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Aerial view of the Seibersdorf Laboratories in Austria.

Contents

- To Our Readers 1
- Staff 4
- Forthcoming Events 5
- Past Events 6
- Technical Cooperation Field Projects 8
- Coordinated Research Projects (CRPs) and Research Coordination Meetings (RCMs) 16
- Developments at the Insect Pest Control Laboratory (IPLC) 19
- Reports 24
- Announcements 26
- Other News 31
- Relevant Published Articles 34
- Papers in Peer Reviewed Journals 35
- Priced and Unpriced Publications 43

IAEA International Atomic Energy Agency

To Our Readers

On November 28, 2012, with the participation of representatives from Member States and the press, the IAEA commemorated 50 years of IAEA's Laboratories in Seibersdorf, Austria. At a ceremony to mark the anniversary, IAEA Director General Yukiya Amano said the Laboratories in Seibersdorf have improved, in the 50 years since they opened, the lives of millions of people through work using nuclear techniques. At the eight nuclear applications laboratories, which include the five FAO/IAEA Agriculture and Biotechnology Laboratories, scientists carry out research and development, provide technical services to Member States and host fellows and scientific visitors. He stated that work at the laboratories has made a difference in controlling animal diseases and insect pests in many countries, contributed to more sustainable soil and water management technologies and the development of hardier and more nutritious crops. Scientists at the laboratories have helped communities identify the best sources of underground water and ensure that this scarce resource is used effectively. They have worked on safe ways to preserve food, and provided vital technical support for cancer treatment and other medical uses of nuclear technology.

New challenges abound in the present and the future, Director General Yukiya Amano said. 'Member States want us to do more in almost all areas of nuclear applications'. He referred to the positive feedback received, reinforcing the critical nature of the services provided by the laboratories, and his announcement to carry out a complete modernization of the Laboratories. His proposal was supported in a resolution of the 56th General Conference, which called upon the IAEA to establish state-of-the-art facilities and equipment at Seibersdorf. The goal, according to the resolution, must be to 'ensure that maximum benefits in terms of capacity-building and technology enhancement are made available to Member States, particularly developing countries.' He pledged his full support and dedication to the fund-raising and ongoing planning for this initiative in order to have both the resources and facilities to be able to deliver and respond to the growing Member State expectations.

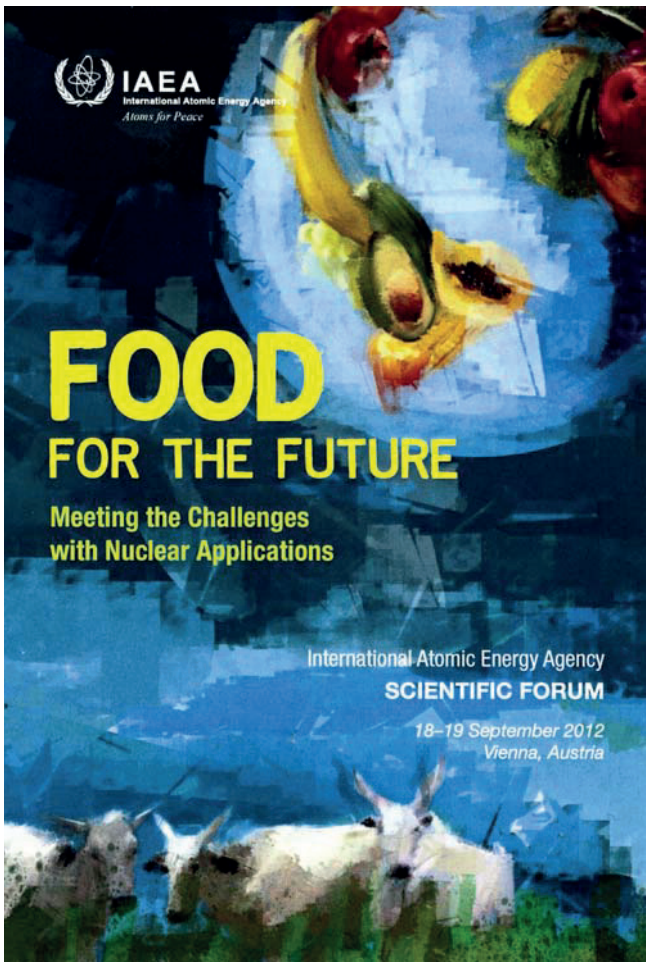
In a meeting at the IAEA headquarters in Vienna on 15 August 2012, Yukiya Amano, IAEA Director General, and José Graziano da Silva, FAO Director General, agreed to further strengthen the long-standing FAO/IAEA partnership, which since 1964 helps developing countries use nuclear techniques to improve food security. The Directors General agreed to support a joint proposal for the IAEA to become a member of the United Nations Secretary-General's High-Level Task Force on the Global Food Security Crisis. Both Director Generals concurred in their meeting that this partnership is essential to maximize both organizations' contribution in the global effort to swiftly and significantly reduce the number of people who suffer from hunger, as well as to increase the use of sustainable agricultural practices.

José Graziano da Silva (DG-FAO) and Yukiya Amano (DG-IAEA) during a visit to the IAEA headquarters in Vienna, Austria.

During his visit, Director General Graziano da Silva was briefed on the on-going applied research, technical support and training activities undertaken by the joint FAO/IAEA Agriculture and Biotechnology Laboratories in Seibersdorf. He expressed his appreciation for the IAEA's strong and dedicated support for the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and also expressed his support for Director General Amano's choice to focus the IAEA's September 2012 Scientific Forum on the theme of food and agriculture.

José Graziano da Silva (DG-FAO) with the Director of the Joint FAO/IAEA Division, Liang Qu, and Section Heads.

The theme of last year's Scientific Forum, held during the 56th IAEA General Conference in September 2012, was 'Food for the Future - Meeting the Challenges with Nuclear Applications'. Having focussed on cancer challenges in 2010 and water challenges in 2011, the Director General decided to give priority in 2012 to another major global challenge, global food insecurity. Thus, the 2012 Scientific Forum presented to policy-makers the successes and opportunities of using nuclear technologies to enhance food security. The three technical sessions on Increasing Food Production, Ensuring Food Protection and Enhancing Food Safety, facilitated by a BBC moderator, examined and discussed the challenges related to the improvement of food production, food protection and food safety through the use of nuclear applications.



In the food protection session it was noted that global food insecurity is inherently linked to pests and diseases that harm or kill livestock and crops, as well as people working in rural agricultural areas. The losses caused by diseases and pests at both the pre- and post-harvest levels average 30-40% of the agricultural outputs, making returns on agricultural investments in land, seeds, water, fertilizer, animal feed, labour and other inputs correspondingly inefficient. It was also stressed that the world is currently facing an unprecedented increase of invasive animal and plant diseases and pests which threaten food security by causing serious losses in production and necessitating costly control measures. It was agreed that nuclear techniques can contribute to provide effective, target-specific and environment-

friendly animal and plant pest and disease control methods, thus contributing to food security by reducing serious losses due to pests and diseases; reducing production costs and the need for agrochemicals; and, overcoming sanitary and phytosanitary barriers to international trade of agricultural products.

During another event the Tsetse Research Group of the Insect Pest Control Laboratory at the FAO/IAEA Agriculture and Biotechnology Laboratories was recognized by Director General Yukiya Amano with an IAEA Superior Achievement Team Award 2012 for their innovative and ground-breaking work on the characterization and management of tsetse viruses. During several years, the tsetse group, under the leadership of Andrew Parker (team leader) and Adly Abd Alla (virologist) worked on a project to characterize viruses that have hampered tsetse colony growth and to devise efficient virus management strategies for tsetse mass-rearing systems in Africa. They not only sequenced the genotype of the viruses and identified a family of insect viruses new to science, but also assessed their physiological effects and main pathways of transmission. They explored possibilities for developing adequate virus management strategies and possibly even to develop virus-free colonies. The practical solutions developed have significantly reduced the virus load in fly colonies and maintained flies free of disease symptoms. The outcome of integrating these management strategies will significantly improve the ability of Member States, supported by the Agency under the African Union Pan-African Tsetse and Trypanosomosis Eradication Campaign, to establish and maintain tsetse colonies that are free of disease symptoms. Their work will also remove some of the constraints that hampered the implementation of the sterile insect technique for tsetse.

Tsetse Research Group recognized by IAEA-DG Yukiya Amano with the IAEA Superior Achievement Team Award 2012.

Concerning staff news, I would like to inform our readers that Gerald Franz, our leading geneticists since the late 1980s, retired in September 2012, when he reached the IAEA's retirement age. Over all these years Gerald has been a great asset to the Subprogramme, providing technically very competent and wise advice in many areas, including risk assessment of the use of transgenic arthropods in plant protection. Using classical genetics, he and his team developed progressively more effective Mediterranean fruit fly genetic sexing strains based on pupal colour mutations, temperature sensitive lethal and that allow eliminating females at the egg stage with a very high accuracy and strain stability. In response to being able to mass-produce only sterile males and of significantly increasing their effectiveness in the absence of sterile females, all SIT programmes in the world against this pest have been using these sexing strains since the 1990s in their mass-rearing factories. This has represented major cost savings and benefits of increased SIT effectiveness for programmes in developing and developed Member States. At the same time, with the goal of developing more generic and therefore faster approaches, he managed a series of coordinated research projects, bringing together world leaders in their respective areas of insect genetics, thereby promoting international collaboration and the development of increasingly sophisticated molecular approaches to arthropod strain improvement. His dedication and hard work are much appreciated. We will miss him much as a friend and colleague, and wish him the best in his well-deserved retirement. We hope that we will be able to continue profiting from his extensive experience for the benefit of FAO and IAEA Member States.

We also want to warmly welcome Kostas (Konstantinos) Bourtzis from Greece, who replaced Gerald. Kostas has excellent academic credentials and international experience and standing. He has been Professor of Molecular Biology, Genetics and Biochemistry at the University of Western Greece, with a very distinguished record as researcher, mainly focussed on insect molecular biology, genetics with emphasis on insect symbiosis and its potential application for pest and disease control. He has a large publication record in international journals and has edited four leading books on insect symbiosis. In view that the IPC Sub-programme is increasingly involved in research on the many roles of insect symbionts and micro-organism to improve the SIT and related genetic control methods in fruit pests, tsetse, mosquitoes and other insects, Mr Bourtzis has the right background and combination of skills for the current and future activities of this position. Kostas has had numerous productive interactions over the years with the FAO/IAEA, collaborating in various projects, participating in several Coordinated Research Projects and consultants meetings as invited consultant, and worked for some time as a visiting scientist at the Insect Pest Control Laboratory in Seibersdorf. We wish him much success in his new position.

Jorge Hendrichs
Head, Insect Pest Control Section

Insect Pest Control Subprogramme

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Forthcoming Events (2013)

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

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.

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.

II. Other Meetings/Events

Symposium on Prospects for Enhancing Augmentative Releases of Beneficial Organisms Using Radiation at Fourth International Symposium on Biological Control of Arthropods, 4-8 March, 2012, Pucon, Chile.

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

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

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

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.

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

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

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 Interregional Training Course (under TC Project INT5151). 29 July - 23 August 2013, Metapa de Dominguez, Chiapas, Mexico.

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

FAO/IAEA Regional Training Course on Area-Wide Integrated Fruit Fly Suppression, including MAT and SIT for Balkans and 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. 11-15 November 2013, Rome, Italy.

Past Events (2012)

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.

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 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 Standardised Entomological Monitoring, Data Collection and GIS-Aided Processing as Needed for AW-IPM of the Tsetse and Trypanosomosis Problem (under 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 TC regional 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 TC regional 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 2011, Rome, Italy.

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

FAO/IAEA Coordination Meeting of the West Africa TC regional 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 TC regional 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 TC regional 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 TC regional 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 Balkans and Eastern Mediterranean (under 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 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 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.

Technical Cooperation Field Projects

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

- 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
T.T.U.T.J of T. Palestinian A.	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

Creating Sustainable Tsetse and Trypanosomosis Free Areas for Enhancing Livestock and Agricultural Development (ETH5016)

IAEA DG Visits Ethiopia

During a visit to Ethiopia in conjunction with his participation in the Second Conference of States and Parties to the Treaty of Pelindaba, which established in 2009 the African continent as a nuclear-weapon-free zone, the IAEA Director General, Yukiya Amano, met Prime Minister Hailemariam Desalegn. In their meeting, the Prime Minister expressed his thanks for the IAEA's assistance in the areas of cancer treatment, water management and in particular the technical support received in relation to the Southern Tsetse Eradication Project (STEP), which intends to integrate the SIT on an area-wide basis to eventually eradicate tsetse flies from 25 000 km² of the Southern Rift valley.

