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Some Cobalt-60 irradiation sources currently in operation. (Left) self-contained irradiation source at "El Pino" Mediterranean fruit fly mass rearing facility in Guatemala, as part of the regional programme Guatemala-Mexico-US against the Mediterranean fruit fly;(right) dry panoramic irradiator at "Moscafrut" Anastrepha *fruit fly mass rearing facility in Tapachula, Chiapas, Mexico as part of the Mexican National Campaign against* Anastrepha *Fruit Flies.*

To Our Readers

In response to requests from our readers, this introduction is mainly dedicated to the ongoing efforts to develop alternatives for insect reproductive sterilization and blood sterilization for their use in insect pest control programmes with a sterile insect technique (SIT) component.

Radioisotope irradiators that are loaded with either cobalt-60 or caesium-137 producing gamma rays have been routinely used for many decades and have proven to be extremely reliable and safe for these purposes in successful area-wide insect eradication or suppression programmes. These include industrial panoramic-type irradiators in larger programmes, all the way to smaller self-contained irradiators. Nevertheless, the transboundary shipment of self-contained gamma irradiators or radioactive material has become logistically more complex due to security issues. This situation was exacerbated when the production of the Gamma Cell 220 (GC220), the source most commonly used for irradiating insects for sterilization purposes, was discontinued.

These events may have created the impression that the use of gamma radiation has become a less viable option, unattainable for insect pest control programmes that want to integrate the SIT. Nevertheless, some of the biggest SIT operational programmes have in recent years been equipped with new self-contained cobalt-60 sources, including the SIT programme against the pink bollworm in Phoenix, Arizona; El Pino Mediterranean fruit fly facility in Guatemala; and the screwworm programme in Panama. Thus these larger and more expensive irradiators, together with panoramic units (that are also costlier than self-contained gamma irradiators) have remained over the years a valid option, especially for larger operational programmes. In addition, the reloading of smaller units with new cobalt or the purchase of refurbished used self-contained irradiators remain viable alternatives.

As we reported some years ago, as a result of these international developments, and the continuing demand in Member States for sterilization hardware, technical advice and training, the Insect Pest Control Subprogramme initiated efforts in the mid-2000s to explore additional options to sterilize insects, especially for those Member States that could not acquire a gamma irradiator for regulatory or other reasons. Alternative technologies using low-energy X ray irradiators, consisting of an X ray tube and a device to transport the material through the X ray beam, had at this time already been under development. These offer some potential advantages over radioisotope radiation as they emit X rays only when the electrical power is turned on, require much less shielding, and have simpler national legislation requirements and lower transport costs. These irradiators have, however, also some limitations as they require a stable power source, a more complex dosimetry and maintenance, and frequent replacements of expensive X ray tubes. Moreover, to date no data are available on the reliability of these X ray irradiators when used on a daily basis for many hours in operational programmes that release sterile males.

Self-contained low-energy X ray irradiators, marketed for the specific purpose of blood irradiation, have dose rates that are too low for insect irradiation on an operational scale. Only one unit was found on the market with a radically different tube that has been upgraded to yield dose rates of up to 100 Gy/min. This was achieved by a novel cylindrical anode design. In order to gain experience with operational procedures and the development of adequate physical and biological dosimetry, such an X ray unit (RS2400) was procured for the FAO/IAEA Agriculture and Biotechnology Laboratories at Seibersdorf from the company that owns the patent on this X ray tube. Several issues arose with the RS2400 that required the investment of a significant amount of person-hours at the Insect Pest Control Laboratory to adapt, improve and validate the machine for insect sterilization.

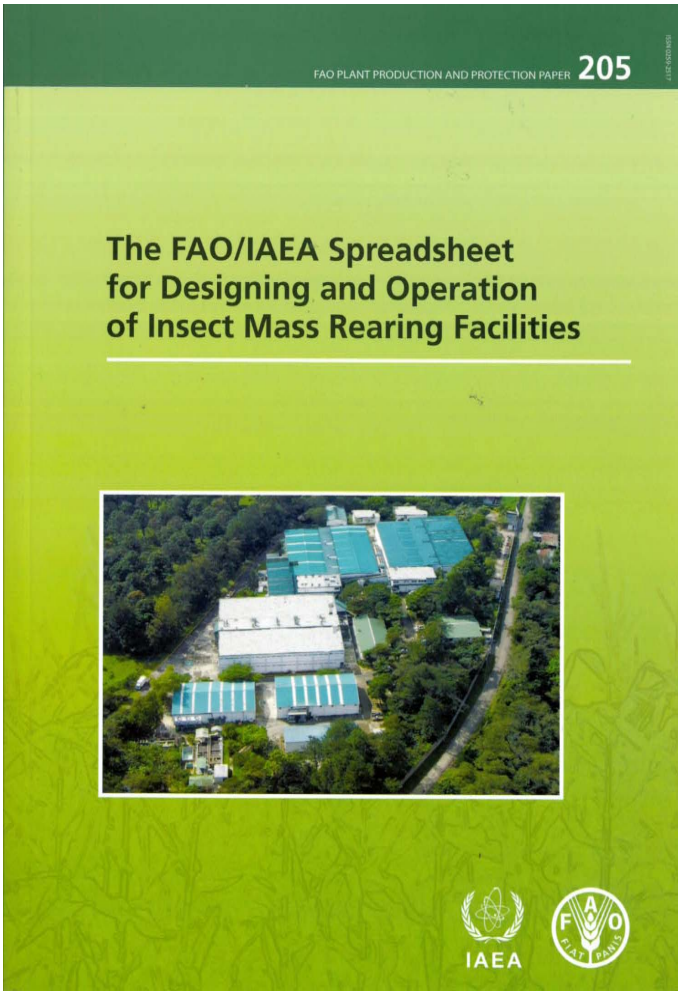
From the initial delivery of the RS2400 X ray irradiator there were problems with arcing across the high voltage connector on the tube due to a hairline fault in the ceramic insulator. The tube was replaced in 2010, which resolved this problem. Once the arcing was resolved, however, it quickly became apparent that the passive cooler supplied with the system was inadequate when installed inside the building (as it was not weather proof), with the system overheating after less than 1 kGy accumulated dose. Once this limit was reached it required several hours for the cooling water reservoir to cool enough for continued use. While integrating an active cooling system the X ray tube overheated and collapsed. Two replacement tubes failed due to various reasons, and the X ray unit has, therefore, been out of service for a full year. In order to avoid the problems with overheating now that we have reverted to the original passive cooling system, a cooling coil from the in-house cold water circuit has been placed in the water reservoir. It is hoped that this will be sufficient to prevent overheating for the relatively low usage in our laboratory. This overheating issue will not be a problem for SIT programmes in tropical regions that can use an outdoor active cooler without risk of the cooling water freezing.

Another issue was related to dose distribution and dose rate. The machine was delivered with an original specification of a dose rate of 45 Gy/min, but the measured dose rate at the centre of a 180 mm diameter canister was only about 16 Gy/min. Further, and more importantly, the dose distribution within this volume was very poor, with the ratio of maximum to minimum dose (dose uniformity ratio (DUR)) being about 6. In a normal production environment, a DUR of 1.4 or less would be considered acceptable. Research at the Insect Pest Control Laboratory found that the DUR could be decreased through 'hardening' the X ray energy spectrum by removing the low-energy photons before they reach the canister containing the pupae. Surrounding the canister with a 0.5 mm steel filter resulted in a radial DUR of about 1.06, although the dose rate was reduced to only 40% as compared to the bare canister. The canisters themselves are now made of carbon fibre reinforced resin, which is lightweight, waterproof and almost transparent to X rays, and they have the steel filtration incorporated inside. The combination of filtering and careful positioning of the canisters has resulted in a DUR of less than 1.3 in a volume of 3.8 litres per canister for a total volume of 18 litres. Other changes that had to be made included an improved carousel system and revised software.

In conclusion, both options of self-contained gamma irradiators and X ray technology produce similar radiation effects on insects, and both have advantages and limitations. Whereas X ray technology, after further necessary refinements, could be a promising alternative to gamma radiation for certain Member States and certain programmes, its reliability still needs to be proven under operational mass-rearing conditions. Gamma radiation for insect sterilization, despite its recent problems of transport and availability, has on the other hand proven its reliability for many decades in operational programmes, which is an absolute prerequisite for success in insect pest control programmes with an SIT component. Furthermore, we will continue to look for other suppliers and systems to expand the range of options available to our Member States.

In terms of new publications, I would like to highlight the *FAO/IAEA Spreadsheet for Designing and Operation of Insect Mass Rearing Facilities*, published by the FAO. This important document for managers combines an interactive spreadsheet in Excel on a CD ROM and a procedures manual to assist in technical and economic decision making when designing, costing, constructing, equipping and operating insect mass-rearing facilities. The software was designed based on the vast experience with Mediterranean fruit fly (*Ceratitis capitata*) mass-rearing as a model for planning insect mass-rearing facilities. Nevertheless, its default settings can be easily changed to suit any other fruit fly or other pest insect

(more details on this and the following publications can be found under Announcements in this newsletter).



Two other publications that I would like to mention are proceedings of two Coordinated Research Projects (CRPs) that have been published as special issues in scientific journals. The first are the *Proceedings of the FAO/IAEA CRP on Improving Sterile Male Performance in Fruit Fly Sterile Insect Technique (SIT) Programmes*, a collection of 28 peer-reviewed papers in the Journal of Applied Entomology that focuses on the post-factory and pre-release management of sterile males, mainly after their emergence at fly emergence and release facilities and the effects of their exposure to nutritional, hormonal, semiochemical and microbiological supplements.

The second are the *Proceedings of an FAO/IAEA Coordinated Research Project on Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens,* a collection of 20 peer-reviewed papers in the Journal of Invertebrate Pathology that focuses on the biology of tsetse flies in relation to the prevalence and the interaction between bacterial symbionts and salivary gland hypertrophy viruses, the development of strategies to manage the virus infections in tsetse colonies, the use of entomopathogenic fungi to suppress tsetse fly populations in combination with the SIT, and the development of symbiont-based strategies to control tsetse flies and trypanosomosis.

Jorge Hendrichs
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Insect Pest Control Subprogramme

http://www-naweb.iaea.org/nafa/ipc/index.html
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Forthcoming Events (2013-2014)

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

Third RCM of CRP on Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade. 26-30 August 2013, Tucumán, Argentina.

First RCM of CRP on Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes. 30 September - 4 October 2013, Vienna, Austria.

Final RCM of CRP on Development and Evaluation of Improved Strains of Insect Pests for SIT. 7-11 April 2014, Capri, Italy.

Second RCM of CRP on Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application. 6-10 May 2014, Bangkok, Thailand.

Final RCM of CRP on Increasing the Efficiency of Lepidoptera SIT by Enhanced Quality Control. 2-6 June 2014, Kelowna, Canada.

First RCM of CRP on Dormancy Management to Enable Mass-rearing and Increase Efficacy of Sterile Insects and Natural Enemies. 21-25 July 2014, Vienna, Austria.

Second RCM of CRP on Enhancing Vector Refractoriness to Trypanosome Infection. 1-5 December 2014, Addis Ababa, Ethiopia.

II. Consultants and Expert Meetings

FAO/IAEA Consultants Meeting on Comparing the Performance of Sterile Males Produced by Genetic, Transgenic or Symbiont-based Technologies. 7-11 April 2014, Capri, Italy.

III. Other Meetings/Events

FAO/IAEA Regional Training Course on Quarantine and International Standards for Phytosanitary Measures for the Indian Ocean (under TC Project RAF5062). 1-5 July 2013, Maputo, Mozambique.

FAO/IAEA Regional Training Course on Comparative Morphometric Analyses of Wings of Insect Pests (under TC Project RAF5060). 22-26 July 2013, Seibersdorf, Austria.

FAO/IAEA Interregional Training Course on The Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests (under TC Project INT5151). 29 July - 23 August 2013, Metapa de Dominguez, Chiapas, Mexico and Antigua / El Pino, Guatemala.

FAO/IAEA Workshop on Reviewing Evidence to Resolve Species Complexes of Tephritid Pests. 31 August 2013, Tucumán, Argentina.

32nd General Conference of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC). 8-12 September 2013, Khartoum, Sudan.

FAO/IAEA Regional Training Course on Area-Wide Integrated Fruit Fly Suppression, including MAT and SIT for the Balkans and the Eastern Mediterranean (under TC Project RER5018). 7-11 October 2013, Opuzen, Croatia.

13th Workshop of the IOBC- Arthropod Mass Production & Quality Assurance (AMRQA) Working Group on Emerging Opportunities for the Mass Production and Quality Assurance of Invertebrate. 6-8 November 2013, Bangalore, India.

Standards Committee Meeting, International Plant Protection Convention, FAO. 18-22 November 2013, Rome, Italy.

Ninth Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 31 March - 4 April 2014, Rome, Italy.

Workshop on Characterization of Symbionts of Fruit Flies of Economic Importance via Bioinformatic Approaches. 4-5 May 2014, Bangkok, Thailand.

9th International Symposium on Fruit Flies of Economic Importance. 12-16 May 2014, Bangkok, Thailand.

Past Events (2012-2013)

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

Second RCM of CRP on Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade. 30 January - 3 February 2012, Brisbane, Australia.

Final RCM of CRP on Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens. 26-30 March 2012, Vienna, Austria.

First RCM of CRP on Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application. 21-25 May 2012, Vienna, Austria.

Third RCM of CRP on Development and Evaluation of Improved Strains of Insect Pests for SIT. 20-24 August 2012, Daegu, Republic of Korea.

Third RCM of CRP on Increasing the Efficiency of Lepidoptera SIT by Enhanced Quality Control. 12-16 September 2012, Phoenix, AZ, USA.

Third RCM of CRP on Development of Generic Irradiation Doses for Quarantine Treatments. 15-19 October 2012, Buenos Aires, Argentina.

Final RCM of CRP on Biology of Male Mosquitoes in Relation to Genetic Control Programmes. 4-8 March 2013, Juazeiro, Bahia, Brazil.

Final RCM of CRP on Applying GIS and Population Genetics for Managing Livestock Insect Pests. 15-19 April 2013, London, United Kingdom.

First RCM of CRP on Enhancing Vector Refractoriness to Trypanosome Infection. 3-7 June 2013, Vienna, Austria.

II. Consultants and Expert Meetings

FAO/IAEA Consultants Meeting on Diapause Management to Facilitate the Rearing of Temperate / Overwintering Pests. 7-11 May 2012, Vienna, Austria.

FAO/IAEA Consultants Meeting to Explore Mechanical, Molecular, Behavioural or Genetic Methods of Sex Separation in Mosquitoes. 1-5 October 2012, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Regional Training Course on Standardized Collection and Processing of Tsetse Flies for Molecular Population Genetic and Morphometric Analyses (under Regional TC Project RAF5060). 23 January - 3 February 2012, Muguga-Nairobi, Kenya.

Workshop on Searching for Solutions for the Control of the Avian Parasite, *Philornis downsi*. 31 January - 3 February 2012, Charles Darwin Research Station, Puerto Ayora, Santa Cruz Island, Galapagos, Ecuador.

