Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Insect & Pest Control Newsletter

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

ISSN 1011-274X

No. 88, January 2017

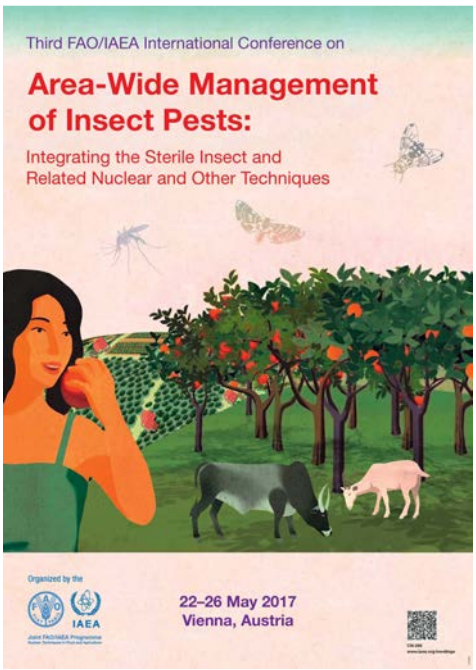
Contents

To Our Readers

The construction of the new Insect Pest Control Laboratory of the FAO/IAEA Agriculture and Biotechnology Laboratories as part of the ReNuAL *project (Renovation of the Nuclear Applications Laboratories) in Seibersdorf, Austria is progressing. The completion of the building shell is expected by early 2017 and interiors by late 2017 (photo 28 November 2016).*

In our NL 84, we reported on the ground-breaking for the *ReNuAL project* (Renovation of the Nuclear Applications Laboratories), which includes the FAO/IAEA Agriculture & Biotechnology Laboratories. The laboratories are unique within the United Nations system in providing Member States with direct access to scientific training, technology and analytical services. *ReNuAL* is getting under way with the construction of a new Insect Pest Control Laboratory (IPCL), pictured on the previous page, due for completion by the end of 2017. The new IPCL will, in general, allow expansion of efforts to assist Member States with the use of nuclear techniques to control insect pests, and more specifically, facilitate and expand the development and transfer of the Sterile Insect Technique (SIT), an environmentally friendly method that has been successfully used for decades to combat fruit flies, moths and livestock pests, such as screwworm and tsetse flies, and is also being developed for disease-transmitting mosquitos.

In 2016, we also reported on the increasing demands from our FAO and IAEA Member States to expand our focus from developing and transferring the SIT for major crop and livestock insect pests to major disease-transmitting mosquitoes. This development will be facilitated and accelerated due to extra-budgetary contributions of US $3.96 million from the United States and US $ 275,000 from Japan to conduct research to suppress *Aedes* vectors of Zika and other viruses, such as dengue, chikungunya and yellow fever. These are therefore very welcome and timely contributions by the Governments of Japan and the USA.



Looking to the year ahead, we are organizing the *Third FAO/IAEA International Conference on Area-wide Management of Insect Pests: Integrating the Sterile Insect and Related Nuclear and Other Techniques*, at the IAEA Headquarters in Vienna, Austria, from 22–26 May 2017. The programme that is being prepared looks very promising and will cover relevant current scientific and applied topics. A number of prominent speakers have been invited to debate new developments and trends. We expect around 400 scientists from all continents and look forward to a successful conference and your active participation.

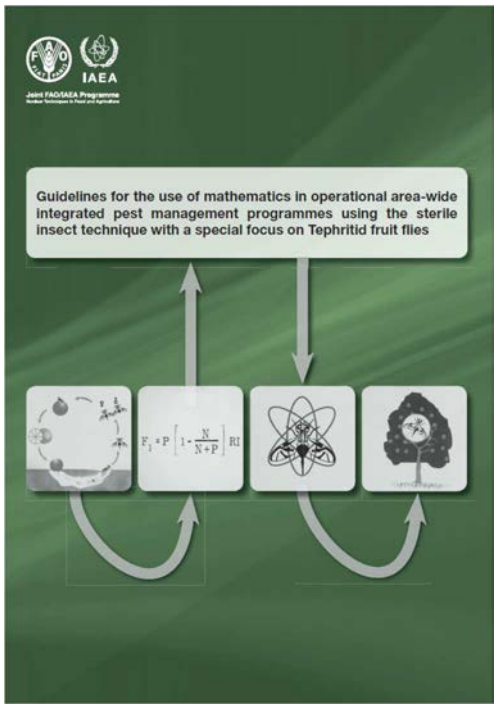
Previously in June 1998 and May 2005 FAO and IAEA sponsored the First and the Second International Area-wide Conferences. Both events greatly increased awareness about area-wide approaches for managing important insect pests. Since then, many new technical innovations have emerged and are being validated. This Third Conference will address technical, managerial and socio-economic components of operational area-wide programmes and present to a wide audience new developments, trends and challenges related to insect pest management, both in the fields of agriculture and public health. For more details see: http://www-pub.iaea.org/iaeameetings/50813/AWConf2017.