DG Yukiya Amano was received by Ethiopia Prime Minister Hailemariam Desalegn.

He stressed the importance of this project for agriculture and rural development in southern Ethiopia, where farming communities involving over 100 000 farmers and 2.5 million cattle are already benefitting from improved living conditions, including the availability of oxen to plough the land, donkeys to pull carts to transport agricultural products to market, and meat and milk to improve human nutrition. They both expressed their commitment to ensuring continued progress in this ambitious and complex project that is very demanding in terms of management and logistics.

Also during the visit to Ethiopia the IAEA Director General, Yukiya Amano, visited the tsetse rearing facility of the Southern Tsetse Eradication Project (STEP) in Addis Ababa on Tuesday 13 November. He was accompanied by HE Ato Desie Delkie, Minster of Science and Technology and HE Ms Tumusiime Rhoda Peace, African Union Commissioner for Rural Economy & Agriculture.

Visit of DG Yukiya Amano to the STEP tsetse rearing facility. (Left to right, foreground: Dr Thomas Cherenet, DG of STEP, DG Amano, HE Ato Desie Delkie, Minister of Science and Technology).

Mr Amano was greeted by the STEP Director General, Thomas Cherenet and senior staff of the project. After a short presentation on the history and progress of the project, the visitors were shown around the mass-rearing facility, including the blood preparation for feeding the flies, the old and new tsetse fly holding systems and the irradiator.

Visit of DG Amano to the STEP tsetse rearing facility.

The STEP is being assisted by the IAEA through Technical Cooperation project ETH5016.

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

The last Regional Coordinator Meeting under project RLA5057 was attended by 12 participants: six were the project counterparts representing Belize, Costa Rica, Dominican Republic, Guatemala, Honduras (two), and Panama, three from the TC sub-regional Andean project RLA5058 'Building Capacity for Suppression of Fruit Flies using an Area-Wide Pest Management Approach', representing Colombia, Ecuador and Peru, TC Project

Manager Geovanna Lucio, and the FAO/IAEA Technical Officer, Jesus Reyes.

Participants of the FAO/IAEA Regional Coordinator Meeting (Panama City, Panama).

Each counterpart presented a comprehensive report of the activities carried out during the last three years in their respective country, including goals achieved as well as the benefits brought by the project. They also informed about the collateral activities each country is carrying out to control fruit flies and the successes achieved in tackling quarantine regulations from the international market to be able to export fresh fruit commodities.

Also, there was much analysis and discussion on management. Each participant contributed significantly to the way the project was planned and executed so that project implementation was completed during 2012. This analysis was a sort of lessons learned aimed at transferring these experiences to the counterparts of the new TC regional project RLA5058 in the Andean region.

Supporting Biological Control of Stable Flies (*Stomoxys calcitrans*) through the Use of Parasitoids Reproduced on Fruit Flies (COS5030)

The Costa Rican agricultural and agribusiness sector contributes 14.1% to national GDP. Pineapple is the most important product in agricultural GDP, which in 2011 accounted for 20% of the foreign currency income. Lately, massive outbreaks of stable fly that breed in pineapple residues as larvae and bite cattle as adult, led to the closing of some pineapple farms and put in danger the entire pineapple sector as well as cattle farmers. In the San Carlos area of Costa Rica, it is common to see hundreds of these hematophageous biting flies taking a blood meal on a single cow. Stress and malnutrition are visible in all farms as cattle spend time and energy to constantly chase the flies and to escape from the painful bites. Consequently, at the request of the Costa Rican government a project on the use of the parasitoid, *Spalangia cameroni*, as a method of biological control of the immature stages of the fly was launched in Costa Rica in 2012.

Stable flies biting and taking a blood meal on cattle.

The plan is to use an existing X ray machine to sterilize pupae of fruit flies for the large scale production of this parasitoid, and then they will be used in the fields and cattle farms through inoculative and augmentative releases to suppress stable fly populations under an area-wide integrated pest management approach.

Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for Integrated Control of Mosquitoes (SRL5044)

FAO/IAEA provided technical assistance to the Anti-Malaria Campaign, Ministry of Health, Sri Lanka, 19-13 July 2012. A mosquito laboratory was established in the Entomology Division of the Ministry of Health to support the activities of a mosquito project assessing the feasibility of using the SIT in the Republic of Sri Lanka.

Our collaborators in Colombo have been experiencing difficulties with establishing colonies of *Anopheles culicifacies*, *An. varuna*, *An. subpictus* and *An. annularis*, Sri Lanka's most important malaria vectors. Although *Aedes aegyptic* and *Ae. albopictus* were successfully colonised, production was low and inconsistent.

Entomology Division Staff, Ministry of Health (Colombo, Sri Lanka).

The mission's objective was two-fold: first, to assess the mosquito rearing protocols used in Colombo and to suggest improvements. Second, to provide training to labora-

tory and field staff on aedine and anopheline culture using the methods used at FAO/IAEA Insect Pest Control Laboratory. Establishing steady colonies of anophelines remain to date a challenge, but larvae rearing and blood feeding procedures have improved based on the recommendations made during the mission. The colonies of *Ae. albopictus* and *Ae. aegypti* are larger following changes made to the egg collection, storage and hatching procedures.

Two dengue vector sentinel sites were visited during the mission where FAO/IAEA staff took part in ovitrap collection and house-to-house larvae surveys.

Support for Capacity Building in Baseline Data Collection for Mosquito Dengue Vector Management in Pakistan (PAK5049)

After a very successful first workshop in May 2012 on dengue vector surveillance, the national Pakistan project PAK5049 was completed with a second workshop held in Islamabad in October 2012, entitled 'Dengue Pathogenesis, Diagnosis and Case Management in Pakistan and Elsewhere'. This workshop included presentations and Round Table discussions led by international experts from the United States, Thailand and Sri Lanka, and was well attended by 70 clinicians from around Pakistan. Experiences of diagnosing and managing dengue in Pakistan and other countries in the region were shared, and the workshop also provided a valuable chance to build networks of experts in dengue to strengthen the national response to this newly emerging arbovirus. Pakistan has proposed a Regional Asian TC project for the 2014-15 cycle to promote dengue vector surveillance towards the possible integration of the SIT with conventional control methods.

Participants of the FAO/IAEA Workshop (Islamabad, Pakistan).

Supporting Area-Wide Integrated Pest Management to Improve the Quality of Fruit for Export (VIE5017)

Dragon fruit is the most important agricultural product of Binh Thuan Province in Vietnam. The total dragon fruit areas of production in the province amount to 18 600 ha, producing ca. 400 000 tons a year, from which 80% are for export. The main destination for exports is China, followed by other Asian countries in the region, USA and Europe. From these production areas, 5 700 ha are under VIETGAP management (from which 1 570 ha are certified for export to USA) and 157 ha are under GLOBALGAP management (fulfilling low residue requirements to export to Europe). Under VIETGAP, different post-harvest treatments are in place due to the requirements of the importing countries (hot water treatment to export to South Korea and Japan and irradiation to export to USA). Other countries do not require any post-harvest treatment, but in the case of Europe, GLOBALGAP management requires low pesticide residues on export commodities. Due to the short shelf life of dragon fruit after harvesting (max 1 month), exports to USA and Europe are via airfreight.

Dragon fruit grove in Binh Thuan Province, Vietnam.

As a result of the high price of the product on the market, the production is growing with new areas of plantation. Nevertheless, as the post-harvest requirements by the importing countries show, the fruit fly infestation is a major phytosanitary problem, damaging the fruit and contributing to the lower quality of the product for marketing and resulting in trade barriers due to the quarantine regulations of the importing countries.

Some baseline data on fruit fly populations and host status already exists. However, a better and more systematic approach to collect baseline data is needed. Identification of alternative hosts and their relative importance (through fruit sampling) contributing throughout the year to the increase of the fruit fly populations is recommended.

Example of an dragon fruit of good quality ready to be consumed.

Efforts to develop a station to apply bait sprays to replace the direct application to the plant with the risk of insecticide drift to the fruits (not recommended for some external markets), should be intensified. Economical and technical feasibility studies to evaluate the area-wide integration of the Sterile Insect Technique (SIT) with other suppression methods will be the focus of the project in the initial phase.

Preventing the Introduction of Exotic Fruit Fly Species and Implementing the Control of Existing Species with the SIT and Other Methods in the Indian Ocean (RAF5062)

Regional Training Course on Fruit Fly Surveillance, Taxonomy and Identification in the Indian Ocean

This Regional Training Course was attended by 23 participants from 6 Member States (France, Madagascar, Mauritius, Mozambique, Seychelles, United Republic of Tanzania) and from Comoros, and was held at the 'Centre de Coopération Internationale en Recherche Agronomique pour le Développement' (CIRAD), St. Pierre, La Reunion, France from 26-30 November 2012.

The course addressed the following aspects:

- Technical lectures and training to field operations staff on surveillance and baseline data collection to plan integrated fruit fly management activities including SIT application in some situations;
- Surveillance techniques used in fruit fly detection and control programmes, including trapping materials for adult surveys, as well as levels of infestation by fruit fly larvae;
- Lectures on basic taxonomic information that will be useful on the identification of the fruit fly specimens;
- Discussion on protocols used for collection and shipment of live and dead fruit fly specimen;
- Fruit fly identification of the genera *Bactrocera* and *Ceratitis*;
- Laboratory exercise to assess identification skills developed during the training.

Participants of the Regional Trainning Course on Fruit Fly Surveillance, Taxonomy and Identification in the Indian Ocean (St. Pierre, La Reunion, France).

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

Regional Training Course on Quarantine and Pest Risk Analysis

This Regional Training Course was attended by 20 participants from 12 Member States (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Greece, Montenegro, Romania, Slovenia, Turkey and Ukraine) and was held at the IAEA Headquarters, Vienna, Austria from 15-19 October 2012.

Participants of the Regional Trainning Course on Quarantine and Pest Risk Analysis (Vienna, Austria).

The programme of the training course consisted of theoretical lectures and practical work sessions and exercises and covered the following main topics:

- Basics of pest risk analysis and pest risk assessment;
- Assessing pest establishment, pest spread and pest impact;
- Ongoing research on post-harvest treatments at the Insect Pest Control Laboratory and a visit to the laboratory;
- Fruit fly pest risk management;
- Development of quarantine export strategies for fruit fly hosts;
- The regulatory process for market access;
- Risk management options and systems approach.

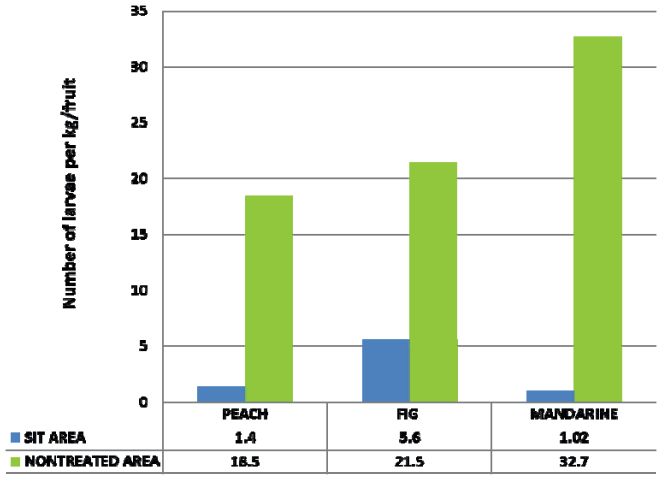
The evaluation of the RTC by the participants showed a high overall rating of the course 4.82 (out of 5).

Ongoing Activities in the Neretva Valley, Croatia

Farmers in Croatia are using nuclear technology to tackle the Mediterranean fruit fly, a common pest that poses a serious threat to the country's lucrative citrus fruit export industry. With the support of the IAEA and the UN's Food and Agriculture Organization (FAO), Croatia is implementing the Sterile Insect Technique (SIT).