5th International Meeting on Taxonomy and Natural History of Tephritoidea. 6-10 February 2012, Brisbane, Australia.

FAO/IAEA Regional Training Course on Standardized Entomological Monitoring, Data Collection and GIS-Aided Processing as Needed for AW-IPM of the Tsetse and Trypanosomosis Problem (under Regional TC Project RAF5060). 6-24 February 2012, Bobo-Dioulasso, Burkina Faso.

FAO/IAEA Coordination Meeting of the Indian Ocean TC regional project RAF5062 on Preventing the Introduction of Exotic Fruit Fly Species and Implementing the Control of Existing Species with the Sterile Insect Technique and other Suppression Methods. 13-15 February 2012, Quatre Bornes, Mauritius.

FAO/IAEA Coordination Meeting of the Andean Regional TC Project RLA5058 on Building Capacity for Suppression of Fruit Flies Using an Area-Wide Pest Management Approach. 27 February - 2 March 2012, Lima, Peru.

Seventh Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 19-23 March 2012, Rome, Italy.

FAO/IAEA Regional Coordination Meeting / Technical Workshop under the Regional TC project RAS5054 on Contributing to the Assessment of the Feasibility of SIT-Based Area-Wide Integrated Management of Old World Screwworm Flies in the Middle East. 19-28 March 2012, Pacora, Panama City, Panama.

FAO/IAEA Coordination Meeting of the Indian Ocean Regional TC Project RAF5065 on Promoting the Sharing of Expertise and Physical Infrastructure for Mass-Rearing Mosquitoes and Integration of the Sterile Insect Technique (SIT) with Conventional Methods for Vector Control, among Countries of the Indian Ocean Region. 10-13 April 2012, Port Louis, Mauritius.

Standards Committee Meeting, International Plant Protection Convention, FAO. 23-27 April 2012, Rome, Italy.

FAO/IAEA Regional Training Course on Fruit Fly Surveillance, Taxonomy and Identification in West Africa (under Regional TC Project RAF5061). 28 May - 1 June 2012, Cotonou, Benin.

FAO/IAEA Coordination Meeting of the West Africa Regional TC Project RAF5061 on Supporting Capacity Building and a Feasibility Study on Control of Fruit Flies of Economic Significance in West Africa. 30 May - 1 June 2012, Cotonou, Benin.

10th Plan of Action of the African Union Pan-African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) meeting. 13-15 June 2012, Accra, Ghana.

FAO/IAEA Coordination Meeting of the Regional TC Project RER5018 on Supporting Fruit Fly Pest Prevention and Management in the Balkans and the Eastern Mediterranean. 2-6 July 2012, Kolymbari, Crete, Greece.

Second International Meeting of Tephritid Workers of Europe, Africa and the Middle East. 3-6 July 2012, Kolymbari, Crete, Greece.

8th Meeting of the Working Group on Fruit Flies of the Western Hemisphere. 30 July - 3 August 2012, Panama City, Panama.

FAO/IAEA Coordination Meeting of the Regional TC Project RLA5057 on Establishing and Maintaining Fruit Fly Free and Low Prevalence Areas in Central America, Panama and Belize, Using the Sterile Insect Technique (SIT). 30 July-3 August 2012, Panama City, Panama.

PAAT Secretariat Meeting. 25-27 September 2012, Vienna, Austria.

Symposium on Development and Evaluation of Improved Strains of Insect Pests for the Sterile Insect Technique at the XXIV International Congress of Entomology. 19-25 August 2012, Daegu, Republic of Korea.

XXII Curso Internacional Sobre Moscas de la Fruta. 20-31 August 2012, Metapa de Dominguez, Chiapas, Mexico.

FAO/IAEA Coordination Meeting of the Regional TC Project RAS5059 on Supporting Area-Wide Integrated Pest Control of Native and Exotic Flies in the Middle East Subregion Incorporating the Sterile Insect Technique (SIT). 10-12 September 2012, Vienna, Austria.

FAO/IAEA Workshop on Assessing Quality Management Aspects of Lepidoptera Mass-produced for the Sterile Insect Technique in a Large Operational Setting. 10-11 September 2012, Phoenix, AZ, USA.

FAO/IAEA Regional Training Course on Quarantine and Pest Risk Analysis for the Balkans and the Eastern Mediterranean (under Regional TC Project RER5018). 15-19 October 2012, Vienna, Austria.

Standards Committee Meeting, International Plant Protection Convention, FAO. 5-9 November 2012, Rome, Italy.

FAO Regional Symposium on the Management of Fruit Flies in Near East Countries. 6-8 November 2012. Hammamet, Tunisia.

2012 International Citrus Congress, 18-23 November 2012, Valencia, Spain.

FAO/IAEA Workshop on Morphometry of Cryptic Species of *Anastrepha fraterculus* Complex of the Neotropical Region (under Regional TC Projects RLA5057 and RLA5058), 19-23 November 2012, Juazeiro, Bahia, Brazil.

FAO/IAEA Regional Training Course on Fruit Fly Detection, Taxonomy and Identification for Indian Ocean (under Regional TC Project RAF5062). 26-30 November 2012. St. Pierre, La Réunion, France.

FAO/IAEA National Meeting on the Status of Tephritid Fruit Flies in China (under TC project CPR5020). 10-14 December 2012, Fuzhou, Fujian, China.

11th Meeting of National PATTEC Coordinators. 10-11 December 2012, Hawassa, Ethiopia.

1st Meeting of the PATTEC Steering Committee. 12 December 2012, Hawassa, Ethiopia.

Symposium on Prospects for Enhancing Augmentative Releases of Beneficial Organisms Using Radiation at the Fourth International Symposium on Biological Control of Arthropods, 4-8 March, 2013, Pucon, Chile.

FAO/IAEA Regional Training Course on Area-Wide Integrated Fruit Fly Suppression, including MAT and SIT in West Africa (under Regional TC Project RAF5061). 11-15 March 2013. Bobo Dioulasso, Burkina Faso.

Eighth Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 8-12 April 2013, Rome, Italy.

FAO/IAEA Regional Training Course on Fruit Fly Detection for the Balkans and the Eastern Mediterranean (under Regional TC Project RER5018). 6-10 May 2013, Adana, Turkey.

Standards Committee Meeting, International Plant Protection Convention, FAO. 6-10 May 2013, Rome, Italy.

Standards Committee Meeting (SC-7), International Plant Protection Convention, FAO. 13-17 May 2013, Rome, Italy.

6th International Workshop on Insect Transgenesis Shanghai, China 21-25 May 2013

FAO/IAEA Regional Meeting on Common Emergency Action Plan for Exotic Fruit Flies. 10-14 June 2013 (under Regional TC Project RAF5062), Quatre Bornes, Mauritius.

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 six major topics, namely:

- Biocontrol using radiation
- Fruit flies
- Mosquitoes
- Moths
- Screwworm flies
- Tsetse flies

Country	Project Number	Title National Projects	Technical Officer
Chad	CHD5003	Finalising the Feasibility Study to Assess Whether the Sterile Insect Technique (SIT) Can Be Applied for the Creation of Sustainable Tsetse-Free Zones	Udo Feldmann
China	CPR5020	Integrating the Sterile Insect Technique (SIT) for Area-Wide Integrated Pest Management of Tephritid Fruit Flies	Rui Cardoso Pereira
Costa Rica	COS5030	Supporting Biological Control of Stable Flies (*Stomoxys calcitrans*) through the Use of Parasitoids Reproduced on Fruit Flies	Jesús Reyes
Ethiopia	ETH5016	Creating Sustainable Tsetse and Trypanosomosis Free Areas for Enhancing Livestock and Agricultural Development	Udo Feldmann Andrew Parker
Guatemala	GUA5017	Using the Sterile Insect Technique (SIT) to Establish Fruit Fly Low Prevalence Pilot Areas and to Assess it as an Alternative for the Control of the Sugarcane Borer in Pilot Areas	Jesús Reyes
Honduras	HON5006	Using Sterile Insect Technique (SIT) to Obtain Recognition as a Mediterranean Fruit Fly Free Area in the Aguan River Valley	Jesús Reyes
Israel	ISR5017	Targeting the Olive Fly with SIT in Olive Orchards Located in the North and South of Israel	Jesús Reyes
Israel	ISR5018	Improvement of Artificial Mass-Rearing Systems for the Ethiopian Fruit Fly, *Dacus ciliatus*, and Establishment of Optimal Sterilizing Doses: Towards Small-Scale SIT	Jorge Hendrichs
Madagascar	MAG5021	Implementing the Sterile Insect Technique (SIT) in Integrated Fruity Fly Control for High Quality Fruit Production	Rui Cardoso Pereira
Mauritius	MAR5019	Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for the Integrated Control of Mosquitoes	Jeremie Gilles
Mauritius	MAR5022	Reducing Insecticide Use and Losses to Melon Fly (*Bactrocera cucurbitae*) through Environment-Friendly Techniques to Increase Production in Different Areas, Phase II	Jorge Hendrichs
Morocco	MOR5032	Supporting Control of the Medfly Using the Sterile Insect Technique for Citrus Fruits and Early Fruits and Vegetables to Establish Low Medfly Prevalence Zones	Jesús Reyes
Myanmar	MYA5021	Integrating Sterile Insect Technique with other Biocontrol Tactics to Improve Diamondback Month Control	Rui Cardoso Pereira

Oman	OMA5002	Assessing the Suitability of Sterile Insect Technique (SIT) and Related Techniques for Combating Date Palm Insect Pests	Marc Vreysen
Panama	PAN5020	Strengthening Technical Capacity to Control Mediterranean Fruit Fly Using the Sterile Insect Technique (SIT)	Jesús Reyes
Pakistan	PAK5049	Support for Capacity Building in Baseline Data Collection for Mosquito Dengue Vector Management in Pakistan	Jeremie Gilles
Palau	PLW5001	Improving the Quality of the Fruits and Vegetables Through an Area-Wide Integrated Pest Management of Bactrocera Fruit Flies in Production Areas of Palau	Rui Cardoso Pereira
Senegal	SEN5033	Supporting the Operational Phase of Eliminating *Glossina palpalis gambiensis* from the Niayes Area by Promoting the Development of Integrated Stockbreeding	Marc Vreysen
Seychelles	SEY5005	Enhancing the Melon Fruit Fly Area-Wide Integrated Pest Management Programme Using the Sterile Insect Technique to Improve National Food Security	Rui Cardoso Pereira
Sri Lanka	SRL5044	Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for Integrated Control of Mosquitoes	Jeremie Gilles
South Africa	SAF5013	Assessing the Sterile Insect Technique for Malaria Mosquitoes in a South African Setting	Jeremie Gilles
Sudan	SUD5034	Supporting a Feasibility Study on the Suitability of the Sterile Insect Technique as a Strategy for the Integrated Control of *Anopheles arabiensis*	Jeremie Gilles
Tunisia	TUN5027	Supporting an Area-Wide Integrated Pest Management Pilot Project for Evaluating the Effectiveness and Economic Feasibility of Using SIT as a Component of Integrated Date Moth control	Marc Vreysen
territories under the jurisdiction of the Palestinian Authority	PAL5004	Integrated management of fruit flies in Palestinian Territories	Jesús Reyes
Uganda	UGA5033	Demonstrating the Feasibility of a Sterile Insect Technique (SIT) Component as Part of an AW-IPM Approach against *Glossina f. fuscipes* to Increase Livestock Productivity	Udo Feldmann
Vietnam	VIE5017	Supporting Area-Wide Integrated Pest Management to Improve the Quality of Fruit for Export	Rui Cardoso Pereira
Zimbabwe	ZIM5017	Improving Crop and Livestock Production through the Eradication of Bovine and Human Trypanosomiasis in Matusadona National Park	Udo Feldmann

		Regional Projects	
Regional Africa	RAF5059	Supporting the Creation of a Tsetse-Free Zone in Southern Mozambique and North-East South Africa	Marc Vreysen Rui Cardoso Pereira
Regional Africa	RAF5061	Supporting Capacity Building and a Feasibility Study on Control of Fruit Flies of Economic Significance in West Africa	Rui Cardoso Pereira
Regional Africa	RAF5062	Preventing the Introduction of Exotic Fruit Fly Species and Implementing the Control of Existing Species with the Sterile Insect Technique and Other Suppression Methods in the Indian Ocean	Rui Cardoso Pereira
Regional Africa	RAF5064	Supporting Area-Wide Tsetse and Trypanosomosis Management to Improve Livestock Productivity and Enable Sustainable Agriculture and Rural Development	Udo Feldmann
Regional Africa	RAF5065	Promoting the Sharing of Expertise and Physical Infrastructure for Mass-Rearing Mosquitoes and Integration of the Sterile Insect Technique (SIT) with Conventional Methods for Vector Control, among Countries of the Indian Ocean Region	Jeremie Gilles
Regional Asia	RAS5059	Supporting Area-Wide Integrated Pest Control of Native and Exotic Flies in the Middle East Subregion Incorporating the Sterile Insect Technique (SIT)	Jesús Reyes
Regional Europe	RER5018	Supporting Fruit Fly Pest Prevention and Management in the Balkans and the Eastern Mediterranean	Rui Cardoso Pereira
Regional Latin America	RLA5057	Establishing and Maintaining Fruit Fly Free and Low Prevalence Areas in Central America, Panama and Belize, Using the Sterile Insect Technique (SIT)	Jesús Reyes
Regional Latin America	RLA5058	Building Capacity for Suppression of Fruit Flies using an Area-Wide Pest Management Approach in the Andean Region	Jesús Reyes
		Interregional Project	
Interregional	INT5151	Sharing Knowledge on the Use of the Sterile Insect and Related Techniques for Integrated Area-Wide Management of Insect Pests	Jorge Hendrichs Jesús Reyes

Highlights of Technical Cooperation Projects

Integrating the Sterile Insect Technique (SIT) for Area-Wide Integrated Pest Management of Tephritid Fruit Flies (CPR5020)

A national meeting on the 'Status of Tephritid Fruit Flies in China' was organized at the Institute of Beneficial Insects, Fujian Agriculture and Forestry University, Fuzhou, Fujian from 10-13 December 2012. About 50 participants attended the meeting representing all the 15 provinces south of Yangtze River (area where tephritid fruit flies are of economic importance). During the first two days each participant provided a brief overview of the tephritid fruit fly status in their respective province, including control and ongoing research. Additionally, methodologies and new developments were shared and discussed among participants.

The meeting participants had the opportunity to visit the Zhangzhou area in the south of Fujian province, where a beer waste protein facility was recently constructed to supply the farmers with the protein for application in bait stations, thereby contributing to the reduction of insecticide applications to the environment. A visit was conducted to an experimental site, where the application of the bait sprays is being integrated with the use of parasitoids and sterile flies as part of a pilot experiment.

Meeting participants during the visit to an experimental field site where the application of bait sprays is being integrated with the use of parasitoids and sterile flies (Zhangzhou, Fujian, China).

