

HENDRICHS, J., and A. ROBINSON (2009). To kill a pest. IAEA Bulletin 51(1):34-38.

HENDRICHS, J., K. BLOEM, G. HOCH, J.E. CARPENTER, P. GREANY and A.S. ROBINSON (2009). Improving the cost-effectiveness, trade and safety of biological control for agricultural insect pests using nuclear techniques. Biocontrol Science and Technology 19(Suppl 1):3-22.

HOOD-NOWOTNY, R., L. MAYR, A. ISLAM, A. ROBINSON and C. CACERES (2009). Routine isotope marking for the Mediterranean fruit fly (Diptera: Tephritidae). Journal of Economic Entomology 102:941-947.

HOWELL, P.I., and M.Q. BENEDICT (2009). Mating competitiveness of *Anopheles arabiensis* males as a function of transgenic state and genetic similarity to females. Journal of Insect Behavior 22:477-491.

HOWELL, P., and B.G.J. KNOLS (2009). Male mating biology. Malaria Journal 8(Suppl 2):S8.

MALCOLM, C.A., B.B. EL SAYED, A. BABIKER, R. GIROD, D. FONTENILLE, B.G.J. KNOLS, A.H. NUGUD and M.Q. BENEDICT (2009). Field site selection: getting it right first time round. Malaria Journal 8(Suppl 2):S9.

MAYAGAYA, V.S., K. MICHEL, M.Q. BENEDICT, G.F. KILLEEN, R.A. WIRTZ, H.M. FERGUSON and F.E. DOWELL (2009). Non-destructive determination of age and species of *Anopheles gambiae* s.l. using near-infrared spectroscopy. American Journal of Tropical Medicine and Hygiene 81:622-630.

METHA, K. Radiation sources supporting the use os natural enemies for biological control of agricultural pests. Biocontrol Science and Technology 19(Suppl 1):335-362.

MORRISON, N.I, D.F. SEGURA, K.C. STAINTON, G. FU, C.A. DONNELLY, and L.S. ALPHEY (2009). Sexual competitiveness of a transgenic sexing strain of the Mediterranean fruit fly, *Ceratitis capitata*. Entomologia Experimentalis et Applicata 133:146-153.

PAPATHANOS, P.A., H.C. BOSSIN, M.Q. BENEDICT, F. CATTERUCCIA, C.A. MALCOLM, L. ALPHEY and A. CRISANTI (2009). Sex separation strategies: past experience and new approaches Malaria Journal. 8(Suppl 2):S5.

PEREIRA, R., J. SIVINSKI and P.E.A. TEAL (2009). Influence of methoprene and dietary protein on male *Anastrepha suspensa* (Diptera: Tephritidae) mating aggregations. Journal of Insect Physiology 55:328-335.

ROBINSON, A.S., B.G.J. KNOLS, G. VOIGT and J. HENDRICHS (2009). Conceptual framework and rationale. Malaria Journal 8(Suppl 2):S1.

ROBINSON, A.S., M.J.B. VREYSEN, J. HENDRICHS and U. FELDMANN (2009). Enabling technologies to improve area-wide integrated pest management programmes for the control of screwworms. Medical and Veterinary Entomology 23:1-7.

SCHETELIG, M.F., C. CÁCERES, A. ZACHAROPOULOU, G. FRANZ and E.A. WIMMER (2009). Conditional embryonic lethality to improve the sterile insect technique in *Ceratitis capitata* (Diptera: Tephritidae). BMC Biology 7:4.

SEGURA, D.F., C. CÁCERES, M.T. VERA, V. WORNOAYPORN, A. ISLAM, P.E.A. TEAL, J.L. CLADERA, J. HENDRICHS and A.S. ROBINSON (2009). Enhancing mating performance after juvenile hormone treatment in *Anastrepha fraterculus:* a differential response in males and females acts as a physiological sexing system. Entomologia Experimentalis et Applicata 131:74-84.

STEINBERG, S., and J.P. CAYOL (2009). Synergism between biological control and sterile insect technique: Can commercial mass production of biocontrol agents and sterile insects be integrated within the same industrial entity? Biocontrol Science and Technology 19(Suppl 1):271-275.

TAKKEN, W., and B.G.J. KNOLS (2009). Malaria vector control: Current and future strategies. Trends in Parasitology 25:101-104.