Exports amount up to 75% of total yield valued to over 20 million euros per year. Without any control measures Mediterranean fruit fly infestation in mandarin's fruits is estimated at 10-30% which also causes major problems to exports due to quarantine restrictions and pesticide residues on fruits. After two years (2010-2011) of successful suppression through an SIT pilot project integrated with other suppression methods, conducted with the cooperation of the FAO/IAEA, the Croatian Ministry of Agriculture expanded the project to most of the lower part of the Croatian Neretva valley in 2012, covering over 4000 hectares of fruit orchards, mainly mandarines.

Routine fruit sampling is undertaken to evaluate fruit infestation and suppression efficacy. Results obtained in 2012 showed a high level of suppression of the Mediterranean fruit fly population, measured as the number of larvae per kg of fruit. Infestation was reduced 73.9% in figs, 92.4% in peaches and 96.8% in mandarins (figure below).



Level of infestation in larvae per kg of fruit in 3 of the major Mediterranean fruit fly hosts in the SIT area and in a non-treated area.

A video recently produced with the ongoing activities can be viewed at http://www.iaea.org/newscenter/multimedia/videos/gc56/180912/croatia/index.html.

Supporting Area-Wide Integrated Pest Control of Native and Exotic Flies in the Middle East Subregion Incorporating the Sterile Insect Technique (RAS5059)

In order to enhance further the effectiveness of the IAEA technical cooperation programme in Israel, Jordan, and the Territories under the Jurisdiction of the Palestinian Authorities (T.T.U.T.J of T. Palestinian A.), a coordination meeting was held at the IAEA Headquarters in Vienna, Austria, 10-12 September 2012. The meeting specifically aimed to: (i) review activities carried out during the last years through projects RAS5051, RAS5053, JOR5010, ISR5015 related to the medfly and the olive fly in each of the participating countries, (ii) update and adjust the RAS5059 project work programme on the basis of information provided by the participants, and (iii) agree on the strategy to implement against exotic fruit fly species that threaten to invade the sub-region.

The meeting was attended by Mr David Opatowski and Mr Moshe Weiss from the Ministry of Agriculture and Rural Development in Israel, Mr Setan Al-Serhan and Ms Mary Bahdousheh from the Ministry of Agriculture in Jordan, Mr Salaheddin Albaba and Mr Amjad Al-mughayyar from the Ministry of Agriculture in T.T.U.T.J of T. Palestinian A., Mr Jesus Reyes-Flores of the Insect Pest Control Section of the Joint FAO/IAEA Division and Ms Jane Gerardo-Abaya of the Technical Cooperation Department of IAEA.

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
Project Number	**Planned New CRPs**	**Scientific Secretary**
D4.20.15	Enhancing Vector Refractoriness to Trypanosome Infection (2013-2018)	Andrew Parker
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

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

The third RCM took place at the Exhibition and Convention Center (EXCO) in Daegu, Korea. It was attended by sixteen scientists, from thirteen countries together with five observers (from USA, Italy, Mexico and Thailand). The meeting was hosted by Ju-Woon Lee, Director of Radiation Technology Practical Application Division, Korea Atomic Energy Research Institute and Kyeong-Yeoll Lee, College of Agriculture & Life Sciences, Kyungpook National University.

Scientists actively working on the development and/or the use of molecular and genetic technologies in fruit fly pests, mosquitoes and lepidopteran pests were present. All attendees are considered world experts in their respective areas and it is worth noting that some recent ground-breaking research in developing elegant molecular and genetic tools for use in insect pests and vectors was published by members of the current CRP. Another significant note is that the CRP provided the ground for the establishment of international collaborations between member scientists.

Participants of the Research Coordination Meeting on Development and Evaluation of Improved Strains of Insect Pests for SIT (Daegu, Republic of Korea).

The first two days of the meeting were allocated for presentations while the remainder was devoted to discussions on the major achievements and the recommendations in four working groups: insect transformation, sex determination, development of novel sexing strains and improvement and evaluation of existing strains for SIT application.

During the last eighteen months, significant progress has been achieved on the exploitation of available genetic tools such as promoters that direct germ line expression of transgenes, promoters that increase the frequency of germ line transformation of insect pest and vector species, tetracycline-repressible regulatory system, site-specific recombinase and integrases, Talon and Zinc Finger Nuclease techniques to gene targeting in non-model insects including fruit fly pests and mosquitoes. In addition, the use of these genetic tools was accelerated with elegant demonstrations in the development of sexing-based systems in some tephritids and calliphorids and it is expected that these strategies can be extended to other species being the subject of SIT programmes. Application of these technologies to SIT programmes in Mediterranean fruit fly, Mexican fruit fly and New World screwworm during the duration of the current CRP is a real possibility.

An important conclusion of the meeting was that insect pest and vector genomes are being sequenced and annotated very fast, providing valuable novel genetic information. This knowledge can easily and effectively be used for the development of specific genetic techniques to be applied to a given insect pest or vector species. These developments can accelerate the application of modern genetic tools to the radiation-based SIT leading to increased cost-efficiency for insect species which are currently the targets of this approach and to an increased ability to quickly establish new SIT programmes for new insect pest and vector species that were not previously amenable to genetic modifications.

The RCM was held in conjunction with the XXIVth International Congress of Entomology (19-25 August 2012) which was attended by more than 2300 entomologists. It covered all scientific fields of entomology, including insect genetics and molecular biology, pest and vector control and other technical issues of major importance for the successful implementation of this CRP.

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

The third RCM was hosted by USDA-APHIS-PPQ and held at the Fiesta Resort Conference Centre in Phoenix, Arizona, US (12-16 September 2012). Eighteen contract and agreement holders from 14 countries attended the meeting. In addition, invited speakers from USDA (Bob Staten and Michelle Walters), Canada (Cara McCurrach and Scott Arthur), and South Africa (Martin Wolfarther) gave presentations on the pink bollworm (*Pectinophora gossypiella*) programme in the US, the SIR codling moth (*Cydia pomonella*) programme in Canada and in South Africa and on the use of strontium for marking sterile moths. The CRP also welcomed two new contract holders from Argentina and Chile. The CRP is progressing very well with the many goals being attained in the 3 working groups on: (1) Factors and variables that affect quality of Lepidopterans used in SIT programmes; (2) Tools and methods to assess field performance and (3) Quality control aspects in relation to rearing of moths'.

Participants of the Research Coordination Meeting on Increasing the Efficiency of Lepidoptera SIT by Enhanced Quality Control (Phoenix, AZ, USA).

Workshop on Assessing Quality Management Aspects of Lepidoptera Mass Produced for the Sterile Insect Technique in Large Operational Settings

Chilled pink bollworm moths being transferred to the release machine in a fixed wing aircraft for aerial release.

The workshop was organized and hosted by USDA-APHIS-PPQ from 10-11 September 2012 in Phoenix, Arizona. The participants of the workshop visited the USDA Pink Bollworm Facility that produces the sterile moths for the eradication programme in Texas, New Mexico, Arizona, California and northern Mexico (Sonora, Chihuahua). Participants were able to view and discuss the various quality control management issues that are put in place in the facility to ensure the production of high quality sterile moths for release. The group also viewed the loading of the release planes and the quality control aspects related to the chilled adult release system.

During the workshop, discussions were held with staff of the Arizona Cotton Research Board and with scientists who have developed transgenic pink bollworm strains. The workshop also included a visit to the University of Arizona, where Bruce Tabashnik gave a presentation on the use of sterile insects as a substitute to 'refugia' to manage resistance in pink bollworm on *Bt* cotton.

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

The third RCM of the CRP was held from 15-19 October 2012 in Buenos Aires, Argentina, and hosted by the Centro Nacional de Energía Atómica (CNEA). The meeting was attended by all eighteen CRP participants and four observers, and was opened by María Julia Palacín, Plant Quarantine Director, SENASA and Eulogia Kairiyama, Radiation Technology and Application Manager, CNEA.

Participants of the Research Coordination Meeting on Development of Generic Irradiation Doses for Quarantine Treatments (Buenos Aires, Argentina).

The participants all reported excellent progress with their work. Several of the studies are almost complete and will be ready soon to propose generic treatment doses for their respective pest groups. These will include proposals for treatments for leaf-mining Agromizidae, scale insects and mites and a number of treatments for individual species, where these will be significantly less than the current generic treatment dose, are expected. Two proposals for generic treatment doses for Lepidoptera eggs and larvae and Lepidoptera pupae were presented. Two new participants to the CRP presented their work on dosimetry in support of quarantine irradiation.

The final RCM will be held in Vienna, Austria, in early 2014. The output of the CRP is expected to be published in a special issue of a journal.

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

Requests from Member States to explore the potential of applying the SIT against mosquitoes in area-wide integrated vector management (AW-IVM) programmes continue to increase. However, because female mosquitoes, unlike male mosquitoes, can transmit disease, they must be eliminated them from the mass production process. In addition, not releasing sterile females would increase SIT programme efficiency in view that sterile males can focus only on achieving matings with wild females. Thus mosquito SIT programme efficiency and safety would be considerably enhanced by the development of improved strains for mass-rearing and release.

Consultants explored means to develop strains that: (a) produce only male insects for release and (b) carry easily identifiable markers to identify released males in the field. They recommended a CRP that will assess mechanical, behavioural and developmental approaches, but primarily will explore classical genetic and modern biotechnology techniques to accomplish female elimination in colonies of major mosquito vectors of disease. To the extent that it is possible, these methods will be developed with a view to application to a spectrum of major mosquito species. Major beneficiaries will be operational AW-IVM programmes in Member States that plan to apply the SIT against mosquitoes.

The development and evaluation of such methods through such a CRP will have the following tangible benefits for SIT mosquito control programmes:

- As only the males are needed for the SIT, the production, handling and release costs can be reduced significantly if sexing strains are used.
- Male-only releases are several-fold more efficient than releases of both sexes. Consequently, when the genetic sexing technology is available SIT programmes can be significantly more efficient and therefore more cost effective.
- Safety of SIT mosquito programmes will be enhanced. Mosquito SIT implementation cannot include the release of sexually sterile biting females. Therefore mosquito SIT requires the exclusive release of sterile males, which is impossible on large scale without genetic sexing strains.

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

FRUIT FLIES

Fruit Fly Rearing and Quality Control

Research activities to support the CRP on 'Resolution of cryptic species complexes of Tephritid pests to overcome constraints to SIT application and international trade'

***Anastrepha fraterculus* complex**

The IPCL hosted seven visiting scientists from Argentina (Fransico Desvescovi and Solana Abraham), Peru (Norma Nolasco), Colombia (Rosario Castañeda), Brazil (Kelly Roriz), Mexico (Juan Rull) and the Czech Republic (Radka Brizova) August-October 2012. The main aim of the visits was to continue with experiments to test the mating compatibility of *Anastrepha fraterculus* populations belonging to five different morphotypes: *A*. spp. Mexican aff *fraterculus* (Xalapa, Mexico), *A*. spp. 4 aff *fraterculus* (Piura, Peru), presumably *A*. spp. 2 aff *fraterculus* (Parnarimi, Bahia, Brazil), *A*. spp. highland areas from the Andean region aff *fraterculus* (Ibague, Colombia), and *A*. spp. 1 aff *fraterculus* (Tucuman, Argentina). Adults from the Colombian population exhibited strong temporal isolation with respect to all tested populations; mating activity for this morphotype began around 16:00 with a peak around 18:00, while adults of the Argentinean and Mexican populations began mating around 8:00 and had finished sexual activity by 11:00. Adults of the Peruvian morphotype mated around noon and could extend sexual activity into early afternoon providing the opportunity for some temporal overlap that resulted in some heterotypic crosses. Sexual isolation appears to be nevertheless strong between these morphotypes.

Pheromone samples and cuticular hydrocarbons extraction of the above mentioned populations have been done for further analyses in collaboration with external researchers and laboratories in the Czech Republic, US, and Argentina. Proteins from the male accessory glands were extracted and characterized for several populations and morphotypes and are showing in some cases distinct banding patterns. Protein analysis is being done in collaboration with Francisco Berguido, from the Animal Production and Health Laboratory in Seibersdorf.