During the first year of the project (and before the start of the IAEA-TC project) some baseline data on fruit fly populations and hosts were conducted. Now, a better and more systematic approach to collect baseline data is ongoing as part of the recommended phased conditional approach.

Efforts ongoing to further develop the use of bait sprays using beer waste protein (an inexpensive and locally available product) to control tephritid fruit flies are being intensified. These methods are extremely valuable since they target the female fruit fly population, and effectively suppress the wild populations. Thereafter, for a more refined and environment-friendly control, they can be integrated with other control strategies, such as sanitation, biocontrol and the use of sterile insects.

Promoting the Sharing of Expertise and Physical Infrastructure for Mass-Rearing Mosquitoes and Integration of the Sterile Insect Technique (SIT) with Conventional Methods for Vector Control, among Countries of the Indian Ocean Region (RAF5065)

The third National Coordinators Meeting of the Regional Indial Ocean TC Project 'Promoting the sharing of expertise and physical infrastructure for mass rearing mosquitoes and integration of SIT with conventional methods for vector control, among countries of the Indian ocean region', was held from 6-10 May 2013 in Sainte Clotilde, La Reunion, France at the Centre de Recherches et de Veille sur les maladies émergentes dans l'Océan Indien (CRVOI) with the support of the Institut de Recherche pour le Développement (IRD).

The meeting was opened by the Director of the Regional Health Agency (Ministry of Health) and was attended by 15 participants from Brazil, France, Madagascar, Mauritius, Seychelles, South Africa, Sri Lanka, and Trinidad and Tobago who all presented their progress since the previous meeting in Seychelles in 2012. The main purpose was the establishment of a robust and common mosquito surveillance system to collect baseline data prior to any future sterile male releases. Several topics were approached and discussed with experts such as pilot site selection, trap selection, mosquito abundance index, dispersal and mark release recapture studies were approached.

All countries from the region have made significant progress and are planning to establish a surveillance system in the coming months. Brazil and Mauritius are the most advanced with at least a 1-year collection of baseline data.

Participants and experts agreed on the possibility in the near future to demonstrate the "proof of principle" of mosquito SIT in pilot sites if the support from the IAEA Technical Cooperation is obtained for the 2014-15 project cycle. Representatives of the Indian Ocean Commission (IOC) closed the meeting and insisted on the need of such a project to reinforce the human and infrastructure capacity of the local mosquito control services and the potential of new approaches in the fight against dengue and Chikungunya within the Indian Ocean region.

Participants of the national coordinators meeting of the regional Indian Ocean project RAF5065 (La Reunion, France).

Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for the Integrated Control of Mosquitoes (MAR5019)

Good progress has been made by the entomology team at the Vector Biology and Control Division of the Ministry of Health and Quality of Life in Mauritius in this second and final year of the TC project MAR5019. Two potential sites have been selected for a pilot trial of the sterile insect technique, at Pointe des Lascars and Panchvati in the North East of the island. Population surveillance at these sites is well underway with the use of ovitraps, and with the recent procurement of BG Sentinel adult traps more thorough surveys will be possible.

Two laboratory colonies of *Aedes albopictus* have been established, and it is hoped that the first trial releases will be conducted within the next few months. The establishment of a new and much larger facility for the project will facilitate the required up-scaling of rearing to enable releases, likely involve around 70,000 male mosquitoes per week, to be conducted.

Additional support is being provided: an X ray irradiator will be made available; two expert missions took place in 2012 and a third is planned for 2013; two procurements of laboratory consumables and mosquito surveillance equipment have been delivered and a third is being processed; and two month-long fellowships at the Insect Pest Control Laboratory commenced in May 2013.

New mosquito facility at Curepipe, Mauritius.

Supporting a Feasibility Study on the Suitability of the SIT as a Strategy for the Integrated Control of *Anopheles arabiensis* (SUD5034)

The new location and building of the insectary in Soba, near Khartoum, is a great improvement to the previous setting. There is also a significant enhancement in the rearing and management of the mosquito colony. The insectary team has grown significantly, there are currently 4 mass rearing racks for larval rearing in use, and a large number of mosquitoes can be produced for field experiments.

To eliminate females from the release material, a method was introduced by which females are killed by offering blood meals containing ivermectin. This method was well received by the insectary staff, as it is simple, effective, and the visibility of what is occurring is easy to follow and manage.

Overall, the organization, use of equipment and team efforts in the insectary have improved significantly and field experiments are continuing to develop the SIT package for *An. arabiensis* in the field.

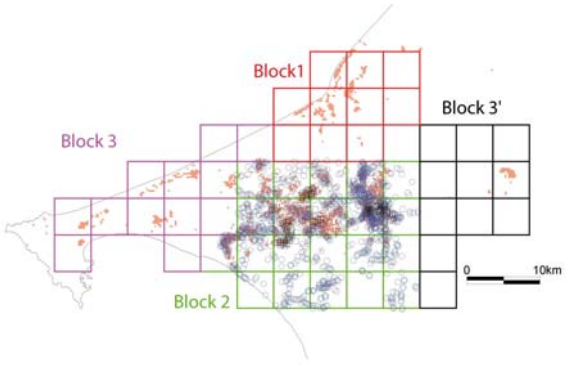
An MSc student from the Soba insectary has now completed a two month fellowship at the IPCL, and she will test on-site in Soba the equipment and tools developed at Seibersdorf for larval rearing, egg collection and quantification, irradiation, blood spiking/female elimination and transportation of male adults to the field. Three expert missions were completed during the first quarter of 2013, and further missions are planned for autumn 2013.

Mosquito adult rearing room in Soba, Sudan.

Supporting the Operational Phase of Eliminating *Glossina palpalis gambiensis* from the Niayes Area by Promoting the Development of Integrated Stockbreeding (SEN5033)

The tsetse project in Senegal, which aims at eradicating a population of *Glossina palpalis gambiensis* from the Niayes area, has progressed from the initial objective of carrying out feasibility studies towards implementing operational suppression and eradication activities in some parts of the project area.

As part of the feasibility studies, data sets were collected on the socioeconomic impact of the presence of the disease trypanosomosis on the farming community. A quantitative analysis of these data indicated that farmers who are located outside of the tsetse-infested area produced on average 38% more milk and sold 2.8 times more animals than farmers located in the tsetse infested area. This translated to an economic difference of 900 million FCFA (or approx. 1.37 million Euro) every year.



Deployment of insecticide impregnated traps in Block 2 (Pout/ Sebikotane) for suppression of the tsetse population. Recently, a Maxent model based on MODIS and Landsat satellites data was used to optimize the integrated control strategy using model predictions of suitable habitats for Glossina palpalis gambiensis*. As a result, 127 new insecticide impregnated traps (black squares) were deployed from March to May 2013 to complement the already deployed traps (blue circles) to account for model predictions.*

Weekly shipments of sterile male pupae from Bobo Dioulasso, Burkina Faso to Dakar, Senegal have continued without interruption. These have recently been supplemented with shipments (2 per month) of male pupae of a colony (Burkina Faso origin) maintained at the Slovak Academy of Sciences (SAS) in Slovakia.

Data of the sterile male trial releases in four different ecological sites (Kayhar, Pout, Diaksao Peuhl and Parc de Hann) are now available and have been analysed. Recapture rates varied between 1.1 % in the Parc to Hann to 4.7 % in Diaksao Peuhl. Daily mortality rates were rather high in the Parc de Hann (> 20 %), but similar (~16 %) in the 3 other sites. This will require the need for two releases of sterile males per week. Average dispersal of the released sterile males was highest in Pout and Kayhar and lower in the two other sites, but indicated that a swath width of 500 m between aerial release lines would be adequate. The competitiveness of the sterile males was excellent and similar in the four sites.

In view of the higher mortality rates of the sterile males in the Parc de Hann, an introgression programme was developed and implemented in an attempt to develop a strain that might be better adapted to the harsh environmental conditions of the Parc de Hann. The outcrossing was performed by taking colony-adapted virgin females from the Burkina Faso (BKF) strain (adapted for more than 35 years to artificial rearing conditions) for mating with surplus males from a local Senegal (SEN) strain. The generations were kept separate for four generations and then pooled to form the out-crossed colony. This colony was transferred to the SAS in Bratislava, Slovakia in mid-2012 for further colony build-up. In each generation, mating competitiveness tests were carried out in standard field cages where introgressed males were competing against BKF males for SEN females. The introgressed strain progressively improved in mating participation with each generation. Once the introgressed colony at the SAS will have reached a suitable size, shipments of sterile male pupae from the introgressed strain will be shipped to Senegal to assess its field performance.

Operational suppression of the *G. palpalis gambiensis* fly population was completed in Kayhar and was followed by operational ground releases of sterile flies from several release points as of April 2012. Suppression using insecticide-impregnated screens and pour-ons on cattle was initiated in Pout/Sebikotane in late 2012. A total of 1,205 insecticide impregnated Vavoua traps were deployed in the area and these were recently complemented with 127 more traps that were deployed as a result of a prediction distribution model of suitable habitat using baseline entomological data. In addition, 2,970 cattle have been treated with insecticide pour-ons as an additional suppression tactic. It is intended to finalize the suppression after 6 months, to be followed by the aerial release of sterile males. Monitoring of the declining fly population was done at regular intervals in both areas.

All flying permits have been obtained to start with the aerial dispersal of the sterile insects. Eight trial releases using boxed flies have been carried out to gain experience with the gyrocopters and to get initial indications of fly performance after release. The new chilled aerial release system, developed by Mubarqui, a Mexican company, was delivered to the project and is ready for installation in the gyrocopters. Operational aerial releases of the sterile males are scheduled to start in July 2013 in Kayhar, to be expanded to Pout in October 2013.

Assessing the Suitability of Sterile Insect Technique (SIT) and Related Techniques for Combating Date Palm Insect Pests (OMA5002)

Date palm is an important agricultural commodity in Oman, and the country has 8 million date palm trees. There are plans to plant another million trees within the next five years. These palm trees are being attacked by 3 main insect pests: (1) the Dubas bug (*Ommatissus lybicus*) an Homopteran insect that remains the main pest of date palm; both nymphs and adults suck the sap from the date palm and repeated heavy infestations cause the weakening and death of the palms; (2) the red palm weevil (*Rhynchophorus ferrugineus*), which is only present in the north-western part of the country (border area with the United Arab Emirates); and (3) the lesser date moth (*Batrachedra amydraula*), another important pest of date palm that may cause more than 50% loss of the crop.

*The lesser date moth (*Batrachedra amydraula*), the insect with the highest potential to develop the SIT (photo by Mohamed Dhouibi).*

The Government of Oman has been exploring new innovative ways of controlling these insects, rather than using broad spectrum insecticides. Oman is being supported by a technical cooperation project that assesses the potential of integrating the SIT against one of these three main pests of dates. Staff of the IPC sub-programme visited the project and discussions were held with the counterparts to explore whether the SIT could make a significant contribution to the control of one of these insect pests. It was decided that:

- The Dubas bug is not a good candidate for SIT, as all of the life cycle stages (nymphs and adults) are harmful to the palm trees, and mass-releases of any of these stages would cause more damage
- The red palm weevil is a potential candidate for SIT in light of recent research on its mating behaviour, but because of restrictions on establishing a rearing colony in Muscat, it was decided to postpone work on this insect to a later date
- Focus will be put on the lesser date moth as the insect with the highest potential to develop the SIT. A new insectary is being constructed that will be used to rear the lesser date moth. An expert mission took place to assist with the establishment of a colony and with the development of an artificial larval rearing diet.

Supporting Capacity Building and a Feasibility Study on Control of Fruit Flies of Economic Significance in West Africa (RAF5061)

Regional Training Course on Area-Wide Integrated Fruit Fly Suppression, including MAT and SIT in West Africa

The FAO/IAEA Regional Training Course was held at the École de Lutte Anti Tsetse (ELAT), Bobo Dioulasso, Burkina Faso from 11-15 March 2013. It was attended by a total of 22 participants, from 10 Member States (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Libya, Mali, Niger, Nigeria, Senegal, Sierra Leone).

The course addressed the following aspects:

- Fruit fly biology and ecology
- Adult and larval surveillance
- Suppression techniques (sanitation, bait sprays, mass trapping, bait stations, biological control, sterile insect technique, and male annihilation technique)
- Area-wide insect pest management (AW-IPM) concept
- Phased conditional approach to AW-IPM of fruit flies
- Field visit to a mango production area and demonstration on adult surveillance (trapping) with different types of traps (Tephri trap, Plastic McPhail, local plastic buckets and plastic bottles), attractants (methyl eugenol, terpinyl acetate, torula yeast and local beer waste protein) and killing agent (proteineous solutions, vapona (DDVP) and deltametrine)
- Visit to Centre International de Recherche-Développment sur l'Elevage en Zone Subhumide (CIRDES) (tsetse flies and biotechnology laboratories)
- Visit to the Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) tsetse fly mass rearing factory (under construction)
- Exercise on development of a fruit fly suppression programme.

Participants of the regional training course on area-wide integrated fruit fly suppression, including MAT and SIT, in West Africa (Bobo Dioulasso, Burkina Faso).

The course was successfully conducted, contributing to the capacity building on fruit fly control of the participants from the West Africa region.

Supporting Fruit Fly Pest Prevention and Management in the Balkans and the Eastern Mediterranean (RER5018)

Regional Training Course on Fruit Fly Detection for the Balkans and the Eastern Mediterranean

The FAO/IAEA Regional Training Course was held in Adana, Turkey from 6-10 May 2013 in conjunction with the meeting of the IOBC-WPRS Working Group on 'Integrated Control in Citrus Fruit Crops'.

It was attended by a total of 22 participants from 12 Member States (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Greece, The Frmr.Yug. Rep. of Macedonia, Montenegro, Romania, Slovenia, and Turkey).

The course addressed the following aspects:

- Fruit fly biology and ecology
- Sexual behaviour and attractants
- Detection procedures
- Regulatory procedures
- Suppression and eradication procedures
- Technical visit to citrus production area where some good agricultural practices are in place, such as sanitation, protein bait sprays, Mediterranean fruit fly monitoring and mass trapping
- Technical visit to a parasitoids rearing facility
- Practical exercise to set up traps for early detection of methyl-eugenol responding *Bactrocera* species such as *B. invadens* and *B. zonata*.

Participants of the regional training course on fruit fly detection for the Balkans and the Eastern Mediterranean (Adana, Turkey).

A protocol on trapping was developed based on the existing action plans for possible outbreaks of *Bactrocera zonata* and *Bactrocera invadens*. This protocol will serve as guide and will harmonize early detection and rapid reaction procedures in the participating Member States.

Establishing and Maintaining Fruit Fly Free and Low Prevalence Areas in Central America, Panama and Belize, Using the Sterile Insect Technique (SIT) (RLA5057)

Workshop on 'Micromorphometric analysis of South American fruit fly *Anastrepha fraterculus*, a cryptic species of fruit fly for Central America

Anastrepha fraterculus (Wiedemann), the South American fruit fly, is actually a complex of species of economic and quarantine importance. It is one of the most serious limitations to the export of fruits and vegetables from Latin America.