VREYSEN, M.J.B., A.S. ROBINSON and J. HENDRICHS (2009). Book Review. Area-wide control of insect pests: from research to field implementation. Medical and Veterinary Entomology 23:293-294.

ZABALOU, S., A. APOSTOLAKI, I. LIVADARAS, G. FRANZ, A.S. ROBINSON, C. SAVAKIS and K. BOURTZIS (2009). Incompatible insect technique: incompatible males from a *Ceratitis capitata* genetic sexing strain. Entomologia Experimentalis et Applicata 132:232-240.

2008

ABD-ALLA, A.M.M., F. COUSSERANS, A.G. PARKER, J.A. JEHLE, N.J. PARKER, J.M. VLAK, A.S. ROBINSON, and M. BERGOIN. (2008). Genome analysis of a *Glossina pallidipes* salivary gland hypertrophy virus (GpSGHV) reveals a novel large double-stranded circular DNA virus. Journal of Virology 82 (9): 595-611.

ABILA, P.P., M.A. SLOTMAN, A. PARMAKELIS, K.B. DION, A.S. ROBINSON, V.B. MUWANIKA, J.C.K ENYARU, L.M. OKEDI, S. AKSOY and A. CACCONE (2008). High levels of genetic differentiation between Ugandan *Glossina fuscipes fuscipes* populations

separated by Lake Kyoga. PLoS Neglected Tropical Diseases 2: e242.

BENEDICT, M.Q. and A.S. ROBINSON (2008). Impact of technological improvements on traditional control strategies, pp. 84-90. *In* Aksoy, S. (ed.), Transgenesis and management of vector-borne diseases. Landes Bioscience, New York, USA.

BROWN, P.J.E., K.J. KOMATSU, P.P. ABILA, A.S. ROBINSON, L.M. OKEDI, N. DYER, M.J. DONNELLY, M.A. SLOTMAN and A. CACCONE (2008). Polymorphic microsatellite markers for the tsetse fly *Glossina fuscipes fuscipes* (Diptera: Glossinidae), a vector of human African trypanosomiasis. Molecular Ecology Resources 8: 1506-1508.

CÁCERES, C. and P. RENDÓN (2008). The FAO/IAEA interactive spreadsheet for design and operation of insect mass rearing facilities, pp. 307-312. *In* Sugayama R. L. et al. (eds.), Fruit Flies of Economic Importance: From Basic to Applied Knowledge, Proceedings of the 7th International Symposium on Fruit Flies of Economic Importance. SBPC, Salvador, Bahia, Brazil.

CORE WORKING GROUP ON GUIDANCE FOR CONTAINED FIELD TRIALS (multi-authored including Benedict, M.Q) (2008). Guidance for contained field trials of vector mosquitoes engineered to contain a gene drive system: recommendations of a scientific working group. Vector-Borne and Zoonotic Diseases 8 (2):127-166.

CORONADO GONZALEZ, P.A., S. VIJAYSEGARAN and A.S. ROBINSON (2008). Mouthpart structure and feeding mechanisms of adult *Ceratitis capitata* (Wied) (Diptera: Tephritidae) Journal of Insect Science 8:73.

DYER, N.A., S.P. LAWTON, S. RAVEL, K.S. CHOI, M.J. LEHANE, A.S. ROBINSON, L.A. OKEDI, M.J.R. HALL, P. SOLANO and M.J. DONNELLY (2008). Molecular phylogenetics of tsetse flies (*Diptera: Glossina*) based on mitochondrial (*COI*, *16S*, *ND2*) and nuclear ribosomal DNA sequences. Molecular Phylogenetics and Evolution 49: 227-239.

ENKERLIN W.R (2008). Análisis costo-beneficio del manejo integrado de plagas, pp.263-287. *In* J. Toledo and F. Infante (eds), Manejo Integrado de Plagas. Trillas, México DF, Mexico.

ENKERLIN W.R. and D.A. LINDQUIST (2008). Manejo integrado de plagas en áreas extensas, pp.237-251. *In* J. Toledo and F. Infante (eds), Manejo Integrado de Plagas. Trillas, México DF, Mexico.

FARIA, M.J., R. PEREIRA, T. DELLINGER and P.E.A. TEAL (2008). Influence of methoprene and protein on survival, maturation and sexual performance of male *Ceratitis capitata* (Diptera:Tephritidae). Journal of Applied Entomology 132: 812-819.