Post-zygotic isolation among adults of the Colombian population and adults of the other populations was tested. Different degrees of post-zygotic isolation were detected. In all cases there is a 50 to 70% reduction in fertility for heterotypic crosses when compared to homotypic parental crosses. Fertility of F1 hybrids appears nevertheless to be somewhat restored. Collective evidence appears to indicate that the Colombian morphotype tested is a distinct biological entity. Results still are under analysis for forthcoming publication.

***Bactrocera dorsalis* complex**

The IPCL also continues working towards resolving the taxonomic status of morphologically cryptic pest taxa of the *B. dorsalis* complex. The IPCL hosted two visiting scientists from Australia (Mark Schutze, from July to August 2012) and China (Wang Bo, from July to December 2012) to support these activities. The focus of this research was to carry out pre- and post-zygotic compatibility studies to 1) complete post-zygotic compatibility tests among populations of *B. dorsalis* (Thailand), *B. papayae* (Malaysia), *B. philippinensis* (Philippines) and *B. carambolae* (Suriname); and 2) undertake mating compatibility tests in field cages between *B. dorsalis* and *B. invadens* populations along a transect to help resolve their taxonomic uncertainty. Initial field cage tests between *B. dorsalis* (Wuhan, China) and *B. invadens* (Kenya) demonstrated random mating (using the Index of Sexual Isolation) with no evidence of post-zygotic incompatibility between these two populations (e.g. egg hatch, larval survival, pupal survival, and sex ratios); future tests with flies from Sri Lanka, India, Myanmar, and Pakistan are anticipated. Much of this work was well underway by the end of 2012, with plans extending into 2013. Furthermore, specimens from these studies will be preserved for additional analysis (e.g. wing geometric morphometrics), which will also contribute towards resolving their biological relationships.

Progress with post-harvest treatments of invasive fruit flies

The IPCL has been collaborating with the USDA-APHIS Centre for Plant Health Science and Technology (CPHST) on a joint project entitled, 'Development of phytosanitary and regulatory treatments for exotic tephritid fruit flies'. The rationale of this project is that there are a number of tephritid fruit flies that pose a high-level threat of entry into the USA and other countries, but approved quarantine treatments are lacking for several important species. Adequate post-harvest treatment schedules for these pests are therefore required. These treatment schedules once developed can then be used by developing countries in combination with pre-harvest pest suppression measures, in order to facilitate the export of their produce by minimizing or preferably eliminating the risk of introduction of these exotic pests into importing countries. In addition, frequent outbreaks in the USA and bordering countries have resulted in temporary domestic quarantines that require regulatory treatments to be available for growers in outbreak areas to be able to move fruit and vegetables to both domestic and international markets.

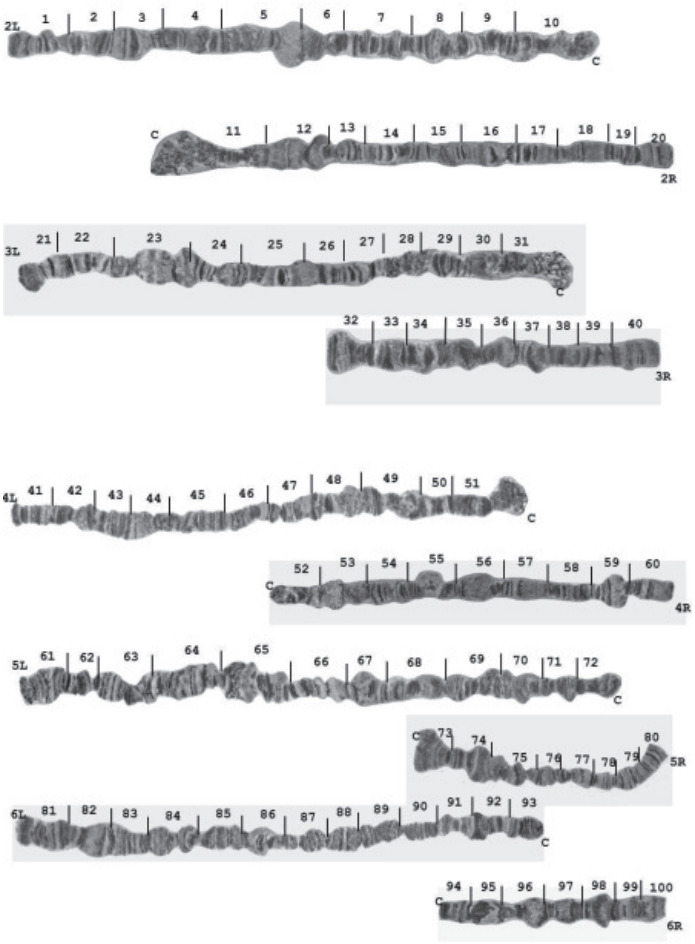
Currently, research is being conducted on three post-harvest treatment types: hot water immersion, methyl bromide fumigation and cold treatment. In addition, comparative data on developmental and biological characteristics of fruit fly species of interest are being collected. For the hot water treatment, artificial fruits have been developed to standardize the testing procedure so that later it can be validated using mango as a host for three fruit flies species (*B. invadens*, *B. zonata*, and *C. capitata*).

Female Anastrepha grandis *ovipositing eggs in zucchini.*

Recently dose-mortality curves that can be used as a guide for methyl bromide fumigation have been developed at 15.5°C (five treatment levels) *in vitro* for the third larval instar of 8 fruit fly species. This study will be followed by another using the same methods at 5°C. A cold treatment study with *B. zonata* has been completed (1.67°C for 18 days), leading to the development of a new treatment schedule for this pest species on citrus. Studies on other species relative to their susceptibilities to cold treatment are on-going. One of these studies is the cold treatment for *Anastrepha ludens* with grapefruit as host for all pre-pupal developmental stages. Successful infestation techniques for *Anastrepha grandis* in zucchini (figure above) and pumpkin have been developed and data on egg-embryo and larva recovery are being analysed. The development of a life table of *A. grandis* is on-going, the goal of which is further development of a protocol for artificial rearing of *A. grandis*.

Fruit Fly Genetic and Molecular Biology

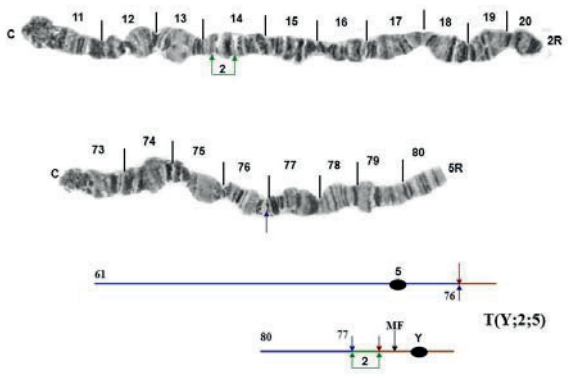
Cytogenetics has played an important role in advancing and supporting SIT programmes against major fruit fly pests. For example, the development of polytene chromosome maps has been a key factor for the construction and characterization of genetic sexing strains (GSS) for fruit fly pest species including the Oriental fruit fly, *Bactrocera dorsalis* and the melon fly, *Bactrocera cucurbitae*. The GSSs of these two *Bactrocera* species were developed some time ago at the Department of Entomology, University of Hawaii and the USDA/ARS Pacific Basin Area Research Center) and were later transferred to the IPCL at Seibersdorf for further evaluation including genetic and cytological analyses.



Revised polytene chromosome maps of B. dorsalis *s.s.*

The first set of polytene chromosome maps for *B. dorsalis* s.s. was initially developed based on two strains maintained in Seibersdorf: a wild type strain and a translocation-based GSS. A revised version of the polytene chromosome maps is now available based on the cytogenetic analysis of a large number of polytene nuclei from additional colonies of this species originating from China and different regions of Thailand. This updated version of the polytene chromosome maps will be used for the accurate characterization of the chromosomal rearrangements and the stability of the *B. dorsalis* GSS.

Polytene chromosome maps have been recently developed for *Bactrocera curcubitae* too (figure next page). Based on these maps, a thorough cytological analysis was carried out in the *B. curcubitae* GSS, which showed that the Y-autosome translocation present in this strain is more complex than initially considered. Comparative analysis of a large number of polytene nuclei from third instar larvae salivary glands from both the wild type strain and GSS suggested that two chromosomes, the second and fifth, are involved in the translocation, and allowed the exact mapping of the chromosomal breakpoints.



Polytene chromosome maps and schematic representation of the induced complex Y; 2; 5 translocation of the B. cucurbitae *GSS indicating the breakpoints of the chromosomal rearrangements on 2R (green arrows), 5 (blue arrow) and Y (red arrow). Black circles represent the centromere of the 5 and Y chromosomes respectively, while MF indicates the predicted position of the Maleness Factor on the Y chromosome.*

TSETSE FLIES

Salivary gland hypertrophy virus

Attempts are continuing to refine a strategy to manage the salivary gland hypertrophy virus (SGHV), which can hamper the development of *Glossina pallidipes* colonies due to reduced productivity. Various virus management strategies are under development that are based on four approaches: (1) blocking virus replication using commercial antiviral drugs, (2) neutralizing the virus infection using virus specific antibodies, (3) modifying the feeding system using clean blood feeding and (4) impeding the 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 show effective results on the reduction of SGHV infection load in the *G. pallidipes* colony for the fourth year. No viral resistance against the drug has been observed. These positive results encouraged the wide administration of this drug to reduce virus infection in the entire *G. pallidipes* colony in Bratislava, Slovakia with no negative impact on the flies' productivity and mortality. These results enticed the manager of the Kality facility, Addis Ababa, Ethiopia to adopt this technology and valacyclovir is now routinely used and added to the blood meal of the *G. pallidipes* colony. Since the start of the treatment fecundity of the colony has improved markedly and the colony is now growing strongly.

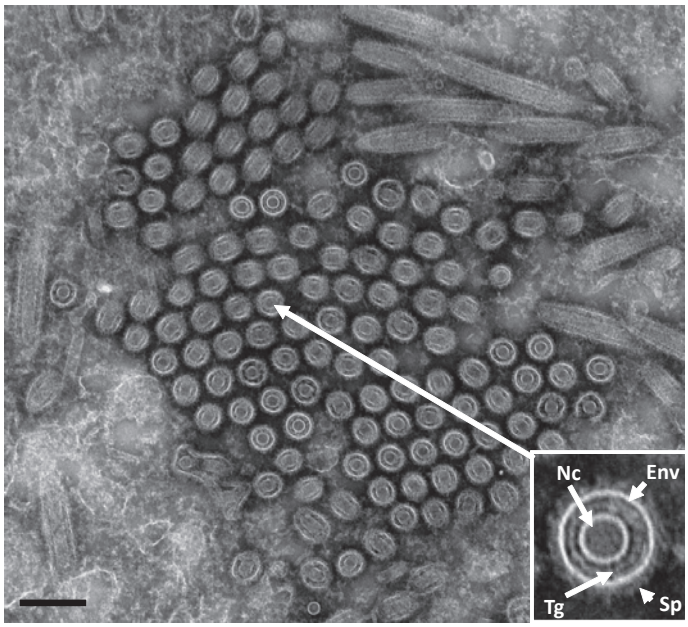
The clean feeding system has been used in Seibersdorf to established two clean feeding colonies with low virus infection level. The use of this technique for approximately two years reduced the virus infection level in the two clean feeding colonies, but also in the regular feeding colony that was fed on the blood remaining after feeding the two clean feeding colonies. The infection level in the regular feeding colony is 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.

Work to impede SGHV infection using a peptide similar to the SGHV ORF005 is being carried out in collaboration with Bryony C. Bonning from Iowa State University, Ames, USA. One polypeptide sequence similar to the amino acid sequence used by B. C. Bonning was found on SGHV ORF005. An oligopeptide was synthesized from this sequence and its impact on virus infection was tested. The preliminary results indicate a significant reduction in the virus load in flies fed on virus infected blood with the oligopeptide as compared to flies fed on blood containing the virus alone. Further studies to optimize and assess the impact of the long-term use of this approach were conducted. When used on a larger rearing scale (approx. 500 flies), some technical difficulties appeared that were related to the solubility and distribution of the oligopeptides in blood, which reduced the efficacy of the oligopeptides against the virus. In addition, we screened the phage display library and selected some strains that bind to the tsetse fly mid-gut or the brush-border membrane vesicles (BBMV). The impact of using these phage strains on reducing the SGHV infection was evaluated on a small scale and it seemed effective. The optimization and use of these phage strains on a larger scale is in progress.