During a tour through Central America, IAEA Director General Yukiya Amano visited the biggest sterile insect mass-rearing facility in the world at El Pino in Guatemala. It has the capacity to produce 2,000 million sterile Mediterranean fruit fly males per week. The sterile males produced at this insect facility are used to contain the spread of this pest from Central America into southern Mexico. In addition, they are shipped each week to the preventive release programmes in the Los Angeles basin in California, and similar areas of high-risk of incursions in Florida.

The IAEA Director General Yukiya Amano and IAEA Director Technical Cooperation for Latin America and the Caribbean Luis Longoria during their visit to the Mediterranean fruit fly facility at El Pino, Guatemala.

This facility is part of the successful Moscamed Program that was established by the federal governments of Guatemala, Mexico and USA close to 40 years ago, and that eradicated the pest from southern Mexico in 1982 and, since then, has maintained the Mediterranean fruit fly-free status of mainland USA, Mexico, Belize and half of Guatemala. This tri-national program has been extremely cost-effective with for example a benefit-cost ratio of 112: 1 for Mexico, that has allowed the development of a multi-billion dollar horticultural industry.

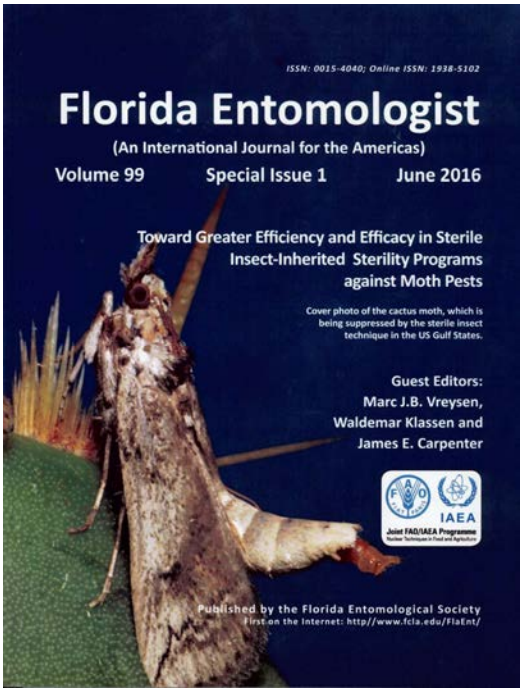
With respect to publications, I would like to highlight the recently published "Guidelines for the Use of Mathematics in Operational Area-wide Integrated Pest Management Programmes Using the Sterile Insect Technique with a Special Focus on Tephritid Fruit Flies". These guidelines provide mathematical tools that can be used by managers at different stages of insect pest suppression/eradication programmes. Among the tools are simple methods for calculating the various quantities of sterile insects required to achieve more realistic sterile: fertile ratios to better suppress pest populations. The manual can be downloaded at http://www-naweb.iaea.org/nafa/ipc/public/tephritid-fruit-flies-manual.pdf.



Between 2009 and 2014, staff of the IPC Subprogramme coordinated a FAO/IAEA Coordinated Research Project (CRP) on "Increasing the Efficiency of Lepidoptera SIT by Enhanced Quality Control". In this CRP targeted research was undertaken to: (1) identify and investigate factors and variables affecting the quality of the produced and released insects and their field performance, (2) identify and develop new tools and methods to assess and predict the field performance of sterile insects, and (3) improve the artificial rearing of several moth species through a better understanding and management of genetic resources.