HELINSKI, M.E.H., and B.G.J. KNOLS (2008). Mating competitiveness of male *Anopheles arabiensis* mosquitoes irradiated with a partially or fully sterilizing dose in small and large laboratory cages. Journal of Medical Entomology 45: 698-705.

HELINSKI, M.E.H., R.C. HOOD, and B.G.J. KNOLS (2008). A stable isotope dual-labelling approach to detect multiple inseminations in un-irradiated and irradiated *Anopheles arabiensis* mosquitoes. Parasites & Vectors 1: 9.

LIEDO, P., W.R ENKERLIN and J. HENDRICHS (2008). La técnica del insecto estéril, pp.202-213. *In* J. Toledo and F. Infante (eds), Manejo Integrado de Plagas. Trillas, México DF, Mexico.

PARKER, NJ., and A.G. PARKER (2008). Simple tools for assembling and searching high-density picolitre pyrophosphate sequence data. Source Code for Biology and Medicine 3 (1): 5.

2007

ABD-ALLA, A., H. BOSSIN, F. COUSSERANS, A. PARKER, M. BERGOIN, and A.S. ROBINSON (2007). Development of a non-destructive PCR method for detection of the salivary gland hypertrophy virus (SGHV) in tsetse flies. Journal of Virological Methods 139: 143-149.

ALEMU, T., B. KAPITANO, S. MEKONNEN, G. ABOSET, M. KIFLOM, B. BANCHA, G. WOLDEYES, K. BEKELE, and U. FELDMANN (2007). Area-wide intervention against the tsetse and trypanosomosis problem: the Ethiopian experience in the Southern Rift Valley, pp. 325-335. *In* M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

BRICEÑO, R.D., W.G. EBERHARD, and A.S. ROBINSON (2007). Copulation behaviour of *Glossina pallidipes* (Diptera: Muscidae) outside and inside the female, with a discussion on genitalic evolution. Bulletin of Entomological Research 97:1-18.

CÁCERES C., E. RAMÍREZ, V. WORNOAYPORN, S.M. ISLAM, and S. AHMAD (2007). A protocol for storage and long-distance shipment of Mediterranean fruit fly (Diptera: Tephritidae) eggs. I. Effect of temperature, embryo age and storage time on survival and quality. Florida Entomologist 90: 103-109.

CÁCERES C., D. MCINNIS, T. SHELLY, E. JANG; A.S. ROBINSON, and J. HENDRICHS (2007). Quality management systems for fruit fly (Diptera: Tephritidae) sterile insect technique. Florida Entomologist 90: 1-9.

GARCÍA, R., L. MÉNDEZ, E. SERRANO, and M.J.B. VREYSEN (2007). Insecticidal wound treatment of livestock on Isla de la Juventud, Cuba: an efficient suppression method of New World screwworm *Cochliomyia*

hominivorax prior to the release of sterile males, pp. 393-403. *In* M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

GARIOU-PAPALEXIOU, A., G. YANNOPOULOS, A.S. ROBINSON, and A. ZACHAROPOULOU (2007). Polytene chromosome maps in four species of tsetse flies *Glossina austeni, G. pallidipes, G. morsitans morsitans* and *G. m. submorsitans* (Diptera: Glossinidae): a comparative analysis. Genetica 129: 243-251.

HELINSKI, M.E.H., R. HOOD-NOWOTNY, L. MAYR, and B.G.J. KNOLS (2007). Stable isotope-mass spectrometric determination of semen transfer in malaria mosquitoes. Journal of Experimental Biology 210: 1266-1274.

HENDRICHS, J., P. KENMORE, A.S. ROBINSON, and M.J.B. VREYSEN (2007). Area-wide integrated pest management (AW-IPM): principles, practice and prospects, pp. 3-33. *In* M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

HENDRICHS, M.A., V. WORNOAYPORN, B.I. KATSOYANNOS, and J. HENDRICHS (2007). Quality control method to measure predator evasion in wild and mass-reared Mediterranean fruit flies (Diptera: Tephritidae). Florida Entomologist 90: 64-70.

HOOD-NOWOTNY, R. and B.G.J. KNOLS (2007) Stable isotope methods in biological and ecological studies of arthropods. Entomologia Experimentalis et applicata 124: 3-16.