To extend our knowledge of SGHV biology, we studied the structure of the virus particles in collaboration with Just Vlak and Henry Kariithi of Wageningen University. The results indicate that the GpSGHV particle has four morphologically distinct structures: nucleocapsid, tegument, envelope, and helical surface substructure (figure next page). In addition to the identification of 45 GpSGHV-encoded proteins distributed within the virus envelope, nucleocapsid and tegument components, 51 host/cellular proteins were identified in the purified virions. These results helped to identify the correct target proteins which can be used to develop antiviral strategies to manage GpSGHV infections in tsetse colonies.

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 indicate that tsetse flies injected with the virus, although they show a significant increase in virus load, did not develop hyperplasia. 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 are fed on blood supplemented with ampicillin, there is 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 symbionts in hybrid crosses between the *Glossina morsitans* subspecies *G. m. morsitans* and *G. m. centralis* and between these subspecies and *Glossina swynnertoni* are being studied in collaboration with Wolfgang Miller and Daniella Schneider of the Medical University, Vienna.



Electron micrographs of negatively stained GpSGHV enveloped virions shows a cryo-section through a group of virions in an infected cell cytoplasm. The inset shows a high magnification image of a cross section through a virion particle, revealing the nucleocapsid (Nc,) tegument (Tg), envelope (Env) and surface projections (Sp). Bars represent 200 nm.

Shipment of *Glossina palpalis gambiensis* male pupae to Senegal

In support of the experimental releases of sterile male tsetse in the Niayes area of Senegal, male pupae of the target species, *Glossina palpalis gambiensis* were shipped from two rearing centres located in Bobo-Dioulasso, Burkina Faso and Bratislava, Slovak Republic. The male pupae were collected from daily batches after emergence of almost all the females flies, chilled to between 7-12 °C, irradiated at 110 Gy and then shipped under the same cool conditions using AcuTemp Boxes with S8 (8°C) phase change packs. The average emergence rates of the shipped male pupae have remained low (60 – 70%) compared to the expected rate of ≥85%. Investigations have been undertaken through the entire process to identify which major factors may be the cause, including chilling, storage and transportation conditions. In this context, tests on the probable effects of vibration on the quality of the shipped pupae were started. Preliminary results on vibration recorded during approximately 1 hour road transportation of male pupae have shown no significant differences in the emergence rates between the two groups (treated 90.58 ± 3.07% and control 91.03 ± 4.10%). The evaluation will be pursued through test shipments to Dakar.

A colony of *G. p. gambiensis* that was developed at the IPCL in Seibersdorf over the past 3 years from pupae produced by wild female flies collected in the Pout area of western Senegal, reached 4500 reproductive females in August 2012. This colony is now maintained at about 4000 females and has been transferred to the semi-automated feeding and handling system TPU3.2. Males from this colony were crossed with females from the CIRDES colony in Burkina Faso to produce a hybrid line with improved characteristics. This line is being expanded in the facility in Bratislava.

MOSQUITOES

Separation of the sexes of *Anopheles arabiensis* by spiking of blood meals and its feasibility for use in large scale mosquito control programmes with an SIT component

The currently available GSS of *Anopheles arabiensis* is based on a dieldrin resistant mutation, but the strain has various limitations: low inherent productivity, treatments of dieldrin required in a mass-rearing facility, residual insecticide health hazard, insecticide residues in the released mosquitoes etc. The IPCL has therefore started examining alternative ways of separating the sexes.

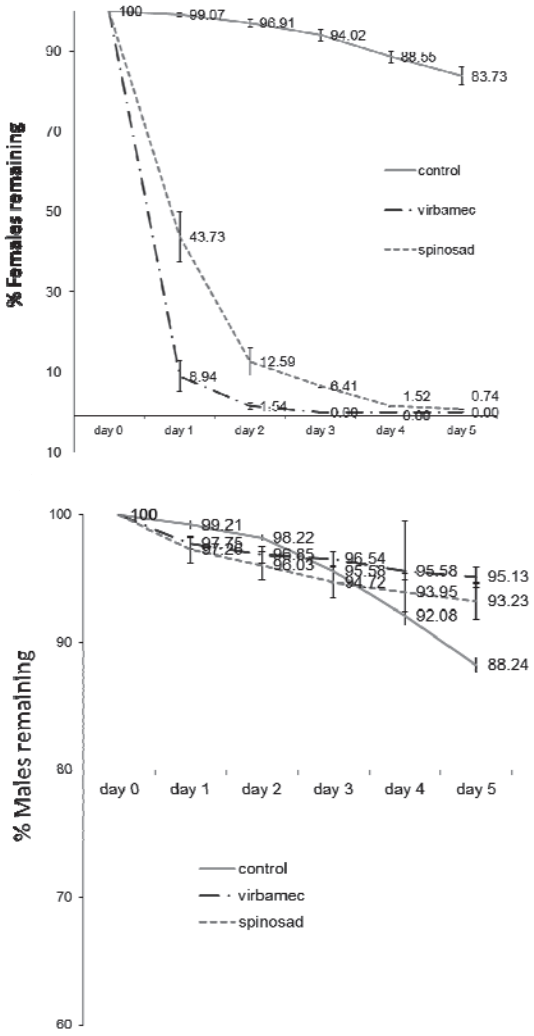
Six toxicants added to blood meals were evaluated in terms of efficiency of female kill, effects on male survival and mating efficiency of the males after female removal. From those, ivermectin and spinosad were tested further (figure next page). Preliminary results indicate that blood meals containing ivermectin can eliminate >99% of the females in two days post emergence, with no adverse effect on male survival. Both the virgin control and experimental males were equally efficient in mating newly added virgin females. Based on the current results, an irradiation step will be added at pupal stage to evaluate the combined effects of treatments on the males produced. These results will show whether this method could be a temporary solution for sex separation of *An. arabiensis* until a better sexing strain has been developed.

Competitiveness tests in semi-field cages between radio-sterilized males and wild males of *Anopheles arabiensis* ANO IPCL1

Effect of the cage size on the insemination rate.

To determine which kind of cages could be used for an estimation of the competitiveness of sterilized males, preliminary experiments were carried out to determine the influence of cage size on insemination rate and hatch rate. Three cage sizes were tested: 30*30*30 cm, 60*60*60 cm and 200*200*200 cm with two replicates per cage. For this experiment only the genetic sexing strain *An. arabiensis* ANO IPCL1 was used. In each cage, irradiated and untreated males were added to virgin

females at a 1:1:1 ratio, i.e. 100 irradiated males (70 Gy) + 100 untreated males + 100 virgin females. Two 30*30*30 cm cages with 200 untreated males and 100 virgin females were used as controls for egg production and hatch rate.

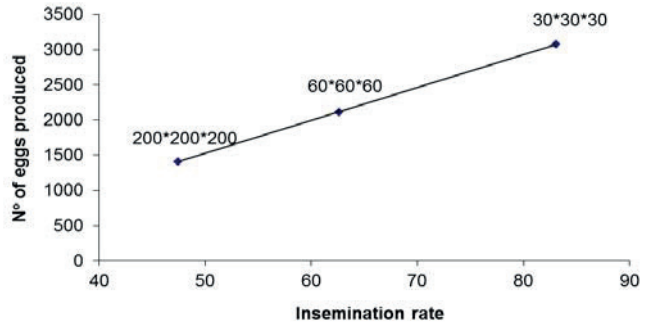


Survival of females treated with Virbamec (ivermectin), spinosad, and control females (a) and males (b) present in the same cages over five days. Bars indicate ±SEM.

A decrease in the insemination rate was observed as the size of the cage increased (from 83 to 47%). Insemination rate determination is time consuming but egg production in the cages significantly reflected the insemination rate (figure next column, linear regression, R^2=82.5, Pearson correlation= 0.908, P<0.05). There was no significant difference in the hatch rate between the different treatments (ANOVA, F3,4=0.96, P=0.49), suggesting that few sterile males mated with females.

Competitiveness test with 200*200*200 cm cages

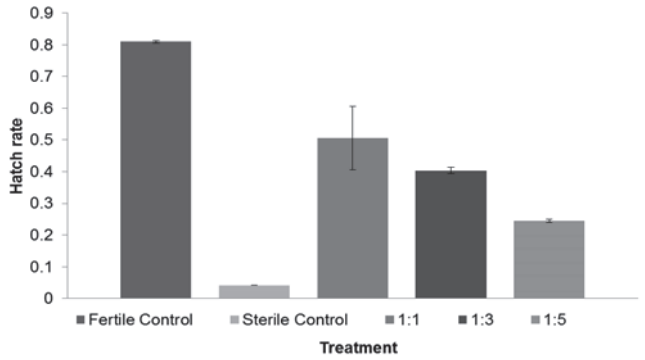
In this experiment, irradiated ANO IPCL1 *An. arabiensis* males were competing against wild type Dongola males for wild type Dongola females at a 1:1:1 ratio using the 200*200*200 cm cages. The experiment was replicated two times using 100 irradiated ANO IPCL1 males, 100 untreated Dongola males and 100 virgin Dongola females in each cage. To test the reproductive ability of each type of male and to assess egg hatch rate for comparison with the experimental cages, two control cages (200*200*200 cm) were set up containing (1) 200 untreated Dongola males and 100 virgin Dongola females, and (2) 200 irradiated ANO IPCL1 males and 100 virgin Dongola females. The mean hatch rate of the eggs laid by females coming from the two experimental cages was (±SD) 69.29± 3.77 %. In comparison, the hatch rate of the control cages was 80.61% and 18.28% for untreated Dongola males and ANO IPCL1 males respectively.



Relationship between insemination rate and the number of eggs produced by the surviving Anopheles arabiensis *females in the diferent cages after the competitiveness treatments.*

Competitive ability of gamma-ray irradiated *Aedes albopictus* under differing release ratios

The competitive ability of sterilized, mass-produced *Aedes albopictus* males in comparison to their wild counterparts is of special concern since many of the handling steps associated with large-scale rearing and sterilization can impact the quality of the resulting adult. If sterilized males are deemed to be less fit, whether due to lowered sperm counts, a reduced capacity to mate with multiple females, etc. than wild males, the number of sterilized males released must be increased to compensate for their lowered ability. To test how increasing the number of sterile males released could affect the overall fertility, 1:1, 3:1 and 5:1 ratios of sterile to fertile males were added to 30*30*30 cm laboratory cages with a standard number of females. Controls for both fertile and sterile males were also carried out. After a mating period females were isolated, blood fed and then tubed individually for oviposition. Individual egg production and hatch rate was determined for each female. Results indicate that when sterile males outnumbered fertile males 5 to 1, the overall fertility of the females was reduced from 80% (fertile controls) to 24%.



Mean proportion hatch (±SEM) of eggs laid by Aedes albopictus *females mated with differing ratios of fertile to sterile males.*

Reports

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

The 2nd International Meeting of Tephritid Workers of Europe, Africa and the Middle East was held at the Orthodox Academy of Crete near Kolymbari. This institution provided high quality technical and accommodation facilities in an isolated location, thereby being ideally suited to facilitate the close interaction between participating scientists, pest control, plant protection and food safety officers, and private sector representatives, both during meetings and also outside of them. Approximately 125 entomologists, geneticists, behaviourists, chemists and researchers from other specialities represented ca. 40 countries.

Participants of the Second International Meeting of Tephritid Workers of Europe, Africa and the Middle East (Kolymbari, Crete, Greece).

The programme included keynote speakers, oral presentations and three poster sessions. There were sessions on fruit fly invasions, quarantine regulations, and risk analysis; taxonomy and genetics; ecology life history and populations dynamics; detection and management; control methods and strategies; biological control and systems approaches; economic importance and area-wide management; behaviour and physiology.

Of major relevance to international fresh fruit trade and an FAO/IAEA Coordinated Research Project were the discussions on the *Bactrocera dorsalis* complex, which includes *B. dorsalis s.s., B. invadens, B. papaya* and *B. philippinensis*. There is growing evidence that it represents one species rather than several ones as established by taxonomists. The invasion of these species into Africa and other regions of the world is becoming a major problem, causing massive losses and drastically affecting international trade. The report at the meeting that *B. zonata* has recently been detected for the first time in Sudan, and is thus threatening to invade all of sub-Saharan Africa is very worrying. Therefore a side meeting was organized with all African participants to discuss the possibility to organize a delimitation and containment effort based on a male annihilation campaign using methyl-eugenol baits. Also the report that *B. invadens*, which has already invaded during the last decade most of sub-Saharan Africa, is already in northern Sudan and is thus threatening to move into North Africa and the Mediterranean Basin, is equally of major concern.