A Special Issue in the peer-reviewed journal Florida Entomologist (http://journals.fcla.edu/flaent/issue/view/4271) has now been published, with 25 research and review articles covering the progress made during this CRP. Over 19 researchers from 14 countries participated in the CRP, conducting coordinated and multidisciplinary research. Significant improvements were made during the CRP with respect to identification of factors that affect field performance of sterile male moths, the development of methods and tools to assess field performance and quality control in relation to mass-rearing and handling of moths.

The CRP, however, also identified some gaps with respect to key factors and variables in the rearing and release processes that may affect the quality of the moths and their field performance and this is the subject of a new CRP.



The New World Screwworm (NWS), a pest of great economic significance to the cattle industry in the Americas, was eradicated from Florida in the late 1950s. Nevertheless, a recent outbreak was detected in the Florida Keys, where Key deer, an endangered species, were found to be infested. The Florida authorities responded rapidly with regulatory and other activities, including the release of sterile NWS in Big Pine Key and neighbouring islands. The releases were initiated on 11 October 2016 and are expected to continue until the outbreak has been brought under control.

In the Caribbean, NWS is still endemic in Cuba, Dominican Republic, Haiti and Jamaica, and its presence represents a continuous threat of reinvasion for North and Central American countries that have been screwworm-free for decades. A recent economic assessment commissioned by IAEA shows its negative impacts on meat and milk production in Cuba, affecting the sustainability of the cattle industry and contributing to rural poverty.

Finally, in the name of all the staff at the Insect Pest Control Subprogramme in Vienna and Seibersdorf, I would like to express our sincere appreciation for the dedication and competence of Jorge Hendrichs, who managed the Section as Section Head for more than 2 decades. Also, I would like to thank all our collaborators in many parts of the world for their support and significant inputs to our joint activities contributing to a successful year.

Rui Cardoso Pereira

Acting Head, Insect Pest Control Section

Staff

Joint FAO/IAEA Division of Nuclear Applications in Food and Agriculture

Name	Title	Email	Extension	Location
Qu LIANG	Director	Q.Liang@iaea.org	21610	Vienna

Insect Pest Control Subprogramme

Insect Pest Control Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture
P.O. Box 100, 1400 Vienna, Austria
Tel.: (+) 43 1 2600 21628; Fax: (+) 43 1 26007

Insect Pest Control Laboratory, FAO/IAEA Agriculture & Biotechnology Laboratories
2444 Seibersdorf, Austria
Tel.: (+) 43 1 2600 28404; Fax: (+) 43 1 26007 2874

Name	Title	Email	Extension	Location
Rui CARDOSO PEREIRA	Acting Section Head	R.Cardoso-Pereira@iaea.org	26077	Vienna
Rafael ARGILES	Entomologist (Livestock Pests)	R.Argiles-Herrero@iaea.org	21629	Vienna
Walther ENKERLIN	Entomologist (Plant Pests)	W.R.Enkerlin@iaea.org	26062	Vienna
Nima MASHAYEKHI-TABRIZI	Programme Assistant	N.Mashayekhi-Tabrizi@iaea.org	21633	Vienna
Elena ZDRAVEVSKA	Team Assistant	E.Zdravevska@iaea.org	21632	Vienna
Marc VREYSEN	Laboratory Head	M.Vreysen@iaea.org	28404	Seibersdorf
Adly ABD ALLA	Virologist	A.Abdalla@iaea.org	28425	Seibersdorf
Kostas BOURTZIS	Molecular Biologist	K.Bourtzis@iaea.org	28423	Seibersdorf
Carlos CÁCERES	Entomologist (Plant Pests)	C.E.Caceres-Barrios@iaea.org	28413	Seibersdorf
Jeremie GILLES	Entomologist (Human Disease Vectors)	J.Gilles@iaea.org	28407	Seibersdorf
Guy HALLMAN	Entomologist (Post-harvest)	G.J.Hallman@iaea.org	28454	Seibersdorf
Andrew PARKER	Entomologist (Livestock Pests)	A.Parker@iaea.org	28408	Seibersdorf
Hanano YAMADA	Entomologist (Human Disease Vectors)	H.Yamada@iaea.org	28429	Seibersdorf
Stephanie BECKHAM	Team Assistant	S.Beckham@iaea.org	28259	Seibersdorf

Forthcoming Events (2017)

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

Second RCM on Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies. 27–31 March 2016, Panama City, Panama.