In recent years international taxonomists have determined that the species of this complex occurring in Central America is different and less harmful than the others occurring in South America, enabling taxonomists from Central America to distinguish the biotype of this fruit fly from the ones established in South America. This is a step further to prevent the establishment of this exotic species in Central America. Also, for SIT application against this pest in South America, it is essential to use the correct biotype against a target population.

The specific objectives of the training workshop were as follows:

- Evaluating the use of micro-morphometric techniques for fruit fly identification, for comparisons of *A. fraterculus* samples from Central America and South America
- Applying these specialized methods used in taxonomy for the recognition of the *A. fraterculus* biotypes found in Central America and South America

- Preparing structures on permanent slides, as well as the analytical methods for the identification of different key biotypes to be used in the future as a reference in Central America
- Analysing and recognizing of morphotypes using the multivariate approach.

The training lasted about 40 hours, with both theoretical and practical sessions, and included hands-on training in methods for data analyses and recognition of morphotypes using the multivariate approach.

Participants of the training course on micromorphometrics of the morphotypes of the Anastrepha fraterculus *complex (Juazeiro, Bahia, Brazil).*

Activities were carried out at the Laboratory of Genetics of the Universidade Estadual do Vale de Sao Francisco and at the Pest Lab at EMBRAPA – Petrolina. There were 10 participants for this workshop from the following Latin American countries: Bolivia, Brazil, Guatemala, Panama, and Peru.

Our thanks go to Aldo Malavasi, director of the Biofabrica Moscamed - Brazil, who offered all possible support to achieve the objectives of the workshop.

Strengthening Technical Capacity to Control Mediterranean Fruit Fly Using the Sterile Insect Technique (SIT) (PAN5020)

Use of systems approach for fruit flies allows Panama to export bell peppers

Over the years the Joint FAO/IAEA Division has helped Panama to develop a critical mass of technicians for controlling the Mediterranean fruit fly and the fruit flies of genera *Anastrepha*, as well as preventing the establishment of the South America fruit fly (*Anastrepha grandis*). These flies do great damage to agricultural world trade, typically shutting countries out of export markets if they cannot prove their produce to be pest free. Given their short shelf life, fruits and vegetables tend to be the most valuable agricultural export products.

Bell pepper screehouses production units (Chiriquí, Panama).

The FAO and IAEA have provided support through a succession of three Panama projects since 2001 against native and exotic fruit flies, which have resulted in the declaration of Colce as Mediterranean fruit fly pest free in 2011; in 2012 in the declaration of Azuero peninsula as a Mediterranean fruit fly free area; and also in 2012, in the official phytosanitary agreement between the Governments of the USA and Panama to export fresh papaya, tomato and bell pepper from Panama to the USA.

Bell pepper packinghouse for export (Chiriquí, Panama).

Immediately after the phytosanitary agreement was signed, a group of 18 Panamanian entrepreneurs build nine screen houses and packing facilities which guarantee the exclusion of the Mediterranean fruit fly as part of a system approach, at a cost of 13 million US dollars. On January 2013, these facilities received certification from the USDA which initiates the exports of bell pepper to the USA. For more information (in Spanish) please visit:

http://www.prensa.com/impreso/economia/pimentones-obtienen-visto-bueno-de-eu/151091

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

Project Number	Ongoing CRPs	Scientific Secretary
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 with 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)	Kostas Bourtzis
D4.10.23	Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade (2010-2015)	Jorge Hendrichs
D4.10.24	Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application (2012-2017)	Carlos Cáceres
D4.20.15	Enhancing Vector Refractoriness to Trypanosome Infection (2013-2018)	Andrew Parker

Project Number	Planned New CRPs	Scientific Secretary
D4.40.01	Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes (2013-2018)	Jeremie Gilles
D4.10.25	Dormancy Management to Enable Mass-rearing and Increase Efficacy of Sterile Insects and Natural Enemies (2014-2019)	Rui Cardoso Pereira

Final RCM of CRP on *Biology of Male Mosquitoes in Relation to Genetic Control Programmes*. 4-8 March 2013, Juazeiro, Bahia, Brazil

From 4-8 March 2013 the final RCM of CRP G3.40.02 on the Biology of Male Mosquitoes in Relation to Genetic Control Programmes was held in Juazeiro, Bahia, Brazil, at the Juazeiro MOSCAMED insect rearing and release facility. At this site, genetically modified *Aedes aegypti* are reared for release in pilot areas as part of suppression trials, and monitoring activities are coordinated prior to and following release.

Participants of the RCM of the CRP on biology of male mosquitoes in relation to genetic control programmes (Juazeiro, Bahia, Brazil).

The RCM was attended by 14 participants from Bangladesh, Benin, Burkina Faso, Cuba, Italy, France (French

Polynesia and La Réunion), Ghana, Mauritius, South Africa, Sudan, Sweden, Trinidad and Tobago and the USA and, who all presented their research progress since the previous RCM in Bologna, Italy in 2011. Alongside these presentations visits were arranged to the MOSCAMED mosquito rearing facility, and a field visit arranged to observe the release of male mosquitoes in one of the current test sites.

Also at this meeting the participants drafted the final CRP report. The excellent results of the research conducted during the course of the 5 year CRP will be published as special issue of the journal Acta Tropica.

Final RCM of CRP on *Applying Population Genetics and GIS for Managing Livestock Insect Pests.* 15-19 April 2013, London, United Kingdom

The fourth and final Research Coordination Meeting (RCM) under the Coordinated Research Project (CRP) entitled '*Applying GIS and Population Genetics for Managing Livestock Insect Pests*' was held in London, United Kingdom, 15–19 April 2013, hosted by the Natural History Museum (NHM). The meeting was attended by 16 scientists from the following Member States: Australia, Brazil, Burkina Faso, Ethiopia, France, Indonesia, Iraq, Israel, Italy, Kenya, UK, USA, and Yemen.

Participants of the RCM of the CRP on applying population genetics and GIS for managing livestock insect pests (London, UK).

Twelve progress report papers on population genetics and geometric morphometrics of new and old world screwworm flies and of tsetse fly species in East and West Africa, as well as new findings to generate geographic information systems (GIS) aided maps illustrating the research findings were presented and reviewed.

A special session focused on a new tutorial DVD on the use of GIS in insect pest control operations. The meeting agreed on a procedure and time frame for publishing the scientific work done and findings generated under the CRP.

The RCM participants highly appreciated the opportunity provided by the NHM management to undertake special tours though the NHM's unique and impressive entomology, parasitic worms and molecular collections.

First RCM of CRP on *Enhancing Vector Refractoriness to Trypanosome Infection.* 3-7 June 2013, Vienna, Austria

The first RCM of this new CRP was attended by 21 participants from Africa (6), Asia (1), Australia (1) Europe (11), and the USA (2), as well as one consultant and four observers. The first two days of the meeting were devoted to presentations on the ongoing and future research of the participants.

Participants of the first RCM on Enhancing Vector Refractoriness to Trypanosome Infection (Vienna, Austria).

Participants were divided into two main topics: (1) The symbionts of tsetse including *Sodalis*, *Wolbachia* and *Wigglesworthia*, with the general objective to better understand the relation between the symbionts and tsetse to make them refractory to trypanosome infection by symbiont-based technologies. The specific objectives are to determine the prevalence of *Wolbachia* in field and laboratory populations; the occurrence of cytoplasmic incompatibility; and the localization of the symbionts in tsetse tissues and the impact of different nutritional treatment and irradiation on tsetse microbiota. (2) The parasite and pathogens of tsetse including the trypanosomes, the salivary gland hypertrophy virus and a pathogenic fungus. The objectives will be to determine the virus latency in the asymptomatic state and the reason for an infection switching status from asymptomatic to symptomatic state, the impact of fungal infection on the vector trypanosome transmission and the interaction between virus infection and the prevalence of tsetse microbiota.

The future work plan for each participant was discussed and agreed to and collaborations were established. The topics for training some participants on microbiota detection from natural tsetse species and analysis by in silico methods and fluorescence microscopy in a workshop to be held in conjunction with the second RCM were discussed and the timing and location were tentatively set for Addis Ababa, Ethiopia from 1-5 December 2014.

Developments at the Insect Pest Control Laboratory (IPCL), Seibersdorf

FRUIT FLIES

Work under the FAO/IAEA USDA/APHIS agreement on 'Development of Phytosanitary and Regulatory Treatments for Exotic Tephritid Fruit Flies'

The post-harvest part of the above mentioned collaborative project is continuing with work assessing relative tolerances of immature stages of *Bactrocera* spp. to heat, cold and methyl bromide fumigation. Our co-operators at the United States Department of Agriculture (USDA) have been awarded funds to continue with the project (post-harvest treatment and mating behavioural studies) until the end of 2014. We are also collaborating with a microscopist for the characterization of *Bactrocera* spp. eggs using a scanning electron microscope. We hope to provide information about the differences in chorion structure and micropyle characteristics between species. Much of the preliminary work has been completed including the development of fixation and dehydration methods.

Research activities to support the CRP on 'Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade'

Bactrocera dorsalis Complex

Research has continued towards resolving species limits among morphologically cryptic pest taxa of the *B. dorsalis* complex. Two visiting scientists from Australia (Mark Schutze) and China (Wang Bo) were hosted to support these activities. The work is focused on pre- and post-zygotic mating compatibility studies among populations of a) *B. dorsalis* (Pakistan) x *B. invadens* (Kenya), b) *B. dorsalis* (Sri Lanka) x *B. invadens* (Kenya), and c) *B. dorsalis* (Pakistan) x *B. dorsalis* (Sri Lanka).

Much of this work will be completed by the end of 2013, possibly extending into 2014 if necessary. Furthermore, specimens from these studies will be preserved for additional analysis (e.g. wing geometric morphometrics, cuticular hydrocarbons), which will also contribute towards resolving their biological relationship.

Under the above mentioned FAO/IAEA USDA/APHIS agreement "Development of Phytosanitary and Regulatory Treatments for Exotic Tephritid Fruit Flies" Ishan Ul Haq, a scientist from Pakistan has returned as a consultant to continue research on enhanced mating behaviour of males belonging to members of the *B. dorsalis* complex. This includes assessing the effect of male exposure to methyl eugenol (ME) and its effect on the level and symmetry of cross-species matings. Mating competitiveness of ME-exposed males is being compared against ME-fed and non-ME-fed males. Studies are also being conducted to assess whether aromatherapy (inhalation of ME by the males) vs. ME-feeding will also enhance male mating competitiveness between members of the *B. dorsalis* complex. If ME inhalation enhances male mating competitiveness then the interaction of juvenile hormone analogue and ME aromatherapy for male sexual maturity acceleration and enhanced mating competitiveness will be investigated.

Verification of strain identity of the Mediterranean fruit fly GSS used in mass-rearing facilities

VIENNA 4 was the first *Ceratitis capitata,* genetic sexing strain (GSS) transferred to a mass-rearing facility (Guatemala, 1994). Thereafter, two new translocation lines were developed, VIENNA 7 and VIENNA 8, which are currently being used in large scale operational programmes. In most cases, these two GSS have been under mass-rearing conditions for many years (2-14 years).

Country	Facility Name	Translocation	Inversion (D53)
Argentina	Bioplanta Mendoza	VIENNA 8 (52B)	Yes
Australia	Western Australia's Agriculture Department	VIENNA 7 (57A)	No
Brazil	Biofábrica Moscamed Brasil	VIENNA 8 (52B)	Yes
Guatemala	Planta El Pino Moscamed Guatemala	VIENNA 8 (52B	No
Israel	Bio-Fly	VIENNA 8 (52B)	Yes
Peru	Centro de Producción y Esterilización Mosca de la Fruta La Molina	VIENNA 8 (52B)	Yes
South Africa	SIT Africa (Pty) Ltd	VIENNA 8 (52B)	Yes
Spain	Bioplanta de Insectos Estériles	VIENNA 8 (52B)	No

A programme was initiated, in collaboration with the mass-rearing facilities worldwide, to verify the strain identity of the Mediterranean fruit fly GSS currently being used. The verification is based on: (a) the position of the Y-autosome translocation breakpoint on chromosome

5 (based on the analysis of polytene chromosomes isolated from trichogen cells); (b) the presence or absence of the inversion D53; (c) the phenotype of males and females as concerns the genetic loci *white pupae* (*wp*) and *temperature sensitive lethal* (*tsl*) and (d) the mitochondrial DNA (mtDNA) haplotype. In collaboration with Antigone Zacharopoulou (University of Patras, Greece) we herein report on the cytogenetic characteristics of the GSS used in the facilities so far analysed (table above).

Insect symbiosis and their applications

Symbiosis is widespread in the biosphere and has shaped the evolution of life on our planet. Symbiotic phenomena are quite common in insects, which represent the most abundant and species-rich group in the animal kingdom. During the last twenty years, intensive research activities have shown that symbiotic bacteria affect all aspects of the biology and physiology of host insect species, including nutrition, ecology, reproduction, evolution, behaviour, immunity, pest status and vector competence.

In the Mediterranean fruit fly *Ceratitis capitata*, for example, pioneering work by Boaz Yuval and Edouard Jurkevitch showed that gut associated bacteria can be used as probiotics to improve the mating behaviour, the fitness of sterile males and overall SIT application. It has also been proposed (and shown at least in mosquitoes) that reproductive symbiotic bacteria, like *Wolbachia*, can be used in synergy with SIT for the control of pests and disease vectors. In addition, *Wolbachia* has recently been shown to interfere and prevent the transmission of major human pathogens like *Plasmodium*, dengue, Chikungunya and filarial nematodes.

Recognizing the importance of symbiosis, a project has been initiated in the frame of the CRP 'Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application' to determine the microbiota associated with key target fruit flies species of SIT application. Using classical molecular and microbiological approaches as well as next generation sequencing techniques, research aims to unravel the gut and reproductive tissues microbiome associated with key pest Tephritid species, including among others the olive fly *Bactrocera oleae*, the mexfly *Anastrepha ludens*, *A. fraterculus* and other *Anastrepha* species. Our goal is to harness the endogenous microbiota and use it as probiotics to improve the fitness of sterile males, to improve and/or reduce the cost of mass rearing (eg larval and adult diet) and, in general, to improve and support SIT-based strategies.

TSETSE FLIES

Salivary gland hypertrophy virus

Some tsetse colonies of *Glossina pallidipes* are infected with the salivary gland hypertrophy virus (SGHV) which hampers the development of these colonies due to reduced productivity. After the development of an efficient strategy to manage the virus that is based on the combination of "clean feeding" and adding valacyclovir (antiviral drug) to the blood meals, attempts are continuing to develop alternative strategies to be used in case resistance of the virus against valacyclovir should appear. Various virus management strategies are under development that are based on four approaches: (1) blocking virus replication using other commercial antiviral drugs, (2) neutralizing the virus infection using virus specific antibodies, (3) exploring the relation between the virus infection and tsetse symbionts, and (4) impeding SGHV infection using a peptide similar to SGHV ORF005 that could possibly bind to the gut epithelium.