There is much fruit fly research being carried out by many new young researchers. This is very positive development; however, the role of the FAO/IAEA programme is very relevant to help focus research on more applied fruit fly problems, in order to develop sustainable pest management systems that can be used by farmers.

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

The 8th Meeting of the Working Group of Fruit Flies of the Western Hemisphere was successfully held with the participation of 250 researchers, plan protection officers and fruit fly experts from 14 countries of the Americas, as well 4 other countries from other continents. The meeting was extremely well organized by the Panamanian National Plant Protection Directorate, Pablo Liedo and the working group steering committee.

Participants of the Eight Meeting of the Working Group on Fruit Flies of the Western Hemisphere (Panama City, Panama).

This working group is the forum at which all aspects of fruit fly basic and applied research, area-wide control, and related phytosanitary issues in terms of quarantines, invasive species and international trade of fruit and vegetables commodities are discussed.

SIT application played a prominent role at this event, confirming that integration of the SIT against fruit fly pest is a key tool for the control of Fruit Flies in South America (Argentina, Brazil, Chile and Peru); Central America (Guatemala and Costa Rica) and, North America (Mexico and US). There are also a number of coun-

tries in different preparatory stage of embarking on such integrated area-wide fruit fly management programmes, several of which are being technically backstopped by the IAEA's Department of Technical Cooperation.

FAO/IAEA activities in terms of developing and promoting integrated SIT application against fruit flies were very visible as a result of much reference to them in 28 oral presentations by invited speakers, 60 posters, and discussions. Important research results were presented, in many of which FAO/IAEA Programme is directly or indirectly involved.

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

PAAT Secretariat's members (FAO, IAEA and WHO), AU-IBAR and AU-PATTEC agreed on a strategy for renewed united fight against tsetse fly transmitted trypanosomoses.

Representatives of the Food and Agriculture Organisation of the United Nations (FAO), the World Health Organization (WHO), the International Atomic Energy Agency (IAEA) and the African Union Commission (AUC) met at IAEA Headquarters in Vienna, Austria, 26-27 September 2012 to discuss a united and streamlined strategy against tsetse fly transmitted trypanosomoses, known as sleeping sickness in humans and nagana in livestock.

In the past years the three UN organizations FAO, IAEA and WHO, provided technical assistance within the remit of their respective mandates and competencies to AU-PATTEC and to tsetse and trypanosomoses (T&T) affected Member States. The three UN agencies collaborate, exchange information and harmonize their relevant activities in the Programme Against African Trypanosomosis (PAAT) forum. All three specialized UN organizations also signed a memorandum of understanding with the AUC to formalize their collaboration and their support to PATTEC.

At the meeting the representatives of the participating organizations agreed that – besides participating and interacting in the Steering Committee of AU-PATTEC – they will continue to interact in the PAAT forum, in order to:

- Harmonize their policies and strategies for T&T interventions within their respective mandates in support of the implementation of the AU-PATTEC Plan of Action;
- Coordinate their efforts in a complementary way in support of the AU-PATTEC;
- Review, appraise and validate project proposals generated by T&T affected countries on request from the respective Member States or AU-PATTEC;
- Share knowledge, information and data on T&T for evidence-based decision making at international, regional and national levels;
- Convene meetings to exchange views and information on T&T intervention actions; and harmonize efforts to strengthen national and
- Regional capacities through the provision of training, technical assistance and decision support tools.

The PAAT Forum will continue to be open to other interested stakeholders (e.g. ILRI, ICIPE, OIE, CIRDES), whose objectives are contributing to the successful implementation of the PATTEC Initiative.

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

The Regional Symposium on the Management of Fruit Flies in Near East Countries was held in Hammamet, Tunisia. Approximately 100 entomologists, geneticists, behaviourists, chemists and researchers from other specialities represented ca. 23 countries.

Participants of the FAO Regional Symposium on the Management of Fruit Flies in Near East Countries (Hammameth, Tunisia).

The programme included keynote speakers, oral presentations and a poster session. There were sessions on biology, ecology and population dynamics, cultural control methods, biocontrol, chemical control, mass trapping and bait stations, male annihilation technique, sterile insect technique, and quarantine and post-harvest treatments.

The main aspects discussed were the detection, taxonomic classification and action plans to respond to detection of the Asian fruit fly pests *Bactrocera invadens* already in northern Sudan, and especially *Bactrocera zonata* already present in Egypt and Libya. FAO/IAEA was asked to support possible efforts at a regional Near East level to install effective detection and rapid response tools to be able to contain the spread of the invasive pests *B. zonata* and *B. invadens*. Some coordination with the European countries, for which the mentioned species represent a threat, was also requested.

Announcements

Call for submission of research proposals for a new FAO/IAEA Coordinated Research Project on *Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes*

Among the major vectors of human diseases, mosquitoes are the most devastating ones. In addition, urbanization, globalization and climate change have further accelerated the spread and outbreaks of new mosquito borne diseases. In view of the problems associated with conventional mosquito control, such as resistance and health effects, major efforts are required to develop new or complementary control techniques, including the SIT, for major mosquito species.

The Sterile Insect Technique (SIT) is an increasingly important component of area-wide integrated vector control (AW-IVC) programmes for key insect vectors such as mosquitoes. With the increase in vector-borne diseases and their toll on human health and mortality, there have been recurring requests from Member States to develop tools and techniques for mosquito SIT, including the development of sexing strains (GC(56)/RES/19) to be able to apply the SIT to control mosquito vector populations (Resolution GC(52)/RES/13). The SIT has the ability to suppress or in special situations to eradicate existing vector populations and to prevent the establishment of new outbreaks.

Operational use of the SIT in other insect pests continues to reveal areas where new technologies could further improve efficiency and thus lead to more efficacious programmes. There are many aspects of the mosquito SIT package that require increased efficiency to be able to reach the operational level, e.g. improved mass rearing, release technology, quality control, field monitoring, etc. However, one critical area where important advances need to be made before any SIT application is possible concerns the development of genetic sexing strains (GSS). Unlike agriculture pests where the releases of both sexes is primarily of economic concern, in mosquitoes, it is an essential prerequisite to release only males since females are blood feeders and transmit the diseases. Without male-only releases, SIT application against mosquitoes is not possible.

Currently, AW integrated pest management (IPM) programmes with an SIT component have been successfully implemented for several very important fruit fly and lepidopteran species where the development of improved strains, especially GSS (in the case of fruit flies), led to major increases in applicability and efficiency of the SIT component. The experience gained from these programmes would prime the new CRP for the development of GSS in mosquitoes.

There are several mosquito species that are vectors of different pathogens in different countries. Of these, based on the severity of the disease, requests from Member States and the availability of the scientific tools and information, the consultants recommend that the initial efforts to develop mosquito GSS should focus on the following species: *Anopheles arabiensis* (vector of malaria), *Aedes albopictus* and *Ae. aegypti* (vectors of dengue, chikungunyia etc.). If research proposals on some of the other species of significant interest are received, they should also be considered.

Mosquito GSS development can be achieved using different approaches, but they all rely on some form of stable genetic change introduced and maintained in the developed strain. Genetic change can be introduced either using irradiation and classical genetics (as in the case of Mediterranean fruit fly GSS) or modern biotechnology, specifically genetic transformation. Both approaches have advantages and disadvantages relating to transferability of systems between species, stability in mass-rearing, regulatory approval, etc. In addition, the existing alternative sex separation methods based on physical, mechanical and behavioural approaches should also be considered. However, it should be noted that these alternative methods are currently appropriate only for small scale operations, highlighting the need to develop for large scale SIT and non-SIT operations state of art sexing strategies based on genetic, molecular and mechanical approaches.

Three main research axes to be addressed by the CRP:

- Explore irradiation and classical genetic approaches for sex separation in mosquitoes - development of GSS based on irradiation and classical genetics
- Explore molecular approaches for sex separation in mosquitoes - Development of GSS based on molecular genetics
- Explore mechanical, behavioural and developmental approaches for sex separation in mosquitoes - Sex Separation using Mechanical, Behavioural, and Developmental Tools

A combination of the following priority topics will be targeted:

(1) Isolation and mapping of genetic markers from different sources including natural populations and / or EMS-based screens.
(2) Development and characterization of irradiation-induced chromosomal rearrangements in the target mosquito species
(3) Cytogenetic analysis of the tools developed in [1] and [2]
(4) Isolation and characterization of selectable markers
(5) Construction and characterization of GSS

(6) Evaluation of GSS on a small scale using standard quality control parameters.
(7) Unravelling the molecular mechanisms of sex determination and sex specific expression in mosquitoes
(8) Isolation of genes and promoters to build transgenic strains
(9) Application of techniques to obtain sex specific expression of lethal factors in several species
(10) Construction of transgenic sexing strains in mosquitoes
(11) Evaluation of transgenic strains at a small scale using standard quality control parameters.
(12) Construction of transgenes with site-specific landing sites
(13) Evaluation and distribution of landing site strains
(14) Develop new and improve existing mechanical, behavioural tools for sex separation

The expected duration of the CRP is 5 years (2013-2018) and the first Research Coordination Meeting is planned for October 2013 in Vienna, Austria. Scientists and researchers who are interested in collaborating in this new CRP should contact Jeremie Gilles (J.Gilles@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 late April 2013 to Official.Mail@iaea.org.

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, sterile insect technique (SIT) and augmentative natural enemy control have not been either practical or 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 af-

fected 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 the knowledge base needed to generate 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.

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

(1) Can dormancy responses be used to manage insect life cycles to enable or improve the efficacy of mass rearing?
(2) Can dormancy responses be used to maintain the genetic integrity of laboratory strains?
(3) 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?
(4) Can dormancy responses be used to reduce radiation injury and enhance sterile insect performance?
(5) Can dormancy responses be managed to decrease shipping-related damage and enhance post-shipping performance of biological control agents?
(6) 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 late 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 in West Africa* (under TC Project RAF5061). 11-15 March 2013. Bobo Dioulasso, Burkina Faso. (**Deadline for nominations: 11 January 2013).**

- Regional Training Course on *Comparative Morphometric Analyses of Wings of Insect Pests* (under TC Project RAF5060). 22-26 April 2013. Seibersdorf, Austria. (**Deadline for nominations: 31 January 2013).**

- Regional Training Course on *Fruit Fly Detection for Balkans and Eastern Mediterranean* (under TC Project RER5018). 6-10 May 2013. Adana, Turkey. (**Deadline for nominations: 28 February 2013).**

- 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. (**Deadline for nominations: 30 March 2013).**

- 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 (**Deadline for nominations: 30 March 2013).**

- Regional Training Course on *Area-Wide Integrated Fruit Fly Suppression, including MAT and SIT for Balkans and 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/workshops (downloadable from: http://www-tc.iaea.org/tcweb/participion/astrainee/default.asp).

Completed forms should be endorsed by and submitted through the official channels established (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 facsimile (+43-1-26007) or email (official.mail @iaea. org) are welcome.

IAEA TECDOC on Quality Control for Expanded Tsetse Production, Sterilization and Field Application

An IAEA TECDOC with the results of the Coordinated Research Project (CRP) on Quality Control for Expanded Tsetse Production, Sterilization and Field Application was published. The final proceedings summarize the achievements of the 6 year CRP.

The use of the sterile insect technique (SIT) for the control of pest insects as part of an integrated, area-wide approach is widely accepted. Its application for the eradication of different tsetse populations, the vectors of human sleeping sickness and African animal trypanosomosis, is attracting increasing interest.

This interest in the application of the SIT against different species of this pest is leading to increased demand for sterile flies, the current bottleneck for expanded SIT application in sub-Saharan Africa. Little systematic work has been done specifically on the quality of mass reared and sterilized tsetse, and there is an urgent need to harmonize and improve the existing ad hoc measures. This CRP produced a quality control manual similar to the one already produced for tephritid fruit flies.