Second RCM on Mosquito Handling, Transport, Release and Male Trapping Methods. 24–28 April 2017, Valencia, Spain.

Fourth RCM on Use of Symbiotic Bacteria to Reduce Mass-rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application. 17–21 May 2017, Vienna, Austria.

Third RCM on Dormancy Management to Enable Mass-rearing and Increase Efficacy of Sterile Insects and Natural Enemies. 29 May–2 June 2017, Vienna, Austria.

First RCM on Integration of the SIT with Biocontrol for Greenhouse Insect Pest Management. 3–7 July 2017, Vienna, Austria.

Fourth RCM on Enhancing Vector Refractoriness to Trypanosome Infection. 27 November–1 December 2017, Pretoria, South Africa.

II. Consultants and Expert Meetings

Consultants Meeting on Development of a Protocol for the Planning and Implementation of a Pilot Trial Using the Sterile Insect Technique against Codling Moth in Selected European Target Areas. 13–17 February 2017, Vienna, Austria.

Consultants Meeting on Mass-rearing Colony Management. 17–21 May 2017, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Regional Training Course on Mosquito Identifications, Surveillance and Trapping Methods for Area-Wide Integrated Mosquito Management in the European Area (under Regional Europe Project RER5022). 23–27 January 2017, Vienna, Austria.

FAO/IAEA Regional Workshop on the Practical Use of GPS/GIS to Improve Management of Fruit Fly Trapping Networks (under Regional Asia Project RAS5076). 30 January–2 February 2017, Arava, Israel.

Annual Meeting of American Mosquito Control Association. 13–17 February 2017, San Diego, California, USA.

FAO/IAEA Regional Training Course on Free Open Source Software for Geographic Information System (GIS) and Data Management Applied to Fruit Flies in Southeast Asia (under Regional Asia Project RAS5067). 6–10 March 2017, Bangkok, Thailand.

Seventh Annual Chapman Phytosanitary Irradiation Forum. 21–22 March 2017, Orange, California, USA.

FAO/IAEA Regional Training Course on Non-native Fruit Flies of Quarantine Significance (under Regional Asia Project RAS5076). 3–7 April 2017, Amman, Jordan.

Regional Training Course: Mosquito Detection, Surveillance, Data Recording and Analysis for Area-Wide Integrated Mosquito Management in the European Area (under Regional Europe Project RER5022). 3–7 April 2017, Valencia, Spain.

Twelfth Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 5–11 April 2017, Incheon, Republic of Korea.

FAO/IAEA Regional Workshop on Establishment and Harmonization of Fruit Fly Trapping Surveillance Networks and Quality Control (under Regional Latin America Project RLA5070). 24–28 April 2017, Santiago de Chile.

Meeting on Breeding Invertebrates for Next Generation Bio Control (BINGO). 18–21 May 2017, Vienna, Austria.

Third FAO/IAEA International Conference on Area-Wide Management of Insect Pests: Integrating the Sterile Insect and Related Nuclear and Other Techniques. 22–26 May 2017, Vienna, Austria.

FAO/IAEA Second Project Coordination Meeting on Strengthening Fruit Fly Surveillance and Control Measures Using the Sterile Insect Technique in an Area-Wide and Integrated Pest Management Approach for the Protection and Expansion of Horticultural Production (under Regional TC Project RLA5070). 22–26 May 2017, Vienna, Austria.

FAO/IAEA Second Project Coordination Meeting on Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with other Suppression Methods (under Regional TC Project RAF5074). 22–26 May 2017, Vienna, Austria.

FAO/IAEA Third Project Coordination Meeting on Integrating Sterile Insect Technique for better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia (under Regional Asia Project RAS5067). 22–26 May 2017, Vienna, Austria.

FAO/IAEA Europe Regional Workshop to Present Respective Experiences with Fruit Fly Activities and Synergize Future Activities (under Regional Europe Project RER5021). 22–26 May 2017, Vienna, Austria.