KAPPMEIER GREEN, K., F.T. POTGIETER, and M.J.B. VREYSEN (2007). A strategy for an area-wide control campaign with an SIT component to establish a tsetse-free South Africa, pp. 309-323. *In* M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

KNOLS, B.G.J., H.C. BOSSIN, W.R. MUKABANA, and A.S. ROBINSON (2007). Transgenic mosquitoes and the fight against malaria: managing technology push in a turbulent GMO world. American Journal of Tropical Medicine and Hygiene 77: 232-242

KNOLS, B., R.C. HOOD, H. BOSSIN, G. FRANZ, A.S. ROBINSON, W.R. MUKABANA, and S.M. KEM (2007). GM sterile mosquitoes – a cautionary note. Nature Biotechnology 24: 1067-1068.

MAMÁN, E., and C. CÁCERES (2007). A protocol for storage and long-distance shipment of Mediterranean fruit fly (Diptera: Tephritidae) eggs. II. Assessment of the optimal temperature and substrate for male-only production. Florida Entomologist 90: 110-114.

M'SAAD GUERFALI M., A. RAIES, H. BEN SALAH, F. LOUSSAIEF, and C. CÁCERES (2007). Pilot Mediterranean fruit fly *Ceratitis capitata* rearing facility in Tunisia: constraints and prospects, pp. 535-543. *In* M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

NESTEL, D., E. NEMNY-LAVY, A. ISLAM, V. WORNOAYPORN, and C. CÁCERES (2007). Effect of pre-irradiation conditioning of medfly pupae (Diptera: Tephritidae): hypoxia and quality of sterile males. Florida Entomologist 90: 80-87.

PARKER, A.G., and K. MEHTA (2007). Sterile insect technique: dose optimization, dosimetry, and irradiation for improved sterile insect quality. Florida Entomologist 90: 88-95.

PEREIRA, R., N. SILVA, C. QUINTAL, R. ABREU, J. ANDRADE, and L. DANTAS (2007). Sexual performance of mass-reared and wild Mediterranean fruit flies (Diptera: Tephritidae) from various origins of the Madeira Islands. Florida Entomologist 90: 10-14.

PEREIRA, R., N. SILVA, C. QUINTAL, R. ABREU, J. ANDRADE, and L. DANTAS (2007). Effect of acclimation to outdoor conditions on the sexual performance of mass-produced medflies (Diptera: Tephritidae). Florida Entomologist 90: 171-174.

PEREIRA, R., G. J. STECK, E. VARONA, and J. SIVINSKI (2007). Biology and natural history of *Anastrepha interrupta* (Diptera: Tephritidae). Florida Entomologist 90: 389-391.

REYES, J.X. CARRO, J. HERNANDEZ, W. MENDEZ, C. CAMPO, H. ESQUIVEL, E. SALGADO, and W. ENKERLIN (2007). A multi-institutional approach to implement fruit fly-low prevalence and fly free areas in Central America, pp. 627-640. *In* M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

SIVINSKI, J., T. HOLLER, R. PEREIRA, and M. ROMERO (2007). The thermal environment of immature Caribbean fruit flies, *Anastrepha suspensa* (Diptera: Tephritidae). Florida Entomologist 90: 347-357.

VREYSEN, M.J.B., A.S. ROBINSON, and J. HENDRICHS (eds.) (2007). Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

VREYSEN, M.J.B., J. GERARDO-ABAYA, and J.P. CAYOL (2007). Lessons from area-wide integrated pest management (AW-IPM) programmes with an SIT component: an FAO/IAEA perspective, pp. 723-744. *In* M.J.B. Vreysen, A.S. Robinson, and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, The Netherlands.