The development of large-scale rearing highlighted the need for improved quality control procedures and, with this in mind, the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture established a CRP in 2003 entitled *Improved and Harmonized Quality Control for Expanded Tsetse Production, Sterilization and Field Application* with the objective of improving and expanding the quality control sections of the *FAO/IAEA Standard Operating Procedures for Mass Rearing Tsetse Flies*. Sixteen institutions from thirteen countries in Africa, Europe and Central America participated in the CRP.

This publication is a report of the results and outputs of that CRP, including the new and revised quality control tests that resulted from it.

New Online Courses on Insect Rearing

There will be a new online, self-paced series of courses on insect rearing that will begin in the spring of 2013 taught through North Carolina State University (NCSU) by Allen Cohen: http://www.cals.ncsu.edu/entomology/node/778.

Allen Cohen helped establish the insect rearing workshops at Mississippi State and later taught workshops in Arizona. He has gone forward with his vision for the discipline of insect rearing by launching the Insect Rearing Education and Research Program (IREaR) at NCSU in 2011. Now, the series of online courses will be launched in early 2013.

These courses are dedicated to advancing insect rearing through formal science and technology education with up-to-date rearing practices, data driven research, quality and process control in rearing systems, quantitative diagnostic techniques and insectary problem solving through a multidisciplinary approach.

The insect rearing courses will be taught through the office of Continuing Education and Professional Development. They will be non-credit and self-paced. There will be course tiers for which levels of certification may be earned upon their completion.

Each of the courses and details can be viewed at http://insectdiets.com/insect-rearing-education-ncsu-63-2/short-courses/

Interregional Training Course on *The Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests* 29 July - 23 August 2013, Metapa de Dominguez, Chiapas, Mexico

Context: Food insecurity is inherently linked to pests and diseases. The losses caused by diseases and pests at both the pre- and post-harvest levels average at 30-40% of the agricultural outputs. This is a very inefficient use of agricultural investments in land, seeds, water, fertilizer, animal feed, labour and other inputs available to feed the growing human population.

Current reliance on pesticides and drugs is not sustainable, impairing the natural balance and causing outbreaks of secondary pests, contaminating the environment and leaving residues on food commodities, and leading to the development of resistance to pesticides used.

In addition, as a result of increasing crop and animal movement and trade, as well as climate change, there is an unprecedented increase of invasive animal and plant pests with dire socio-economic consequences.

An area-wide integrated approach that targets the management of populations of major pest insects, although management-intensive and logistically more complex, can contribute in some situations to a more effective and sustainable control.

Purpose of the Course: The purpose of this four-week interregional course is to provide a broad overview on the application of nuclear-related techniques, within the context of area-wide integrated insect pest management programmes, to managers of insect control programmes, animal health and plant protection officials and applied research entomologists.

The course will include radiation-induced sterility, the sterile insect technique (SIT), F-1 sterility, other methods of insect control, integration of control methodologies for area-wide insect management, the biology, ecology and dynamics of pest insect populations subjected to control, economic analysis of area-wide programmes and reviews of successful and ongoing area-wide programmes with an SIT component.

The aim is to widen the knowledge and horizon of current and future decision makers to a broader list of major insect pest problems, including pests or vectors of diseases that are currently not yet established in the participants' countries.

Participants: The course is directed at top-level vector disease and pest control management personnel that are or will likely become high-level decision makers and senior managers of pest control programmes or campaigns. A key aspect of this training is to develop good pest control managers in Member States with the broad background and skills required to conduct complex area-wide programmes. There is a need to transfer technology while also developing the required managers of projects to effectively integrate the SIT. Future decision makers need to be made aware of upcoming risks, develop a sense of preparedness and be trained on preventive and management strategies against potential new major pests and disease vectors.

Application Procedure: Nominations should be submitted on the standard IAEA application form for training courses/workshops (downloadable from: http://www-tc.iaea.org/tcweb/participion/astrainee/default.asp). Completed forms should be endorsed by and submitted through the official channels established (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). (**Deadline for nominations: 30 March 2013).**

Participants' Qualifications: The course is open to about 22 participants from IAEA and FAO Member States in all geographical regions. Preference will be given to qualified candidates from developing countries. Applicants must have at least a Bachelor of Science degree or equivalent in entomology or a related biological field. As the course will be conducted in **English**, participants must have an adequate working knowledge of that language.

Preference will be given to those in pest control policy-formulating positions or involved in preparing applied pest control programmes, or who have had at least several years of practical experience in applied research or teaching on pest control. The key criterion is the candidate's actual participation in operational area-wide pest control programmes or the potential when he/she has returned home to provide leadership in area-wide pest management and the use of the SIT in future programmes.

Other News

A new Dacine fruit fly searchable database

Profiles on the distribution, lure response, pest status and host plant lists are available for 623 of the *Bactrocera* and *Dacus* species known to occur in the Asia-Pacific region. In addition, five high quality photographs may be viewed for each of 245 species, under each species profile page. The resource can be visited at http://www.herbarium.hawaii. edu/fruitfly/index.php.

Source: Luc Leblanc, University of Hawaii (12 May 2012).

USDA-APHIS/PPQ removes *Anastrepha ludens* regulated areas in Texas

In October 2012, USDA-Animal and Plant Health Inspection Service, Plant Protection and Quarantine (APHIS/PPQ) notified stakeholders that it removed the last Mexican fruit fly (mexfly) regulated area from the Lower Rio Grande Valley of Texas. As a result, no mexfly-regulated areas remain in Texas. APHIS/PPQ cooperated with the Texas Department of Agriculture and the Texas citrus industry to control transient mexfly populations. Control actions have included the application of the sterile insect technique, fruit removal from infested areas, and the use of foliar bait sprays near the detection sites.

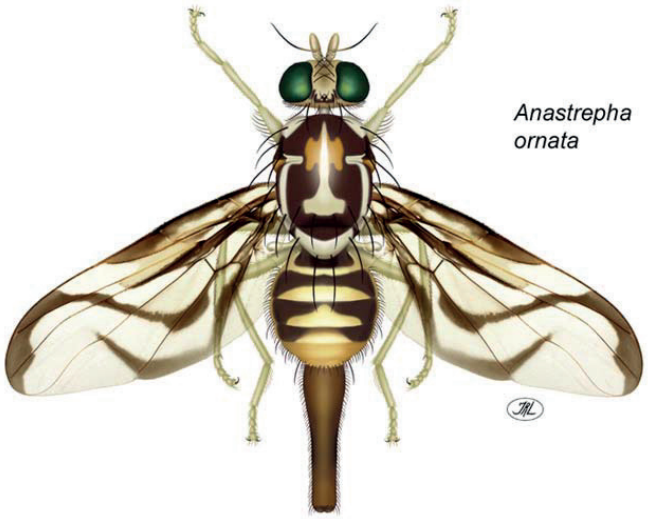
Source: John Stewart, USDA-APHIS (8 November 2012).

Anastrepha and *Toxotrypana*: Descriptions, illustrations, and interactive keys

The Center for Plant Health Science and Technology (CPHST) is pleased to announce the release of its latest identification tool, '*Anastrepha* and *Toxotrypana*: descriptions, illustrations, and interactive keys,' developed through collaboration between CPHST and an international team led by USDA Agriculture Research Service's Systematic Entomology Laboratory.

True fruit flies (Diptera: Tephritidae) include some of the world's most serious agricultural pests. Besides causing billions of dollars in direct losses to a wide variety of fruit, vegetable and flower crops, they limit the development of agriculture in many countries because of the strict trade quarantines imposed to prevent their spread.

Of the more than 4,600 tephritids known worldwide, nearly 200 are considered pests. Reliable identifications of specimens are critical for effective control programmes for pest fruit flies and for regulatory agencies to detect new outbreaks of invasive species.



Anastrepha and *Toxotrypana* are the two most economically important genera of true fruit flies in the American tropics and subtropics. Together they form the most diverse clade of fruit flies in the region, with more than 250 valid species and numerous undescribed species, many of which are extremely similar. This system attempts to bring together in a single package all the relevant taxonomic information for these species, as well as images for each species, and a choice of two electronic keys (Intkey or Lucid) that allow the user greater flexibility than a dichotomous key. To access the tool, go to: http://delta-intkey.com/anatox/.

Source: http://delta-intkey.com/anatox/ (9 September 2012).

Technical leaflet released in three languages on the discrimination between two invasive *Bactrocera* fruit fly pest

During the 2nd International TEAM Meeting (Tepthritid Workers of Europe, Africa and the Middle East) in Kolymbari, Crete, Greece (see page 128 of the abstract book at www.teamfly2012.com), Salah, Abdelgader and Villiers reported that in July 2011, the invasive fruit fly pest *Bactrocera zonata* was recorded for the first time in Sudan from traps in three locations in Wad Medani, Gezira, Sudan.

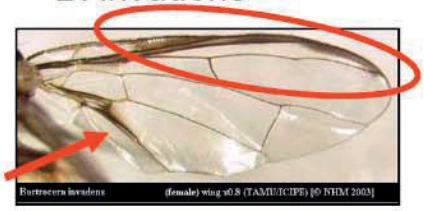
As this is a region where another methyl eugenol responding Asian fruit fly pest already exists (*B. invadens*) and to help Sudan and other African countries to discriminate among these two invasive pest species, a technical leaflet in Arabic, English (see next page) and French was prepared to help with differentiation between specimen of *B. invadens* and *B. zonata*. It was prepared by Marc De Meyer (Royal Museum for Central Africa, Belgium) and Ian White (Natural History Museum, UK) and has been distributed electronically to the African participants of the TEAM meeting.

Source: Insect Pest Control Section (July 2012).

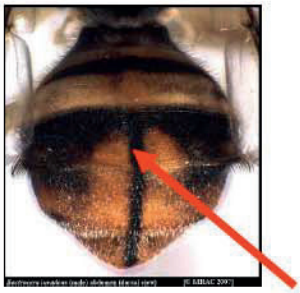
DIFFERENTIATION BETWEEN *BACTROCERA INVADENS* & *BACTROCERA ZONATA*

Both are large brownish flies with long antennae, yellowish legs and largely transparent wings. They resemble wasps.

B. invadens

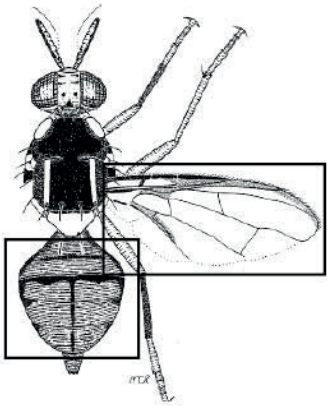


Dark band along margin complete (circled in red)
Dark anal streak present (red arrow)

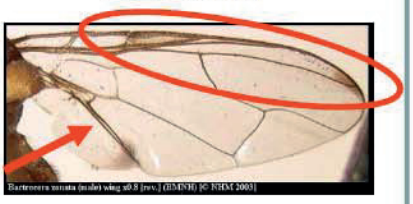


Abdomen with ' **T** ' shaped pattern

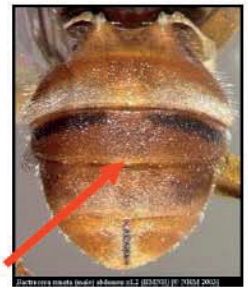
Major differences



B. zonata



Dark band reduced to spot at beginning and end (circled in red)
Dark anal streak absent (red arrow)



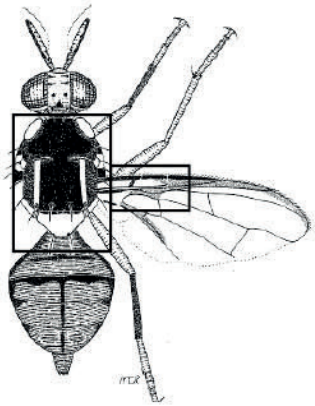
Abdomen without ' **T** ' shaped pattern

B. invadens

Thorax colour variable but at least partly black

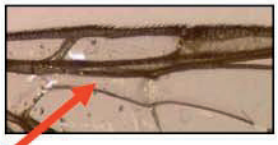
Wing: cell br with small hairs

Minor differences



B. zonata

Thorax colour completely brown



Wing: cell br without small hairs, transparent

Marc De Meyer (Royal Museum for Central Africa, Belgium) & Ian White (research associate, Natural History Museum, UK).
Images copyright as indicated (R.S. Copeland / Natural History Museum / CIRAD / RMCA)

Relevant Published Articles

Population structure of *Bactrocera dorsalis* s.s., *B. papayae* and *B. philippinensis* (Diptera: Tephritidae) in southeast Asia: evidence for a single species hypothesis using mitochondrial DNA and wing-shape data

Mark K Schutze[1,2], Matthew N Krosch[1,2], Karen F Armstrong[1,3], Toni A Chapman[1,4], Anna Englezou[1,4], Anastasija Chomič[3], Stephen L Cameron[2], Deborah Hailstones[1,4] and Anthony R Clarke[1,2]

[1] *CRC for National Plant Biosecurity, Australia*

[2] *School of Earth, Environmental and Biological Sciences, Queensland University of Technology, Brisbane, QLD, Australia*

Abstract

Background: *Bactrocera dorsalis* s.s. is a pestiferous tephritid fruit fly distributed from Pakistan to the Pacific, with the Thai/Malay peninsula its southern limit. Sister pest taxa, *B. papayae* and *B. philippinensis*, occur in the southeast Asian archipelago and the Philippines, respectively. The relationship among these species is unclear due to their high molecular and morphological similarity. This study analysed population structure of these three species within a southeast Asian biogeographical context to assess potential dispersal patterns and the validity of their current taxonomic status.