FAO/IAEA Regional Workshop on Geographical Information Systems, Databases and Information Analysis (under Regional Latin America Project RLA5070). 5–9 July 2017, Guatemala City, Guatemala.

Second Meeting of the Phytosanitary Measures Research Group. 10–13 July 2017, Wageningen, the Netherlands.

Meeting of the Technical Panel on Phytosanitary Treatments (TPPT), International Plant Protection Convention FAO. 17–21 July 2017, Vienna, Austria.

FAO/IAEA Regional Training Course on Fruit fly Detection, Surveillance, and Databases and Data Analysis in Africa (under Regional Africa Project RAF5074). 24–28 July 2017, Nairobi, Kenya.

FAO/IAEA Interregional Training Course on The Use of the Sterile Insect and Related Techniques for the Integrated Area-Wide Management of Insect Pests (under Interregional Technical Cooperation Project INT5155). 31 July–25 August 2017, Metapa de Dominguez, Chiapas, Mexico and Antigua / El Pino, Guatemala.

FAO/IAEA Regional Training Course on Quarantine and International Standards for Phytosanitary Measures for Fruit Flies in Southeast Asia (under Regional Asia Project RAS5067). 16–20 October 2017, Hanoi, Viet Nam.

Past Events (2016)

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

Second RCM on Dormancy Management to Enable Mass-rearing and Increase Efficacy of Sterile Insects and Natural Enemies. 18–22 April 2016, Stellenbosch, South Africa.

Third RCM on Enhancing Vector Refractoriness to Trypanosome Infection. 6–10 June 2016, Lyon, France.

Third RCM on Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes. 10–14 October 2016, Tapachula, Mexico.

First RCM on Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes. 31 August–4 September 2016, Durban, South Africa.

II. Consultants and Expert Meetings

FAO/IAEA Consultants Meeting on Integration of the SIT with Biocontrol for Greenhouse and other Confined Insect Pest Management. 14–18 March 2016, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Regional Latin America Training Course and Workshop on Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm (under Regional TC Project RLA5067). 11–15 January, 2016, Juazeiro, Brazil.

International Meeting in Order to Assess New Alternatives to *Aedes aegypti* Control in Brazil. 17–18 February 2016, Brasilia, Brazil.

FAO/IAEA Experts Meeting on *Aedes* Mosquito Population Control Using an Integrated Vector Management Approach with SIT Component (under TC Project INT5155). 22–23 February 2016, Brasilia, Brazil.

FAO/IAEA Regional Meeting on *Aedes* Mosquito Population Control Using an Integrated Vector Management Approach with SIT Component (under TC Project INT5155), 24–26 February 2016, Brasilia, Brazil.

WHO Global Consultation of Research Related to Zika Virus Infection, 7–9 March 2016, Geneva, Switzerland.

Emergency Response Consultation on New Vector Control Tools for Control of Zika Virus Disease, 14–15 March 2016, Geneva, Switzerland.

FAO/IAEA Regional Meeting on *Aedes* Mosquito Population Control Using an Integrated Vector Management Approach with SIT Component (under TC Project INT5155). 24–26 February 2016, Brasilia, Brazil.

FAO/IAEA First Coordination Meeting of Regional Latin America Project Strengthening Fruit Fly Surveillance and Control Measures Using the Sterile Insect Technique in an Area-wide and Integrated Pest Management Approach for the Protection and Expansion of Horticultural Production (under Regional TC Project RLA5070). 4–8 April, 2016, Guatemala City, Guatemala.

Eleventh Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 4–8 April 2016, Rome, Italy.

Third Meeting of the Tephritid Workers of Europe, Africa and the Middle East (TEAM). 11–14 April 2016, Stellenbosch, South Africa.

Workshop on Dormancy Management to Enable Insect Mass-rearing. 15–17 April 2016, Stellenbosch, South Africa.

Workshop on Bioinformatics Approaches for Microbiota Profiling Based on Amplicon Sequencing Data. 30 May–1 June 2016, Lyon, France.

Workshop on Tissue Localization and Analysis of Insect Endosymbionts by Fluorescence Microscopy: Theoretical Background and Practical Applications. 2–4 June 2016, Lyon, France.

XXV International Fruit Fly Course. National Fruit Fly Programme DGSV-SENASICA-SAGARPA (in support of TC Project RLA5070). 20 June–8 July 2016. Metapa de Dominguez, Chiapas, Mexico.