Priced and Unpriced Publications

2010

VREYSEN M.J.B. and ROBINSON A.S (eds.) (2010). Proceedings of an FAO/IAEA Coordinated Research Project on Improvement of Codling Moth SIT to Facilitate Expansion of Field Application. Journal of Applied Entomology (volume 134 (3): 163-273

2009

BENEDICT M.Q, ROBINSON A.S and KNOLS B.G.J. (eds.) (2009). Development of the Sterile Insect Technique for African Malaria Vectors. Malaria Journal: 8 Suppl. 2. (unpriced)

BLOEM, K. GREANY, P. and HENDRICHS J. (eds.) (2009). Use of Radiation in Biological Control. Biocontrol Science and Technology. 19 Suppl. 1. Available on (http://www.informaworld.com/openurl?genre=issue&issn=0958- 3157&volume=19&supp=1&uno) (unpriced)

GIBSON, G., COLWELL, D.D., ROBINSON A.S. and STEVENS, J.R. (eds.) (2009) Proceedings of an FAO/IAEA Coordinated Research Project on Enabling Technologies for the Expansion of Screwworm SIT Programmes. Medical and Veterinary Entomology 23: Sup. 1. (130 pp.). Freely available on http://www3.interscience.wiley.com/jounal/118540244/home. (unpriced)

IAEA. 2009. Manual for the Use of Stable Isotopes in Entomology. Vienna, Austria. 74 pp. (unpriced)

2008

LEAK, S.G.A., EJIGU, D., and VREYSEN, M.J.B. (2008) Collection of Entomological Baseline Data for Tsetse Area-wide Integrated Pest Management Programmes. Food and Agriculture Organization of the United Nations, Rome, Italy. 205 pp. (unpriced)

FAO/IAEA. 2008. Model Business Plan for a Sterile Insect Production Facility. IAEA, Vienna, Austria. 386 pp. (unpriced)

2007

ENKERLIN, W. (ed.). 2007. Guidance for Packing, Shipping, Holding and Release of Sterile Flies in Area-Wide Fruit Fly Control Programmes. FAO Plant Production and Protection Paper 190, Rome, Italy. 134 pp. (unpriced)

FAO/IAEA. 2007. Cost-Benefit Analysis Model: A Tool for Area-Wide Fruit Fly Management. CD ROM, Vienna, Austria. (unpriced)

FAO/IAEA. 2007. Proceedings of an FAO/IAEA Coordinated Research Project on Quality Assurance of Mass-Reared and Released Fruit Flies for use in SIT Programmes. Florida Entomologist 90: 1-179. Freely available on http://www.fcla.edu/FlaEnt (unpriced)

IAEA. 2007. Development of Improved Attractants and their Integration into Fruit Fly SIT Management Programmes. IAEA-TECDOC-1574, ISBN 987-92-0-109407-0. IAEA, Vienna, Austria. (unpriced)

VREYSEN, M.J.B., ROBINSON, A.S., and HENDRICHS, J. 2007 (ed.). Area-Wide Control of Insect Pests. From Research to Field Implementation. Springer, Dordrecht, The Netherlands. 789 pp. (unpriced)

ZIMMERMANN, H., BLOEM, S. and KLEIN, H . 2007. The Biology, History, Threat, Surveillance and Control of the Cactus Moth, *Cactoblastis cactorum* / Biologia, Historia, Amenaza, Monitoreo y Control de la Palomilla del Nopal, *Cactoblastis cactorum* FAO/IAEA, Vienna, Austria. 93 pp. (bilingual: English and Spanish) (unpriced)

2006

FAO/IAEA. 2006. Using GPS Instruments and GIS Techniques in Data Management for Insect Pest Control Programmes. Tutorial CD produced by Arava Development Co. for FAO/IAEA. IAEA, Vienna, Austria. (unpriced)

IAEA. 2006. Designing and Implementing a Geographical Information System. A Guide for Managers of Area-wide Pest Management Programmes. Non-serial IAEA publication. IAEA, Vienna, Austria. (unpriced)

IAEA. 2006. Status and Risk Assessment of the Use of Transgenic Arthropods in Plant Protection. IAEA-TECDOC-1483, ISBN 92-0-113005-8. IAEA, Vienna, Austria. (Euro 15)

2005

DYCK, V.A., HENDRICHS J., ROBINSON A.S. 2005 (eds.). Sterile Insect Technique. Principles and Practice in Area-wide Integrated Pest Management. Springer, Dordrecht, The Netherlands. 787pp. (unpriced)

Environmental Benefits of Medfly SIT in Madeira and Their Inclusion in a Cost-Benefit Analysis. IAEA-TECDOC-1475, ISBN 92-0-110505-3. IAEA, Vienna, Austria. (Euro 15)

IAEA. 2005. The Cactus Moth *Cactoblastis cactorum*: An Economic, Social and Ecological Threat. CD ROM, Video NTSC available in English. IAEA, Vienna, Austria. (unpriced)