The use of the antiviral drug valacyclovir continues to suppress SGHV infection in the *G. pallidipes* colony for the fifth year. No viral resistance against the drug or negative impact of tsetse mortality and productivity have been observed. These positive results encouraged the administration of this drug to also reduce virus infection in the *G. pallidipes* colony in Bratislava, Slovakia with no negative impact on the flies' productivity and mortality so far. Also the manager of the Kality facility, Addis Ababa, Ethiopia has adopted this strategy and valacyclovir is now routinely added to the blood meals used for feeding their *G. pallidipes* colony. Since the start of the treatment, fecundity of the colony has improved markedly and the colony is now growing. To find alternative antiviral drugs against the *G. pallidipes* virus, 15 other drugs are under investigation.

The clean feeding system, which avoids the re-use of blood for feeding colony flies, has been used at the IPCL to establish two clean feeding colonies that are now salivary gland hyperplasia (SGH) free and that have a low virus infection level. The use of this technique for approximately two years reduced the virus infection level in the two clean feeding colonies, but also in the regular feeding colony that was fed on the blood remaining after feeding the two clean feeding colonies. The infection level in the regular feeding colony is now so low that it has become difficult to find symptomatic infected flies. Although this result confirms the effectiveness of this technique to reduce and possibly remove the virus infection from the colonies, it also has highlighted the need to maintain a virus-contaminated colony to enable further experimental work to evaluate the other virus management strategies. Therefore, a virus infected colony was established by injecting the virus in teneral flies. This colony is maintained separately from the remaining colony and it is considered as virus source colony (excess males showed 60% SGH prevalence). The combination between the valacyclovir treatment and clean feeding system reduced significantly the time needed to remove the virus infection symptoms from the infected colony

Drion Boucias from the University of Florida, USA, has been studying other aspects of the virus biology during a sabbatical at the IPCL. The results of these studies indicate that tsetse flies injected with the virus showed a significant increase in virus load but did not develop SGH. Hyperplasia developed only in later progeny (from the

fourth larva on) of injected females. The correlation between virus infection and the symbionts *Sodalis* and *Wolbachia* was also investigated. The results indicate a strong correlation between the presence of symbiotic bacteria and the prevalence of the virus in F_1 progeny. When adults flies injected with SGHV were fed on blood supplemented with ampicillin, there was a significant reduction in the virus load and SGH prevalence in the F_1 progeny compared to the progeny of flies fed on ampicillin-free blood. As the ampicillin treatment removes the bacterial symbionts it is suggested that the presence of the symbionts plays an important role in virus transmission to the progeny. Further studies on the role of symbiotic bacteria in the virus infection process are continuing. The dynamics of tsetse endogenous symbionts in hybrid crosses between the subspecies *G. morsitans morsitans* and *G. morsitans centralis* and between these subspecies and *G. swynnertoni* are being studied in collaboration with Wolfgang Miller and Daniela Schneider of the Medical University, Vienna.

In addition, the research aims at identifying symbiotic bacteria which may interfere with the establishment and transmission of trypanosomes and/or SGHV, thus developing refractory tsetse fly lines which could be used for mass rearing and SIT-based applications. This initiative is carried out within the framework of the new CRP on "Enhancing Vector Refractoriness to Trypanosome Infection".

The effect of the *G. pallidipes* SGHV on other tsetse species is being assessed by Guler Demirbas, a visiting scientist from Turkey. She has been testing the impact of injecting *G. palpalis gambiensis* and *G. brevipalpis* with the virus extracted from *G. pallidipes*. The results indicate that the virus can replicate in *G. p. gambiensis,* but not in *G. brevipalpis*. Testing the impact of the virus injection on other tsetse species is under way.

Gisele Ouedraogo, a visiting scientist from Burkina Faso, is studying the prevalence of SGHV infection in wild tsetse populations of West Africa. Her preliminary data indicate a higher prevalence of the virus in *G. tachinoides* that in *G. p. gambiensis*.

Reloading of the GC220 at the Insect Pest Control Laboratory

Foss Therapy Services of California was contracted to reload the Insect Pest Control Laboratory's Gamma Cell 220 (GC220) cobalt-60 irradiator in 2010. The contract was for the supply and installation of 555 TBq (15 kCi) of ^{60}Co. The GC220 has many pencil positions in the source cage, so the new source pencils could be added without removing any of the old pencils, avoiding the cost of return shipment and disposal. The ^{60}Co was supplied from Russia and the installation was performed on site by moving the GC220 to a secure location and erecting a portable hot cell. The moving, disassembly, inspection, installation of the new pencils and reassembly took one week. The costs were approximately: ^{60}Co $160 000, installation charges $21 000, international shipping $56 000, inland transport $10 000 and hire of source shipping container $50 000 for a total cost of just under $300 000. For comparison, the cost of an RS2400 X ray irradiator is around $250,000. The central dose rate of the GC220 after the installation was approximately 240 Gy min^{-1} to a usable volume of about 1.5 litres compared with 14.5 Gy min^{-1} to 18 litres for the RS2400. For the GC220 this gives a throughput of 37 litres per hour, assuming 2 minutes to change the load and a dose of 100 Gy. For the RS2400 the equivalent figure is 90 litres per hour, assuming 5 minutes is required to change the load. As the ^{60}Co has a half-life of 5.3 years the throughput declines to 32 litres per hour after 5 years. In comparison, the RS2400 requires frequent replacements of expensive X ray tubes, and the cost of electricity consumption has to be included. Moreover, the reliability of these X ray irradiators needs to be validated in operational programmes when used on a daily basis for many hours.

MOSQUITOES

Swarm participation of sterile *Anopheles arabiensis* males in the target area of Sudan

This study investigated the capability of released sterile *An. arabiensis* males to survive, disperse and participate in swarms according to the distance from the release site to the swarm position, using mark-release-recapture techniques. *An. arabiensis* (Dongola strain, originating from Sudan) was cultured at the Tropical Medicine Research Institute laboratory (Soba, Khartoum, Sudan). The figure (next page) describes the geographical layout of the experiment. Three distances from the main swarm were tested: 50, 100 and 200 metres. In the current study, no reduction was observed in the competitiveness of sterile compared to wild male *An. arabiensis* as it is usually observed and linked to laboratory colonization. There was no evidence for reduced dispersal, survival or swarm site selection. However, even if the sterile male mosquitoes participated in swarms, it still needs to be assessed how successful they will be in copulating with virgin females.

We have also shown that under the conditions tested, released male *An. arabiensis* could easily disperse 200 meters, and find and participate in a swarm, meaning that in the context of SIT application sterile males could be released according to a grid with 400 m between release points. However, this grid may need to be modified following future studies, since longer distances from the swarm (500 m, 1 km or 2 km) have yet to be tested. Indeed, *Anopheles* mosquitoes are known to be able to fly relatively long distances.

Releases of sterilized *Aedes albopictus* males in laboratory and semi-field cages: release ratios and mating competitiveness

To counter any effects that SIT mass rearing, sterilization and release processes may have on male *Aedes albopictus* mating abilities, so-called "overflooding" ratios where

Map of the Nile area in Northern State, Sudan where Anopheles arabiensis *swarms were studied. The big blue square indicates the position of the main swarm. The small blue squares A and B indicate the two small swarms. The red, orange and green spots indicate 50, 100 and 200 m release points, respectively.*

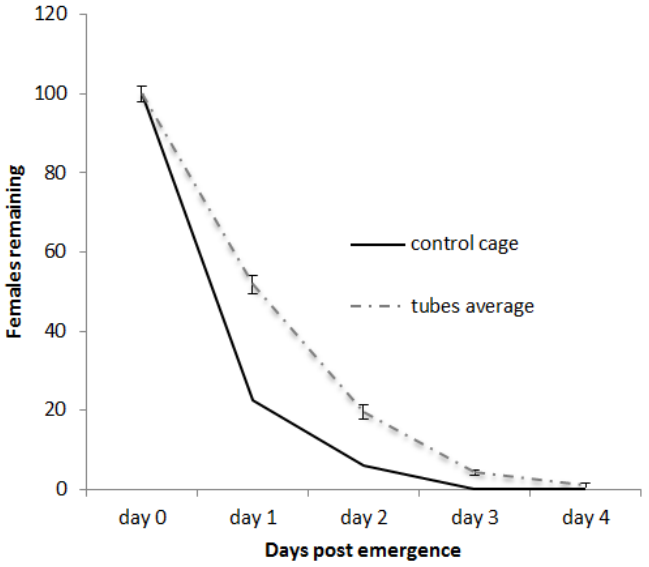
sterile males far outnumber wild males in the field are used. Such skewed releases greatly increase the probability of a sterile male mating with a wild female. Field or semi-field cage mating ability trials are often used to determine adequate release ratios, though they can be time consuming and laborious to set up and manage and are often only done periodically. If smaller, laboratory based cages could mimic results seen in larger, field and semi-field cages, mating ability trials could be done more frequently, which would allow a more dynamic approach to releases, informed by the ever-changing state of the colony. To test how skewed ratios of sterile to fertile males would affect overall fertility in a population, three release ratios were tested: 1:1, 3:1 and 5:1. Fertile and sterile controls were included in the trial and all treatments were tested in two laboratory sized cages (small = 30 cm square, large = 60 cm square) and one semi-field cage (1.75 m square).

Calculated competitive index values ('C') indicate great similarity between sterile males and their fertile counterparts in small laboratory cages (C = 0.85) and parity between sterile and fertile males in both large laboratory and semi-field cages (for both sizes, C = 1).

Increasing sterile:fertile ratios significantly decreased mean hatch rates. All treatment ratios were also significantly different from both fertile and sterile controls. This pattern of induced sterility was consistent across cage size: 1:1 induced an average of 57±6 % sterility, with 3:1 and 5:1 inducing 71±5 % and 81±4 % sterility, respectively. At a 5:1 ratio, the induced sterility was the highest of all treatment ratios, but was still significantly less than the induced sterility of the sterile control, indicating the need for greater release ratios if elimination is desired.

Spiking blood with ivermectin will kill female *Anopheles gambiae*

The method by which females of *An. arabiensis* can be eliminated by spiking blood meals with ivermectin is transferable to *An. gambiae*. However, young females of the *An. gambiae* laboratory strain from Burkina Faso were more willing to feed on fresh bovine blood, as opposed to defrosted bovine blood. Overall, it was possible to eliminate all females from cages by day 4 post emergence (similar to observations for *An. arabiensis*) regardless of blood source, however, more females were killed on days 1 and 2 when fresh blood was offered.



Elimination of female Anopheles gambiae *by spiking bloodmeals with ivermectin. The efficiency of elimination is increased when using fresh bovine blood (dotted line) as opposed to defrosted bovine blood (continuous line).*

Reports

Technical Panel on Phytosanitary Treatments. 3-7 December 2012, Tokyo, Japan

The Technical Panel on Phytosanitary Treatments (TPPT) of the International Plant Protection Convention met in Nagoya, Japan from 3-7 December 2012. The panel considered a number of treatment proposals, including five radiation treatments. The radiation treatments consisted of:

- Generic irradiation treatment for all insects (Arthropoda: Insecta) except lepidopteran pupae and adults (Insecta: Lepidoptera) in any host commodity, first proposed in 2007, and four new treatments
- Generic irradiation for eggs and larvae of Lepidoptera
- Generic irradiation for pupae of Lepidoptera
- Irradiation for *Dysmincoccus neobrevipes* Beardsly, *Plannococcus liliacinus* (Cockerell) and *Planococcus minor* (Maskell) (Hemiptera: Pseudococcidae)
- Irradiation for *Ostrinia nubilalis*.

Participants of the Technical Panel on Phytosanitary Treatments (TPPT) of the International Plant Protection Commission (Nagoya, Japan).

The generic irradiation treatment of 400 Gy for all insects except Lepidoptera pupae and adults will be removed from the list of topics as the proposers are unable to provide additional information to justify the treatment. The two other generic dose proposals for Lepidoptera will also not be added to the list of topics for consideration as it was considered that the data available were not sufficient to support the two proposals. The proposal for *Ostrinia nubilalis* also requires additional information, but the proposals for the two Pseudococcidae were accepted for passing to the Standards Committee.

Several other proposals, utilizing either heat or cold treatment, were discussed and a total of ten post-harvest treatments were recommended for forwarding through the consultation process.

11th Meeting of National PATTEC Coordinators and 1st Meeting of the PATTEC Steering Committee. 10-12 December 2012, Hawassa, Ethiopia

From 10-12 December the Africa Union Pan African Tsetse and Trypanosomosis Eradication Campaign (AU-PATTEC) organized the 11th meeting of the National PATTEC coordinators and the 1st meeting of the PATTEC Steering Committee, respectively, in Hawassa, Ethiopia.

Some ninety national PATTEC coordinators and focal points from 29 African countries and representatives of international organizations, research institutions and private and public partners presented their work in support of the objectives of the PATTEC initiative to address and eventually eliminate the tsetse and trypanosomosis problem in Africa.

The Coordinators Meeting noted that twelve years after the establishment of PATTEC there are commendable efforts to address the T&T problem, but further funding and harmonization / standardization of intervention efforts are needed. The Ethiopian Southern Tsetse Eradication Project (STEP) demonstrated to the meeting participants aerial spraying operations and aerial releases of sterile male tsetse flies in the in the STEP area in different parts of the Southern Rift Valley.

First Meeting of the AU-PATTEC Steering Committee (Hawassa, Ethiopia).

Twenty-six Steering Committee members, or their representatives, invited guests, observers and AU-PATTEC secretariat staff participated in the 1st PATTEC Steering Committee. After a summary presentation on PATTEC tsetse and trypanosomosis intervention operations in Member States and activity reports by international organizations, research institutions and private and public partners, the meeting discussed the revised PATTEC Strategic Plan (2013-2017) and generated several specific suggestions for follow up by PATTEC management and partners.

87th Annual Western Orchard Pest and Disease Management Conference. 9-11 January 2013, Portland, Oregon, USA

20 Years of Successful Implementation of the Codling Moth Okanagan Kootenay SIR Programme (OKSIR) in Canada

Staff of the IPCL participated in the 87th Orchard Pest and Disease Management Conference that was held in Portland, Oregon, USA from 9-11 January 2013, and delivered an invited presentation at the request of organizers on the principles of area-wide integrated pest management (AW-IPM) and the sterile insect technique, as the SIT is very often missing from the agenda of this annual meeting. The conference contained sessions on programme implementation, monitoring, biocontrol, invasive species, chemical control, biology and mating disruption.

(Top) Organic apples being produced in the Okanagan Valley as a result of the use of sterile insect; (bottom) release of sterile moths using all-terrain vehicles.

A very interesting presentation was delivered by Hugh Philip and Cara Nelson on 20 years of successful implementation of the codling moth Okanagan Kootenay Sterile Insect Release programme (OKSIR) in Canada. The release of sterile moths in the Okanagan valley of British Columbia has resulted in a decrease of over 80% in insecticide use and sales, and has kept codling moth populations below an economic threshold level for the last two decades. However, the OKSIR programme is facing several new challenges in view of the recent changes in the dynamics of the apple and pear industry with 60 % less surface area covered with apple and pear orchards.