Results: Geometric morphometric results generated from 15 landmarks for wings of 169 flies revealed significant differences in wing shape between almost all sites following canonical variate analysis. For the combined data set there was a greater isolation-by-distance (IBD) effect under a 'non-Euclidean' scenario which used geographical distances within a biogeographical 'Sundaland context' ($r^2 = 0.772$, $P < 0.0001$) as compared to a 'Euclidean' scenario for which direct geographic distances between sample sites was used ($r^2 = 0.217$, $P < 0.01$). COI sequence data were obtained for 156 individuals and yielded 83 unique haplotypes with no correlation to current taxonomic designations via a minimum spanning network. BEAST analysis provided a root age and location of 540kya in northern Thailand, with migration of *B. dorsalis* s.l. into Malaysia 470kya and Sumatra 270kya. Two migration events into the Philippines are inferred. Sequence data revealed a weak but significant IBD effect under the 'non-Euclidean' scenario ($r^2 = 0.110$, $P < 0.05$), with no historical migration evident between Taiwan and the Philippines. Results are consistent with those expected at the intra-specific level.

Conclusions: *Bactrocera dorsalis* s.s., *B. papayae* and *B. philippinensis* likely represent one species structured around the South China Sea, having migrated from northern Thailand into the southeast Asian archipelago and across into the Philippines. No migration is apparent between the Philippines and Taiwan. This information has implications for quarantine, trade and pest management.

The full paper was published in: BMC Evolutionary Biology (2012) 12:130.

Generic phytosanitary irradiation treatments

Guy J Hallman

United States Department of Agriculture, Agricultural Research Service, Weslaco, TX, USA

Abstract

The history of the development of generic phytosanitary irradiation (PI) treatments is discussed beginning with its initial proposal in 1986. Generic PI treatments in use today are 150 Gy for all hosts of Tephritidae, 250 Gy for all arthropods on mango and papaya shipped from Australia to New Zealand, 300 Gy for all arthropods on mango shipped from Australia to Malaysia, 350 Gy for all arthropods on lychee shipped from Australia to New Zealand and 400 Gy for all hosts of insects other than pupae and adult Lepidoptera shipped to the United States. Efforts to develop additional generic PI treatments and reduce the dose for the 400 Gy treatment are ongoing with a broad based 5-year, 12-nation cooperative research project coordinated by the joint Food and Agricultural Organization/International Atomic Energy Agency Program on Nuclear Techniques in Food and Agriculture. Key groups identified for further development of generic PI treatments are Lepidoptera (eggs and larvae), mealybugs and scale insects. A dose of 250 Gy may suffice for these three groups plus others, such as thrips, weevils and whiteflies.

The full paper was published in: Radiation Physics and Chemistry (2012) 81: 861-866.

Control of stored product pests by ionizing radiation

Guy J Hallman

United States Department of Agriculture, Agricultural Research Service, Weslaco, TX, USA

Abstract

Food irradiation for prevention of food-borne illness and disinfestation of commodities of pests is increasing in a number of countries. The goal of this review is to analyze the literature and current use of irradiation to control stored product pests and suggest research to optimize its potential. Doses to prevent reproduction of stored product pests range from 0.05 kGy for *Tenebrio molitor* L. to 0.45 kGy for *Sitotroga cereallela* (Olivier). Small but increasing amounts of grains and pulses are being irradiated in the world today especially in Asia. At least 33 countries permit irradiation of some stored products with 14 countries permitting it for all stored products. Ways in which stored product irradiation research and application may influence other uses of irradiation technology are also discussed. Deactivation of weed seeds might be an area of stored product phytosanitation where irradiation would have an advantage over other measures.

The full paper was published in: Journal of Stored Products Research (2013) 52: 36-41.

Phylogenetics of the Old World screwworm fly and its significance for planning control and monitoring invasions in Asia

A.H. Wardhana[1,2,3] M.J.R. Hall[1], S.S. Mahamdallie[1], S. Muharsini[2], M.M. Cameron[3], P.D. Ready[1]

[1]*Department of Entomology, Natural History Museum, London, UK*

[2]*Department of Parasitology, Indonesian Research Centre for Veterinary Science, Bogor, Indonesia*

[3]*Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London, UK*

Abstract

Phylogenetic, genealogical and population relationships of *Chrysomya bezziana*, the Old World screwworm fly (OWSF), were inferred from DNA sequences of mitochondrial cytochrome b (*cyt b*), nuclear elongation factor-1α (*EF-1α*) and nuclear white eye colour (white), using sequences of *Chrysomya megacephala* and *Chrysomya rufifacies* as outgroups. *Cyt b* (717 bp, 754 specimens), *EF-1α* (361 bp, 256 specimens) and *white* (577 bp, 242 specimens) were analysed from up to two African and nine Asian countries, including 10 Indonesian islands. We show that OWSF occurs as distinctive African and Asian lineages based on *cyt b* and *white*, and that there is a marked differentiation between Sumatran and Javan populations in Indonesia, supported by the genealogy and analysis of molecular variance of *cyt b* alone. Four *cyt b* sub-lineages are recognised in Asia: only 2.1 occurs on the Asian mainland, from Yemen to Peninsular Malaysia; only 2.2, 2.3 and 2.4 occur in central Indonesia; 2.4 predominates on New Guinea; and 2.1 co-occurs with others only on Sumatra in western Indonesia. This phylogeography and the genetic distances between cyt b haplotypes indicate pre-historic, natural dispersal of OWSF eastwards into Indonesia and other Malesian islands, followed by vicariant evolution in New Guinea and central Indonesia. OWSF is absent from Australia, where there is surveillance for importation or natural invasion. Judged by *cyt b* haplotype markers, there is currently little spread of OWSF across sea barriers, despite frequent shipments of Australian livestock through Indonesian seas to the Middle East Gulf region. These findings will inform plans for integrated pest management, which could be applied progressively, for example starting in East Nusa Tenggara (central Indonesia) where OWSF has regional *cyt b* markers, and progressing westwards to Java where any invasion from Sumatra is unlikely. *Cyt b* markers would help identify the source of any re-emergence in treated areas.

The full paper was published in: International Journal for Parasitology (2012) 42: 729-738.

Short-term anoxic conditioning hormesis boosts antioxidant defenses, lowers oxidative damage following irradiation and enhances male sexual performance in the Caribbean fruit fly, *Anastrepha suspensa*

Giancarlo López-Martínez and Daniel A. Hahn

Department of Entomology and Nematology, University of Florida, Gainesville, FL, USA

Abstract

Most organisms are repeatedly exposed to oxidative stress from multiple sources throughout their lifetimes, potentially affecting all aspects of organismal performance. Here we test whether exposure to a conditioning bout of anoxia early in adulthood induces a hormetic response that confers resistance to oxidative stress and enhances male sexual performance later in life in the Caribbean fruit fly, *Anastrepha suspensa*. Anoxic conditioning of adults prior to emergence led to an increase in antioxidant capacity driven by mitochondrial superoxide dismutase and glutathione peroxidase. When exposed to gamma irradiation, a strong oxidative stressor, males that received anoxic conditioning had lower lipid and protein oxidative damage at sexual maturity. Anoxia conditioning led to greater male sexual competitiveness compared with unconditioned males when both were irradiated, although there was no effect of anoxia conditioning on mating competitiveness in unirradiated males. Anoxia also led to higher adult emergence rates and greater flight ability in irradiation-stressed flies while preserving sterility. Thus, hormetic treatments that increased antioxidant enzyme activity also improved male performance after irradiation, suggesting that antioxidant enzymes play an important role in mediating the relationship between oxidative stress and sexual selection. Furthermore, our work has important applied implications for the sterile insect technique (SIT), an environmentally friendly method of insect pest control where males are sterilized by irradiation and deployed in the field to disrupt pest populations via mating. We suggest that hormetic treatments specifically designed to enhance antioxidant activity may produce more sexually competitive sterile males, thus improving the efficacy and economy of SIT programs.

The full paper was published in: The Journal of Experimental Biology (2012) 215: 2150-216.

Papers in Peer Reviewed Journals

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ABD-ALLA, A., M. BERGOIN, A. PARKER, N.K. MANIANIA, J.M. VLAK, K. BOURTZIS and S. AKSOY (in press). Improving sterile insect technique (SIT) for tsetse flies through research on their symbionts and pathogens. Journal of Invertebrate Pathology.

AHMADI, M., A.M.M. ABD-ALLA and S. MOHARRAMIPOUR (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. and M.J.B.VREYSEN (in press). The interaction of dispersal and control methods for the riverine tsetse fly *Glossina palpalis gambiensis* (Diptera: Glossinidae): a modelling study. Population Ecology.

DAMIENS D., M.J.B. VREYSEN, and J.R.L. GILLES (in press). *Anopheles arabiensis* sperm production after genetic manipulation, dieldrin treatment, and irradiation. Journal of Medical Entomology.

DAMIENS D., S.M. SOLIBAN, BALESTRINO F., R. ALSIR, M.J.B. VREYSEN, and J.R.L. GILLES (in press). Different blood and sugar feeding regimes affect the productivity of *Anopheles arabiensis* colonies (Diptera: Culicidae). Journal of Medical Entomology.

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JEHLE, J.A., A.M.M. ABD-ALLA and Y. WANG (in press). Phylogeny and evolution of Hytrosaviridae. Journal of Invertebrate Pathology.

GÓMEZ, Y., P.E.A. TEAL and R. PEREIRA (in press). Enhancing efficacy of Mexican fruit fly SIT programmes by large-scale incorporation of methoprene into pre-release diet. Journal of Applied Entomology.

HAQ, I. and J. HENDRICHS (in press). Pre-release feeding on hydrolysed yeast and methoprene treatment enhances male *Bactrocera cucurbitae* Coquillett (Diptera: Tephritidae) longevity. Journal of Applied Entomology.

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KARIITHI, H.M., J. VAN LENT, M.M. VAN OERS, A.M.M. ABD-ALLA and J.M. VLAK (in press). Proteomic footprints of a Glossinavirus (Hytrosaviridae): An expeditious approach to virus control strategies in tsetse factories. Journal of Invertebrate Pathology.

LIENDO, M.C., F. DEVESCOVI, G.E. BACHMANN, M.E. UTGÉS, S. ABRAHAM, M.T. VERA, S.B. LANZAVECCHIA, J.P. BOUVET, P. GÓMEZ-CENDRA, J. HENDRICHS, P.E.A. TEAL, J.L. CLADERA, and D.F. SEGURA (in press). Precocious sexual signalling and mating in *Anastrepha fraterculus* (Diptera: Tephritidae) sterile males achieved through juvenile hormone treatment and protein supplements. Bulletin of Entomological Research.

MALELE, I., O. MANANQWA, H.H. NYINGILILI, W.A. KIWIKA, E.A. LYARUU, A.R. MSANGI, J.O. OUMA, G. NKWENGULILA and A.M.M. ABD-ALLA (in press). Prevalence of SGHV among tsetse species of economic importance in Tanzania and their implication for SIT application. Journal of Invertebrate Pathology.

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