2004-1995

ZIMMERMAN, H., S. BLOEM, and H. KLEIN. 2004. Biology, History, Threat, Surveillance, and Control of the Cactus Moth, *Cactoblastis cactorum*. Non-serial publica-

tion, ISBN 92-0-108304-1. IAEA, Vienna, Austria. (Euro 30)

IAEA. 2003. Automation for Tsetse Mass Rearing for Use in Sterile Insect Technique Programmes. IAEA-TECDOC-1353, ISBN 92-0-104303-1. IAEA, Vienna, Austria. (Euro 15)

IAEA/FAO. 2003. Trapping Guideline for Area-Wide Fruit Fly Programmes. Non-serial publication (English and Spanish versions). IAEA, Vienna, Austria. (unpriced)

IAEA. 2003. Improved Attractants for Enhancing Tsetse Fly Suppression. IAEA-TECDOC-1064, ISBN 92-0-110403-0. IAEA, Vienna, Austria. (Euro 15)

FAO/IAEA. 2002. Proceedings of an FAO/IAEA Research Coordination Project on Medfly Mating. Florida Entomologist 85: 1-181. Freely available on http://www.fcla.edu/FlaEnt

IAEA. 2002. The Sterile Insect Technique. An Environment-Friendly Method of Insect Pest Suppression and Eradication. Video (NTSC, PAL format) – CD (English, Spanish and French). IAEA, Vienna, Austria. (unpriced)

IAEA. 2002. Evaluation of Lepidoptera Population Suppression by Radiation Induced Sterility. IAEA-TECDOC-1283, ISSN 1011-4289. IAEA, Vienna, Austria. (Euro 15)

TAN, K. H. (ed.). 2000. Proceedings: Area-Wide Control of Fruit Flies and Other Insect Pests. International Conference on Area-Wide Control of Insect Pests, and the 5th International Symposium on Fruit Flies of Economic Importance, 28 May-5 June 1998, Penang, Malaysia. Penerbit Universiti Sains Malaysia, Pulau Pinang, Malaysia. ISBN 983-861-195-6. (unpriced)

IAEA. 1999. Development of Female Medfly Attractant Systems for Trapping and Sterility Assessment. IAEA-TECDOC-1099, ISSN 1011-4289. IAEA, Vienna, Austria. (Euro 15)

IAEA. 1999. The South American Fruit Fly, *Anastrepha fraterculus* (Wied.) Advances in Artificial Rearing, Taxonomic Status and Biological Studies. IAEA-TECDOC-1064, ISSN 1011-4289. IAEA, Vienna, Austria. (Euro 15)

IAEA. 1998. Genetic Engineering Technology for the Improvement of the Sterile Insect Technique. IAEA-TECDOC-993, ISSN 1011-4289. IAEA, Vienna, Austria. (Euro 15)

IAEA. 1997. Evaluation of Genetically Altered Medflies for Use in Sterile Insect Technique Programmes. Proceedings of Symposium, 92-0-103897-6. (Euro 29)

IAEA. 1997. Control of the Mediterranean Fruit Fly in the Near East Region Using the Sterile Insect Technique. Non-serial publication STI/PUB/1020. IAEA, Vienna, Austria. (unpriced)

IAEA. 1996. Standardization of Medfly Trapping for Use in Sterile Insect Technique Programmes. IAEA-TECDOC-883, ISSN 1011-4289. IAEA, Vienna, Austria. (Euro 15)

IAEA. 1996. A Farewell to Tsetse 1996. Video (English - PAL, SECAM). IAEA, Vienna, Austria. (unpriced)

IAEA. 1995. EASTMED A Proposal for Medfly Control or Eradication with the Sterile Insect Technique. Non-serial publication STI/PUB/982. IAEA, Vienna, Austria. (unpriced)

IAEA. 1995. Economic Evaluation of Damage Caused by, and Methods of Control of, the Mediterranean Fruit Fly in the Maghreb. IAEA-TECDOC-830, ISSN 1011-4289. IAEA, Vienna, Austria. (Euro 15)

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Impressum

Insect Pest Control Newsletter No. 75

The IPC Newsletter is prepared twice per year by the Insect Pest Control Subprogramme
Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture.

International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Printed by the IAEA in Austria, July 2010.

10-24291