Discussions were held on how the OKSIR programme could best respond to these changes, on possibilities for commercialization of sterile moths outside Canada, and how the programme could better advertise its achievements (via websites, presentations at international meetings, conferences, publications etc.). In addition, options for regular external reviews with international experts were discussed that would increase the programme's international credibility and standing.

In a side meeting, a possible codling moth SIT trial in the states of California and Washington, USA was discussed and the possibilities explored for the OKSIR programme to deliver the sterile moths. The OKSIR programme has been collaborating with USA researchers providing sterile moths for the past few years to assist in mating disruption trials.

For more info on the OKSIR programme contact Ms Cara Nelson, General Manager, Okanagan Kootenay Sterile Insect Release Program, 1450 KLO Road, Kelowna, BC V1W 3Z4, Phone: (250) 469-6182, Cell: (250) 808-0287, Email: CNelson@oksir.org, Website: www.oksir.org.

Symposium on Prospects for Enhancing Augmentative Releases of Beneficial Organisms Using Radiation at Fourth International Symposium on Biological Control of Arthropods. 4-8 March 2013, Pucon, Chile

The 4th International Symposium on the Biological Control of Arthropods was held in Pucón, Chile, from 4 - 8 March 2013. The symposium was attended by about 200 local and international participants. It was divided into 18 sessions covering many aspects of arthropod biocontrol. The fifth session on *Prospects for enhancing augmentative releases of beneficial organisms using radiation* was organized by the Joint FAO/IAEA Division. It included presentations by five speakers sponsored by the Joint Division. Their presentations included: *Integrating augmentative biological control and inherited sterility for management of Lepidopteran pests* (James E. Carpenter); *Current management efforts against* Cactoblastis cactorum *as a pest of North American prickly pear cactus,* Opuntia *spp.* (Stephen D. Hight, James E. Carpenter, Laura Varone, and Guillermo A. Logarzo); *Mobile mating disruption – the challenge of cross-species behavioural suppression* (David M. Suckling, Bill Woods, and Eric B. Jang); *Improving mass rearing and commercial shipments of* Spalangia endius *W. (Hymenoptera: Pteromalidae) through irradiation of its host* (Miguel C. Zapater and Gladys Perez-Camargo); and *Integrating the SIT with parasitoids and pathogens against fruit fly*

pests: the potential of using sterile insects as vectors of pathogenic microorganisms (Pablo Montoya and Salvador Flores). A short introductory presentation on the sterile insect technique and the various potential uses of radiation in biocontrol of arthropods was also included.

Another presentation of particular interest to nuclear applications was 'Banker plants, trap crops and other bioprotection developments in Canadian greenhouse floriculture' by Michael Brownridge of Vineland Research and Innovation Center, Canada. In the presentation he mentioned the increasing problem of agromizid leaf miners and the fact that all propagating material is now imported, mostly from Central America and East Africa. Afterwards we discussed both irradiation as a disinfestation method for incoming propagation material and the recent interest from Flowers Canada in the use of SIT to control *Liriomyza trifolii* in greenhouses.

Eighth Session of the Commission on Phytosanitary Measures (CPM), International Plant Protection Convention. 8-12 April, Rome, Italy

The session was opened by FAO's Deputy Director-General for Operations, Mr Daniel Gustafson. He highlighted that the IPPC is the largest body at FAO. He noted that IPPC has heightened its interest in the link between normative work like standard setting and the impact that this achieves in terms of implementation. He commented that it is precisely this linkage between normative work, public goods and national level impacts that has made FAO proud to house the IPPC Secretariat.

There were ca. 350 participants, including 124 with official credentials out of 178 representatives of the Contracting Parties, regional plant protection organizations, specialized UN agencies and other international and regional institutions related to plant protection.

The CPM noted that reports of the Standards Committee and expert drafting groups such as the *Technical Panel on Phytosanitary Treatments* (TPPT) and *Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies* (TPFF), which the FAO/IAEA Joint Division has been supporting, are available on the IPPC portal.

The CPM also commented that draft specifications or the revision of International Standards on Phytossanitary Measures (ISPMs) 4 (Requirements of Pest Free Areas), 6 (Guidelines for Surveillance) and 8 (Determination of Pest Status in an Area) are being produced. These revisions are of much relevance to the activities the Insect Pest Control Subprogramme and its stakeholders in Member States, therefore the close cooperation with the IPPC will be maintained at the highest level.

Standards Committee Meeting (SC7), International Plant Protection Convention. 13-17 May, Rome, Italy

The meeting took place at FAO Headquarters in Rome with the participation of five of the seven officially nominated SC Members representing FAO's seven regions. Two fruit fly International Standard for Phytosanitary Measures (ISPM) were discussed: the draft on 'Determination of Host Status of Fruit to Fruit Flies (Tephritidae)' and the draft annex of ISPM 26 'Establishment of Fruit Fly Quarantine Areas Within a Pest Free Area in the Event of an Outbreak'.

*Prickly pear (*Opuntia ficus-indica*) fruit sample to determine the host status.*

The comments received during country consultation and by the IPPC Technical Panel on Glossary (TPG) were addressed. No substantial changes were made on the draft annex of the ISPM 26 and one main change was made to the draft ISPM on 'Determination of Host Status of Fruit to Fruit Flies (Tephritidae)'. This change refers to the host status definition, which was recommended to be part of this standard (not part of the Glossary), including the definitions of natural host, non-natural host and non-host. The more narrow definition was suggested to be "host status (of a fruit to a fruit fly)", which takes into consideration the physiological stage of the fruit.

During the meeting, both draft ISPMs were approved for the last round of country consultation that will address only substantive issues.

6th International Workshop on Insect Transgenesis. 21-25 May 2013, Shanghai, China

The Sixth International Workshop on Transgenesis and Genomics of Invertebrate Organisms took place 21-25 May in Shanghai, China. It was attended by over seventy scientists from seven countries (including Australia, Austria, China, France, Italy, the United Kingdom and the United States of America).

The meeting was organized by Antony A. James (University of California, Irvine, CA, USA), Alfred Handler (United States of Agriculture, Agricultural Research Service, Gainesville, FL, USA) and the local host, Yongping Huang (Shanghai Institute of Plant Physiology and Ecology, Shanghai Institute of Biological Sciences, Chinese Academy of Sciences).

Participants of the Sixth International Workshop on Transgenesis and Genomics of Invertebrate Organisms (Shanghai, China).

During the last years, significant progress has been made on the development and exploitation of transgenic technologies for the genetic transformation of diverse invertebrate species, including insect species of agricultural and human health importance. These technologies and platforms are based, among others, on the use of transposable elements, tetracycline-repressible regulatory systems, site-specific recombinases and integrases, and Talen and Zinc Finger Nucleases.

Scientists actively working in the field of insect transgenesis and genomics presented, through oral and poster presentations, their recent research developments in the frame of six scientific sessions: 'Transgenesis Technologies', 'Site-Specific Recombination', 'Functional Genomics', 'Genomics – Transcriptomics', 'Genetic Manipulation for Applications' and 'Paratransgenesis'.

There were over forty oral presentations which were focused on different species such as tephritid fruit flies (*Ceratitis capitata*, *Bactrocera dorsalis*, *Anastrepha suspensa* and *Anastrepha ludens*), mosquitoes (*Anopheles gambiae*, *Anopheles stephensi*, *Anopheles sinensis*, *Aedes aegypti* and *Aedes albopictus*), *Tribolium castaneum*, *Helicoverpa armigera*, and *Drosophila melanogaster*, while a rather significant number of talks emphasized the research on the silkworm, *Bombyx mori*.

It is interesting to note that the meeting was of high relevance to Sterile Insect Technique (SIT) programmes since there were several reports on the development of sexing-based strategies for a number of SIT target species, including tephritid species (the Mediterranean fruit fly, *Ceratitis capitata* and the Caribbean fruit fly, *Anastrepha suspensa*) and mosquito species, but also for beneficial species such as the silkworm *Bombyx mori*.

In conclusion, this international meeting covered all recent advances in the scientific field of insect transgenesis. It is expected that these advances will eventually support existing SIT projects, for example by increasing cost-efficiency, and will facilitate the development of new ones against other major insect pest and disease vector species.

Announcements

Call for Submission of Research Proposals for a new FAO/IAEA Coordinated Research Project on *Dormancy Management to Enable Mass-rearing and Increase Efficacy of Sterile Insects and Natural Enemies*

Insect pests cause significant and widespread damage worldwide. Insecticide application remains the predominant method of controlling these pests. According to FAO, 30-40 % of agricultural production is lost to pre-harvest and post-harvest infestations mainly caused by insect pests. Despite growing worldwide dependence on agrochemicals, suppression of pest populations is frequently inadequate. In addition, due to regulation, pest resistance, and environmental and human health concerns, there is an increasing demand for the replacement of the intensive use of these chemicals by environmentally friendly, effective and sustainable methods within integrated pest management approaches. Chief among these are biological control applications based on the use of sterile insects and natural enemies.

Most insects face times of the year when reproduction or development are suppressed due to a lack of resources or unfavourable environmental conditions. Dormancy responses have evolved to mitigate the stresses of these unfavourable times and to synchronize insect life cycles with favourable periods. Dormancy responses can include both pre-programmed, hormonally mediated diapause, and also quiescence induced directly by the environment (e.g. low temperatures, drought, lack of hosts, etc.). Quiescence is a state of developmental arrest that can occur in any life stage. In contrast, diapause is a stage-specific developmental arrest that can be either facultative (determined by token stimuli) or obligate (occurring regardless of prevailing environmental conditions).

Many univoltine pest species have an obligatory diapause that synchronizes them with resource availability. For such univoltine insect pest species, the sterile insect technique (SIT) and augmentative natural enemy control have been neither practical nor possible due to obligatory diapause responses that prevent or interfere with continuous mass rearing. Examples include the European cherry fruit fly, apple maggot fly, Chinese citrus fruit fly, Russian melon fly, and processionary moths. Although obligatory diapause has been a major roadblock to developing biological control programs for many pests, current research suggests that there are approaches that can potentially disrupt obligatory diapause and facilitate mass rearing. Four approaches appear particularly promising for circumventing the challenges of obligate diapause, including: (1) simple environmental manipulations, such as thermal shock, (2) chemical or hormonal treatments, such as application of organic solvents, (3) choosing geographical populations without diapause or artificial selection for nondiapausing strains within populations, and (4) genetic modification by mutagenesis or transgenesis of critical genes for diapause. Successfully circumventing obligate diapause with any of these approaches, or a combination thereof, would provide new opportunities for effectively mass rearing of important pest species.

While obligate diapause is an obstacle in some cases, two aspects of dormancy responses can be effectively exploited to improve the efficacy of biological control programs.

First, dormancy can be used to stockpile mass-reared insects and to time the supply of biological control agents to coincide with seasonal demand for releases. The ability to synchronize the supply of control agents with demand is critical for the growing biological control industry. Furthermore, inducing dormant states opens up new opportunities for either enhancing classical cryopreservation of embryos (in liquid nitrogen) or developing new methods for long-term cold storage of other life stages, such as larvae or pupae. Development of such techniques would make it feasible to maintain strains over the long term without compromising the genetic integrity of those strains, while avoiding the efforts and costs involved in continuous rearing. This ability to maintain stocks without continuous rearing is especially important when considering the rapid accumulation of mutant and transgenic strains in entomological research laboratories.

Second, increased stress tolerance is often a hallmark of dormancy that could be exploited in biological control applications. The efficacy of biological control, including sterile insect programs and natural enemy releases, is affected by the quality of insects released into the field. Poor performance of insects used in field releases can be a product of stresses experienced at multiple points during the production, marking, irradiation, shipping, and release process. The ability to specifically induce dormant states, including either diapause or quiescence, could potentially reduce the above stresses, thereby improving the performance of individuals in field releases. For example, some diapausing insects are known to be resistant to low-level irradiation. Perhaps diapause could be exploited to reduce off-target irradiation damage, outside of germ-line genomic DNA, and improve the performance of sterile insects. Similarly, insects are exposed to mechanical disturbance, hypoxia, and thermal stress during shipping that may be mitigated by inducing dormant states prior to shipping.

Beyond applications to existing biological control tactics, there is an opportunity to develop novel strategies for controlling pest populations by managing diapause and dormancy responses. For example, new approaches to prevent diapause, terminate diapause, or prolong diapause could be exploited to desynchronize insects from

favourable environmental conditions, thus inducing 'ecological suicide' in pest populations.

Developing dormancy management tools could be important for biological control involving sterile insects or natural enemy releases. Six key questions should be addressed:

- Can dormancy responses be used to manage insect life cycles to enable or improve the efficacy of mass rearing?
- Can dormancy responses be used to maintain the genetic integrity of laboratory strains?
- Can dormancy responses be used to enable or enhance the shelf life of sterile insects and natural enemies while making them available for release upon demand?
- Can dormancy responses be used to reduce radiation injury and enhance sterile insect performance?
- Can dormancy responses be managed to decrease shipping-related damage and enhance post-shipping performance of biological control agents?
- Can studying dormancy responses foster the development of novel approaches for insect pest management, for example 'ecological suicide'?

The expected duration of the CRP is 5 years (2014-2019) and the first Research Coordination Meeting is planned for June 2014 in Vienna, Austria. Scientists and researchers who are interested in collaborating in this new CRP should contact Rui Cardoso Pereira (R.Cardoso-Pereira@iaea.org). Information on the IAEA Coordinated Research Programme and how to apply for research contracts and research agreements can be found at http://www-crp.iaea.org/. Applications should be submitted by **30 November 2013** to Official.Mail@iaea.org.

Announcement of FAO/IAEA Interregional and Regional Training Courses

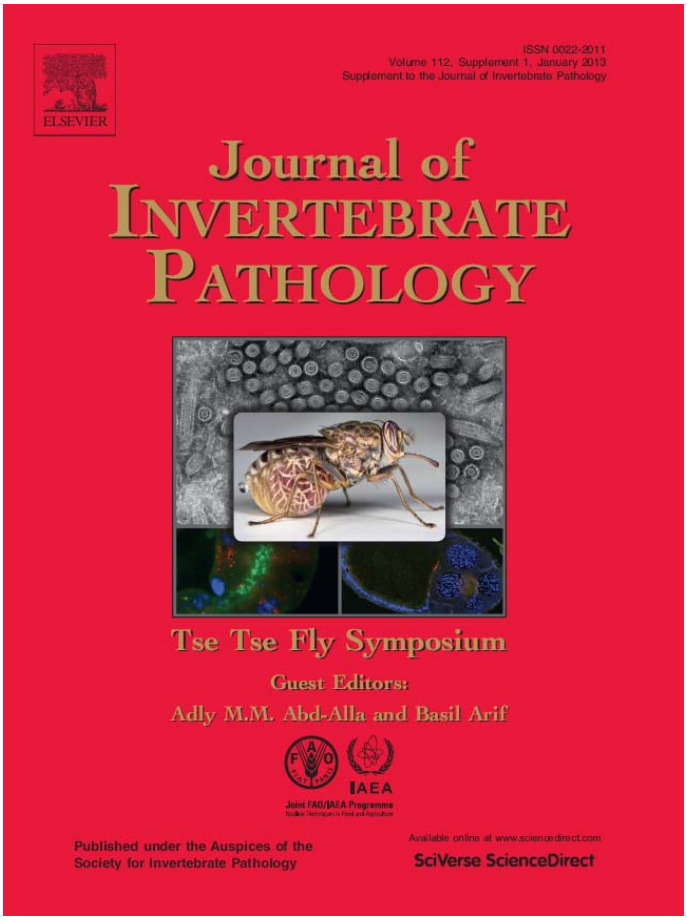
- Regional Training Course on *Area-Wide Integrated Fruit Fly Suppression, including MAT and SIT for the Balkans and the Eastern Mediterranean* (under TC Project RER5018). 7-11 October 2013. Opuzen, Croatia. (**Deadline for nominations: 31 July 2013).**

Application procedure: Nominations should be submitted on the standard IAEA application form for training courses (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 (either the Ministry of Foreign Affairs, the National Atomic Energy Authority, the Office of the United Nations Development Programme, the Office of the FAO Resident Representative or the Ministry of Agriculture). The completed forms must be submitted to the International Atomic Energy Agency, Vienna International Centre, P.O. Box 100, 1400 Vienna, Austria. Advance nominations by email (official.mail @iaea. org) are welcome.

Proceedings of the CRP on *Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens*

Sleeping sickness or Human African Trypanosomosis affects people in approximately 36 countries in sub-Saharan Africa and is caused by *Trypanosoma brucei gambiense* (T.b.g.) or *Trypanosoma brucei rhodesiense* (T.b.r.). The former is responsible for about 95% of the chronic cases in central and western Africa, whereas T.b.r. causes the acute form of the disease in eastern Africa. The parasites are transmitted by one or more blood-feeding tsetse fly species belonging to the genus *Glossina*. Other *Glossina* transmitted trypanosomes also infect cattle and cause a disease called nagana, a Zulu word meaning 'to be depressed'. Nagana results in millions of dollars of economic losses to countries that can ill afford such losses.



The management of nagana based on the recurrent treatment of livestock with trypanocidal drugs is costly and not sustainable in view of increasing resistance of the parasites. In attempts to develop more sustainable approaches to the management of the disease in mainland Africa, several Governments adopted the Sterile Insect Technique (SIT). This technique, when integrated with other control tactics, has been previously successful in eradicating tsetse flies from the Island of Unguja (Zanzibar), United Republic of Tanzania. It relies on limiting the reproductive capacity of the flies by releasing large

numbers of reproductively sterilized, colony reared males.

In order to initiate an SIT strategy against *Glossina pallidipes* in Ethiopia, tsetse fly colonies were established in Seibersdorf, Austria and in Addis Ababa, Ethiopia. However, two colonies in Seibersdorf collapsed due to infection by the *Glossina pallidipes* salivary gland hypertrophy virus (GpSGHV). The virus also caused low production and poor stability of the colonies in Ethiopia. The question of how to limit the spread of the virus in the colonies so as to produce sufficient flies for an SIT strategy became paramount.

Approximately seven years ago a coordinated research project (CRP) entitled 'Improving SIT for Tsetse Flies through Research on Their Symbionts and Pathogens' was initiated under the auspices of the Joint FAO/IAEA Division. This FAO/IAEA coordinated research project included 23 scientists from 18 countries representing a broad range of expertise to investigate the problem and to develop solutions. These scientists had expertise in insect viruses and especially in a closely related virus that causes similar symptoms in the common house fly, *Musca domestica* (MdSGHV), as well as in tsetse symbionts, parasites and fungal pathogens.

The individual studies in the programme involved detailed investigations into the biology of the insect in relationship to the causative trypanosomes, parasites, and symbionts, as well as epidemiological investigations of the disease in various parts of Africa and practical procedures to manage the virus that have been transferred to tsetse mass-rearing facilities. The scientists convened at about 18 month intervals to report their findings and to coordinate their research; the last in Vienna in March 2012, when the coordinated research project was completed.

This special issue of the Journal of Invertebrate Pathology contains the final peer-reviewed research results of the CRP, including an introductory review paper, two invited reviews to provide the background to the project and additionally 17 research articles. Further research, carried out by CRP participants and collaborators during the CRP and published previously, is listed in Table 1 of the introductory paper.

It is our hope as guest editors that this issue of the Journal of Invertebrate Pathology will provide an extensive treatise on the tsetse fly and its symbionts and pathogens that will inform the insect pathology community about this extremely important problem that continues to affect both humans and cattle in sub-Saharan Africa.

Guest Editors: Adly M.M. Abd Alla & Basil Arif.

Proceedings of the CRP on *Improving Sterile Male Performance in Fruit Fly Sterile Insect Technique (SIT) Programmes*

This special issue of the Journal of Applied Entomology contains 28 original papers that have resulted from a 6-year coordinated research project (CRP) sponsored by the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, Vienna, Austria. The overall aim of the CRP was to assist FAO and IAEA Member States in achieving sustainable fruit and vegetable production and to overcome phytosanitary barriers to international trade through the integrated area-wide application of the sterile insect technique (SIT) against major fruit flies of economic importance.

About 70 species of tephritid fruit flies (Diptera: Tephritidae) are key pests of fruits and vegetables and among the worst agricultural pests worldwide. The economic damage to established and emerging horticultural industries is very high, both due to direct crop losses and suppression costs and indirectly due to trade barriers imposed by countries to prevent the introduction of exotic tephritid fruit flies with imported fresh fruit and vegetables. Unless systematic suppression measures are implemented, infestation rates can reach up to 100%, depending on the tephritid fruit fly species, host fruit and climatic conditions. This scenario, combined with the removal of key insecticides from the market, their replacement with much more costly products and the increasing requirement from importing countries for low insecticide residues, makes integration of the environmentally friendly SIT an appealing option for the control of fruit fly pests.

Research to improve the SIT has largely focused on the development and adaptation of mass-rearing and sterilization processes for different pest species. Nevertheless, the sterile insects also have to be shipped as pupae to fly emergence and release facilities where they are maintained until their release in the target areas.

A consultants' meeting convened in Vienna in October 2003 confirmed that at these facilities, many of the processes could be changed and improved to enhance the quality and performance of sterile males, in particular their sexual competitiveness. The meeting concluded that research exploring the use of nutritional, hormonal and semiochemical supplements and ways to better manage the physical conditions and handling of emerged fruit flies in fly emergence and release facilities would hold great potential to improve the cost-effectiveness of the SIT against these pests.

In response, the CRP entitled 'Improving Sterile Male Performance in Fruit Fly Sterile Insect Technique (SIT) Programmes' was initiated in 2004 and completed in 2009. It included researchers from Argentina, Australia, Brazil, China, Croatia, France, Greece, Israel, Mauritius, Mexico, the Philippines, Portugal, South Africa, Spain, Thailand, the UK and the USA. During this 6-year period, Brazil, Guatemala, Mauritius, and Spain each hosted a research coordination meeting under the CRP.

Many of the research results emanating from this productive CRP have already been transferred to operational emergence and release facilities, thereby reducing the cost and increasing the effectiveness of ongoing programmes integrating the SIT against several *Anastrepha*, *Bactrocera* and *Ceratitis* pest species.

Guest Editors: Jorge Hendrichs and Rui Pereira.

The FAO/IAEA Spreadsheet for Designing and Operation of Insect Mass Rearing Facilities

This document combines an interactive spreadsheet in Excel on a CD ROM and a procedures manual to assist in technical and economic decision making with the designing, costing, constructing, equipping and operating of insect mass-rearing facilities. The model can be used by managers as a support tool for facility design, required investments and financial planning of facilities of different sizes using different scenarios. It also allows rearing staff to model potential production changes in order to reduce rearing costs and increase production efficiency.

The software was designed using the Mediterranean fruit fly (*Ceratitis capitata*) as a model for planning insect mass-rearing facilities, but its default settings can be easily changed to suit any other fruit fly or other pest insect.

The manual also includes an appendix on site selection and biological/physical factors that need to be considered when constructing a facility and another appendix on criteria that are relevant for selecting the location and establishment of mass-rearing facilities.

The spreadsheet can be used as a tool to evaluate production and estimate levels of production needed to meet weekly goals for rearing, sterilization, and release.

For online reading/downloading of the manual, please visit the FAO AGP website (www.fao.org/agriculture/crops) under the menu item 'Publications'.

Illustrated Guideline of the World's Fruit Fly Pests

A Spanish version of this non-exhaustive guide which includes photos of 63 major fruit fly (Diptera: Tephritidae) pests in the world, has been published recently. This guide is intended to provide a general reference to those plant protection officials involved in quarantine activities, monitoring and management of fruit flies, and in the production and marketing of fresh fruits and vegetables which are hosts to fruit flies.

This guide was produced by the Insect Pest Control Subprogramme of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture supported by the IAEA's Technical Cooperation Department. It is aimed to be an identification reference tool for projects and programme managers using an area-wide integrated pest control approach.

Announcement of Upcoming International Meetings

Emerging Opportunities for the Mass Production & Quality Assurance of Invertebrates

13th WORKSHOP OF THE IOBC GLOBAL WORKING GROUP ON MASS REARING AND QUALITY ASSURANCE

Joint Meeting of:

IOBC Global Working Group on Mass Rearing and Quality Assurance (MRQA)
Indian Council of Agricultural Research (ICAR)
Society for Biocontrol Advancement (SBA), India
International Biocontrol Manufacturers Association (IBMA), Invertebrate Biocontrol Agents Group

Hosted by:

National Bureau of Agriculturally Important Insects (ICAR), Bangalore, India

To be Held:

From 6 to 8 November, 2013 in Bangalore, India

9th ISFFEI 2014 BANGKOK THAILAND

"Cordial strong bond beyond *fruit fly* work"

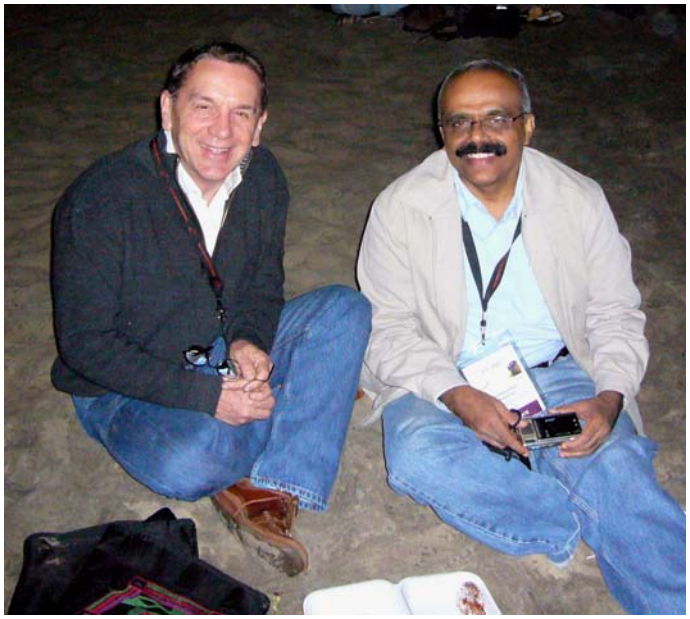
The Organizing Committee of the 9th ISFFEI takes pleasure in inviting scientists, researchers, academicians and those who are involved with various aspects of fruit flies of economic importance from government agencies, universities, research and extension institutions, international agencies, and fruit industries worldwide to present and discuss all aspects of fruit flies of economic importance including recent development related to environment - friendly pest management strategies. The "9th International Symposium on Fruit Flies of Economic Importance" will take place from **12-16 May, 2014 at Montien Riverside Hotel,** "The Spirit of Thai Hospitality" which is located on **the side of Chao Phraya River or "the River of Kings"** which is one of the most romantic locations of Bangkok.

Important dates: Registration: On-line registration will be starting from 1 May 2013 at: http://www.fruitflythailand.doae.go.th
Abstract submission: *1 May to 30 September, 2013.*
Papers acceptance announcement: *December 2013.*

In Memoriam

Javaregowda Nagaraju (1954-2012)

Dr J. Nagaraju passed away on the 31st of December 2012. All those who knew him are devastated by his sudden death. He was a passionate, inspired and imaginative scientist and a beloved friend. He brought a vast contribution to silkworm biology, in many distinct areas. His curiosity was endless, with a permanent attention that scientific progress be useful to society.



Javaregowda Nagaraju (right) during a meeting in Durban, South Africa, summer 2008.

J. Nagaraju started his career at the Central Sericultural Research and Training Institute in Mysore (Karnataka), as a Central Silk Board (CSB) employee. In 1989, he came to Lyon (France) for a two-year stay at the CNRS to work on the cellular and molecular genetics of the silkworm. This is when we started to work in collaboration. Back in India, he was invested by the CSB with the mission of running Seribiotech, a brand new research laboratory in Bangalore in the fast emerging field of biotechnology, aiming at blending fundamental and applied research. After the Seribiotech experience, he moved to Hyderabad in 1998 and joined the Center for Cellular and Molecular Biology (CCMB) and the Centre for DNA Footprinting and Diagnostics (CDFD) where he finally settled down. In 1997, he stayed for one year at Harvard University in the laboratory of Daniel Hartl.

J. Nagaraju first developed fingerprinting of the *Bombyx* genome by various approaches to assess the genetic diversity of the silkworm in multiple ecotypes and inbred lines. With his team at Seribiotech, he characterized the first *Bombix mori* microsatellites, their type, abundance and polymorphism, and their potential for traceability of genetic resources. He maintained interest in repetitive DNA throughout his career and more recently developed SilkSatDB, a silkworm microsatellite data base and then InSatDb, an interactive interface to query information regarding microsatellite characteristics of fully sequenced insect genomes.

His experience in the study of genome polymorphism and plasticity led him to investigate the genetic diversity of Basmati rice, a high added value product of India agriculture. By using SSR markers, he could develop rapid multiplex microsatellite marker assays for the authentication of traditional Basmati varieties, which awarded him the gratefulness of the Indian government.

In CCMB and CDFD, he also took interest in many fundamental questions. One concerned determination of sex, a fascinating paradigm owing to the myriad of sex determining primary signals among insect species, which he approached with Giuseppe Saccone (Italy). He worked at deciphering the collection of the genes carried by the Z chromosomes (in silkworm males are ZZ and females ZW) and initiated a study of the female specific chromosome W that is strongly female determining and was long thought to harbour feminizing genes. J. Nagaraju identified such a W-chromosome linked gene, a remarkable finding since that gene may be a master contributor of the female sex. He conducted such critical work in collaboration with Kasuei Mita, Toshiki Tamura and colleagues from Japan. Unfortunately, this masterpiece will be published after his death.

Recently, J. Nagaraju's group and we in Lyon constructed silkworm transgenic lines which added a genetic trait that confers refractoriness to infection by baculovirus, a major pathogen in Indian sericulture facilities. The beneficial trait was introgressed into a commercial race, allowing the combination of high silk productivity and immunity to the virus. This first industrial application of transgenesis illustrates the will of J. Nagaraju to exploit genetic concepts practically. Several important traits have not yet been handled successfully in traditional breeding schemes. He always pleaded for the incorporation of modern genetic analysis in selection, which coupled with conventional breeding, allows the dissection of complex, multi-gene controlled traits. In this respect, J. Nagaraju was a restless go-between, linking the community of the basic scientists and that of the sericulture industry.

The sad passing away of J. Nagaraju poses the question of his successor as a guide of Indian silkworm research programmes and as a recognized international spokeperson who always worked to connect science and society.

Source: Pierre Couble, CNRS Research Director, Villeurbanne, France.

Other News

USDA-APHIS/PPQ News

CPHST certifies new irradiation facility for phytosanitary treatments. During the week of April 22, the Center for Plant Health Science Technology, Agricultural Quarantine Inspection (CPHST AQI), Raleigh, certified the Gateway America irradiation facility in Gulfport, Mississippi. This is the first southern state facility certified since the *Irradiation Treatment: Location of Facilities in the Southern United States* rule was published in July 2012. The facility uses a class 3 gamma irradiator, specifically, the Gray*Star Genesis II Underwater Co_{60} Irradiator. While in Mississippi, CPHST also provided certification and irradiation treatment database training to field operations staff.

Pa'ina Hawaii irradiation facility fully operational. The Pa'ina Hawaii Irradiation facility on the island of Oahu is fully operational and is treating commercial shipments of papaya, sweet potato, basil, and curry leaves for movement as maritime or air cargo to the U.S. mainland. PPQ Hawaii is monitoring the treatment and shipment.

United States Federal Register notice allows litchi, longan, and rambutan imports from the Philippines. On February 7, USDA-APHIS-PPQ published a *Federal Register* notice, effective immediately, to authorize the importation of fresh litchi, longan, and rambutan fruit from the Philippines. Mitigations for quarantine pests include irradiation treatment and a phytosanitary certificate that contains an additional declaration. Commercial consignments will only be allowed into the continental United States.

CPHST delivers fruit fly rearing monitoring tool. On April 1, CPHST delivered a Mass-Rearing Monitoring Tool (aka "Dashboard") to the Edinburg Mexican Fruit Fly (Mexfly) Rearing Facility, Texas. The "Dashboard" consists of an Excel spreadsheet that enables production personnel to input and monitor production data on a daily basis. The spreadsheet automatically calculates and projects results graphically. This tool provides a method to track current production and estimate levels of production needed to meet weekly goals for rearing, sterilization, and release. This tool also allows rearing staff to assess potential production changes in order to reduce rearing costs and increase production efficiency. The "Dashboard" was first developed by the CPHST Guatemala station to monitor production at the Mexfly facility in San Miguel Petapa. The Mission Lab assisted the Edinburg rearing staff by taking baseline measurements and providing operational procedures to transfer this technology to the program.

CPHST validates use of Guatemalan-produced Mexican fruit fly eggs for mass rearing. CPHST scientists have cooperated with the fruit fly mass rearing facility in Edinburg, Texas, to develop shipping, egg bubbling, and handling procedures for Guatemalan-produced Mexican fruit fly eggs. The eggs shipped to Texas for mass rearing have produced large numbers of high quality flies for use in sterile insect technique releases. This is the first time that Mexican fruit fly eggs shipped from outside the United States have been used for domestic fruit fly control programs.

CPHST evaluates fruit fly aerial release methods. On February 26, CPHST completed a coordinated evaluation of single swath aerial releases for sterile Mediterranean fruit fly in Florida. PPQ, the Florida Department of Agriculture and Consumer Services, and the Cooperative Fruit Fly Detection Program participated in the aerial releases and the collection of field data. Periodic release evaluations are conducted to assess the distribution, density, and longevity of sterile flies released in the field and involve the release of flies in several swaths in the test area. This test was enhanced by marking the flies in each swath with different colours, so that the distribution of flies from each swath could be precisely evaluated. The results of this test indicated that the desired distribution of sterile flies could be obtained with a reduced number of swaths. This could result in significant cost savings in aerial release expenses for fruit fly eradication programs.

Release of revised ISO/ASTM standard on dosimetry for sterile insect programs. ASTM International and the International Organization for Standardization are jointly publishing a revision of "ISO/ASTM 51940 Standard Guide for Dosimetry for Sterile Insect Release Programs". The ASTM task force that develops and oversees this standard has been chaired since its inception in the late 1990's by a CPHST scientist. This standard details methods to ensure that mass-reared, released insects receive a dose of radiation within a prescribed range that provides program security (sterility) while not unduly degrading the insects' ability to compete for mates in the field. This is the second major revision and now includes information on dosimetric methods for low-energy X ray units, which are increasingly being used for sterile insect production.

Source: USDA-APHIS.

Medhost, online interactive encyclopedic bibliography of the host plants of Mediterranean fruit fly

APHIS/CPHST (Center for Plant Health Science and Technology) has released *Medhost*, an online interactive encyclopedic bibliography of the host plants of Mediterranean fruit fly, which can be accessed at https://www.gpdd.info/MedHost/

Medhost is a primary reference to assess risk and develop mitigation protocols for Mediterranean fruit fly in interstate and international movements of fruit and vegetable commodities. The reference contains information on Mediterranean fruit fly host plants, including:

- valid botanical names;
- synonyms and common names;
- native, cultivated, and naturalized areas of distribution of host plants;
- field and laboratory infestation data; and
- references that list host plants.

Furthermore, The Universidade de Sao Paulo (USP) has developed two independent data bases for *Anastrepha* (www.lea.esalq.usp.br/anastrepha/**)** and for Mediterranean fruit fly **(**www.lea.esalq.usp.br/ceratitis/).

Source: USDA/APHIS (6 March 2013).

Seminar on 'Sterile Insect Technique in Pest Management' in Bangladesh

The Zoological Society of Bangladesh (ZSB) organized a seminar exclusively on "Sterile Insect Technique in Pest Management" in the auditorium of the Atomic Energy Centre, Dhaka on 20th April, 2013.

Renowned scientist Dr. M. A. Hamid Miah, former Director General, Bangladesh Rice Research Institute (BRRI), and Bangladesh Jute Research Institute (BJRI) graced the seminar as Chief Guest. The seminar was addressed by ZSB President Dr. Manzur A. Chowdhury followed by three speeches, and an open discussion session. Dr. Rezaur Rahman, former Chief Scientific Officer and Director of Bangladesh Atomic Energy Commission (BAEC), and Mr. Touhid Uddin Ahmed, former Head, Medical Entomology Department, IEDCR were present as designated discussants. The seminar was attended by more than 120 distinguished ZSB members from different universities, research organizations, government officials, and private companies.

Three speakers from BAEC delivered their valuable speeches on: (i) Global advances in Sterile Insect Technique (SIT) for Pest Management, (ii) Laboratory research and field-cage trials of fruit fly SIT in Bangladesh - problems and prospects, and (iii) Management of blowfly, *Lucillia cuprina* using SIT - experience from laboratory research to field application.

In his speech Dr. Shakil Ahmed Khan of Insect Biotechnology Division, Institute of Food and Radiation Biology (IFRB) gave a brief on the basic principles of SIT and showed the global advances of SIT achieved in case of different insect pests with especial emphasis on the development of mosquito SIT.

Dr. Mahfuza Khan from the Insect Biotechnology Division, IFRB, presented her laboratory research and semi-field cage experiments on melon fly, *Bactrocera cucurbitae* (Coq.) and oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera:Tepritidae). She also mentioned their on-going research and future plan to release sterile *B. cucurbitae* in designated fruit and vegetable growing areas of Bangladesh and discussed the problems and prospects for the implementation of fruit fly SIT. It was reported that in Bangladesh, 10-30% annual losses of fresh fruits and vegetables are caused by different tephritid fruit flies. The melon fly, *B. cucurbitae* represents 74.51% of the total fruit fly population.

Dr. Zahidur Rahman Majumder presented the feasibility study of using SIT in the sun-dried fish industry in off-shore islands and costal areas of Bangladesh. Several public awareness drives by IAEA experts, *viz*., Dr. R. J. Mahon, Dr. R. J. Grindle, and Dr. U. Feldmann during their visit in Bangladesh in 2005-2006.

All speakers extended their sincere thanks to the IAEA for their continuous support under different Co-ordinated Research Programmes (CRP), Regional Contract Agreements (RCA), and Technical Co-operation (TC) projects.

In the discussion session a positive response was received from the audience for the implementation of SIT as a component of Area-Wide Integrated Pest Management (AW-IPM) along with the use of baited traps impregnated with cue-lures and methyl-eugenol, field sanitation, and the release of parasitoids. The seminar was closed by vote of thanks by Prof. Dr. Niamul Naser, General Secretary, ZSB.

Source: Mahfuza Khan, Bangladesh Atomic Energy Commission (9 May 2013).

Relevant Published Articles

Combining tactics to exploit Allee effects for eradication of alien insect populations

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Abstract

Invasive species increasingly threaten ecosystems, food production, and human welfare worldwide. Hundreds of eradication programs have targeted a wide range of nonnative insect species to mitigate the economic and ecological impacts of biological invasions. Many such programs used multiple tactics to achieve this goal, but interactions between tactics have received little formal consideration, specifically as they interact with Allee dynamics. If a population can be driven below an Allee threshold, extinction becomes more probable because of factors such as the failure to find mates, satiate natural enemies, or successfully exploit food resources, as well as demographic and environmental stochasticity. A key implication of an Allee threshold is that the population can be eradicated without the need and expense of killing the last individuals. Some combinations of control tactics could interact with Allee dynamics to increase the probability of successful eradication. Combinations of tactics can be considered to have *synergistic* (greater efficiency in achieving extinction from the combination), *additive* (no improvement over single tactics alone), or *antagonistic* (reduced efficiency from the combination) effects on Allee dynamics. We highlight examples of combinations of tactics likely to act synergistically, additively, or antagonistically on pest populations. By exploiting the interacting effects of multiple tactics on Allee dynamics, the success and costeffectiveness of eradication programs can be enhanced.

The full paper was published in: Journal of Economic Entomology (2012) 105:1-13.

Could sterile males be used to vector a microbiological control agent? The case of *Rhynchophorus ferrugineus* and *Beauveria bassiana*

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Abstract

Rhynchophorus ferrugineus (Coleoptera, Curculionidae) is the most threatening pest of palms worldwide. The potential of gamma-irradiated males to spread a pathogenic strain of the entomopathogenic fungus *Beauveria bassiana* (Ascomycota: Clavicipitaceae) to control this pest was studied. First, the effects of gamma irradiation (15 and 25 Gy) on the mating success and performance of adult males irradiated at age one day were studied in the laboratory. Although male longevity decreased after irradiation (118.6 vs. 244.7 days for irradiated and control males, respectively) and their testes suffered from the treatment, fecundity of mated females did not depend on the irradiation status of the male (86.8±5.5 eggs in 15 days). However, egg hatching was significantly lower in couples with irradiated males (31.4% vs. 86.5% for irradiated and control couples, respectively), and this value decreased after a second mating (6.1% vs. 85.9%). Therefore, irradiation did not affect male sexual competiveness but sperm quality. Second, a semi-field assay was carried out to evaluate infestation in young *Phoenix canariensis* caused by different combinations of couples with irradiated and/or *B. bassiana*-challenged males. The number of immature stages found in infested palms was significantly higher when females mated with untreated males and lower when mated with irradiated males (either *B. bassiana*-infected or not). Some females from the fungus-challenged treatments showed post-mortem hyphal growth, and this horizontal transmission proves that irradiated males could act as a vector for *B. bassiana* and should be considered as a new method to improve the biological control of *R. ferrugineus*.

The full paper was published in: Bulletin of Entomological Research (2013) 103: 241-250.

Papers in Peer Reviewed Journals

In Press

AHMADI, M., A.M.M. ABD-ALLA and S. MOHAR-RAMIPOUR (in press). Combination of medicinal plant essential oils with gamma radiation in management of *Tribolium castaneum* contamination. Journal of Radiation Research.

BALESTRINO F., S.M. SOLIBAN, M.Q. BENEDICT and J. GILLES (in press). Mosquito mass rearing technology for *Anopheles arabiensis* (Diptera: Culicidae): a cyclone device for continuous unattended larva-pupa separation. Journal of the American Mosquito Control Association.

BARCLAY, H.J., D. MCINNIS and J. HENDRICHS (in press). Modeling the area-wide integration of male annihilation and the simultaneous release of methyl-eugenol-exposed *Bactrocera* spp. sterile males. Annals of the Entomological Society of America.

DONG, Y.C., Z.J. WANG, A.R. CLARKE, R. PEREIRA, N. DESNEUX and C.Y. NIU (in press). Pupal diapause development and termination is driven by low temperature chilling in *Bactrocera minax*. Journal of Pest Science.

HAQ, I., M.J.B. VREYSEN, A. ABD-ALLA and J. HENDRICHS (in press). Ability of genetic sexing strain male melon fly (Diptera: Tephritidae) to suppress wild female remating: implications for SIT. Florida Entomologist.

MAVOUNGOU J.F., N. PICARD, L.T. KOHAGNE, B. M'BATCHI, J. GILLES and G. DUVALLET (in press). Spatio-temporal variation of biting flies, *Stomoxys* spp. (Diptera: Muscidae), along a man-made disturbance gradient, from primary forest to the city of Makokou (North-East, Gabon). Medical and Veterinary Entomology.

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ABBEELE, J.V.D, K. BOURTZIS, B. WEISS, C. CORDON-ROSALES, W. MILLER, A. ABD-ALLA and A. PARKER (2013). Enhancing tsetse fly refractoriness to trypanosome infection - A new IAEA coordinated research project. Journal of Invertebrate Pathology 112 (Supplement 1): S142-S147.

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ABD-ALLA, A.M.M., H.M. KARITHI, A.H. MOHAMED, E. LAPIZ, A.G. PARKER, and M.J.B. VREYSEN (2013). Managing hytrosavirus infection in *Glossina pallidipes* colonies: feeding regime affects the prevalence of salivary gland hypertrophy syndrome. PlosOne 8(5): e61875.

BARCLAY, H.J. and M.J.B. VREYSEN (2013). The interaction of dispersal and control methods for the riverine tsetse fly *Glossina palpalis gambiensis* (Diptera: Glossinidae): a modelling study. Population Ecology 55: 53-68.

BELLINI, R., F. BALESTRINO, A. MEDICI, G. GENTILE, R. VERONESI, and M. CARRIERI (2013). Mating competitiveness of *Aedes albopictus* radio-sterilized males in large enclosures exposed to natural conditions. Journal of Medical Entomology 50: 94-102.

BOUCIAS, D.G., H.M. KARITHI, D.I. SCHNEIDER, K. KELLY, W.J. MILLER, A.G. PARKER, and A.M.M. ABD-ALLA (2013). Transgenerational transmission of the *Glossina pallipedes* hytrosavirus depends on the presence of a functional symbiome. PLoS One 8(4): e61150.

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