Workshop to Standardize Sampling and Bioassay Methods for Assessing Field Performance of Sterile Male Lepidoptera. 29–30 August, Durban, South Africa.

FAO/IAEA First Coordination Meeting of Interregional Project Sharing Knowledge on the Sterile Insect and Related Techniques for the Integrated Area-Wide Management of Insect Pests and Human Disease Vectors (under Regional TC Project INT5155). 4–8 July, 2016, Tapachula, Mexico.

FAO/IAEA Regional Workshop on Strengthening Regional Capacity in Latin America and the Caribbean for Integrated Vector Management Approaches with a Sterile Insect Technique Component, to Control *Aedes* Mosquitoes as Vectors of Human Pathogens, particularly Zika Virus (under Regional TC Project RLA5074). 9–11 July 2016, Tapachula, Mexico.

FAO/IAEA Regional Training Course on Taxonomy and Identification of Fruit Fly Pest Species for Southeast Asia (under Regional TC Project RAS5067). 11–15 July 2016, Bangkok, Thailand.

FAO/IAEA First Coordination Meeting of Africa Regional Project Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with Other Suppression Methods (under Regional TC Project RAF5074). 25–29 July, 2016, Maputo, Mozambique.

FAO/IAEA Second Coordination Meeting of Regional Project Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia (under Regional TC Project RAS5067). 14–19 August, 2016, Kuala Lumpur, Malaysia.

First Meeting of the Tephritid Workers of Asia, Australia, and Oceania (TAAO). 15–18 August 2016, Kuala Lumpur, Malaysia.

FAO/IAEA Expert Workshop to Discuss and Establish Criteria for Selection of Initial Pilot Sites (under Regional TC Project RLA5074). 15–19 August, 2016, Vienna, Austria.

FAO/IAEA First Coordination Meeting of Europe Regional Project Establishing Genetic Control Programmes for *Aedes* Invasive Mosquitoes (under Regional TC Project RER5022). 22–26 August, 2016, Vienna, Austria.

Workshop to Standardize Sampling and Bioassay Methods for Assessing Field Performance of Sterile Male Lepidoptera. 29–30 August 2016, Durban, South Africa.

Meeting of the Technical Panel on Phytosanitary Treatments (TPPT), International Plant Protection Convention FAO. 29 August–2 September 2016, Tokyo, Japan.

FAO/IAEA Regional Training Course on Fruit Fly Detection, Surveillance and Area-Wide Integrated Pest Management for Balkans and Eastern Mediterranean (under Regional TC Project RER5021). 5–9 September 2016, Opuzen, Croatia.

FAO/IAEA Southeast Asia Regional Workshop on Sterile Insect Technique-based Approaches to Control Populations of Mosquito Disease Vectors: with Special Reference to Dengue, Chikungunya and Zika Vectors (under Regional TC Project RAS5066 and INT5155). 5–9 September 2016, Kuala Lumpur, Malaysia.

FAO/IAEA Workshop on Surveillance Systems against Non-native Fruit Fly Pests and Emergency Response Capacity (under TC Project MOR5035). 5–9 September 2016, Rabat, Morocco.

International Congress of Entomology, Symposium on Innovative Strategies of Mosquito Control. 26 September 2016, Orlando, Florida, USA.

International Congress of Entomology, Symposium on The Role of National, Regional, and International Plant Protection Organizations to Prevent the Introduction and Spread of Plant Pests. 27 September 2016, Orlando, Florida, USA.

FAO/IAEA Workshops on Identification of Non-native Fruit Flies of Quarantine and Economic Significance (under TC Project MOR5035). 28–30 September 2016, Rabat, Morocco.

FAO/IAEA Workshop on Geographical Information Systems, Databases and Information Analysis in Support of Mediterranean Fruit Fly Management (under TC Project MOR5035). 4–8 October 2016, Rabat, Morocco.

Ninth Meeting of the Tephritid Workers of the Western Hemisphere (TWWH). 17–21 October 2016, Buenos Aires, Argentina.

FAO/IAEA Workshop on South American Fruit Fly (*Anastrepha fraterculus*) Cryptic Species (under Regional TC Project RLA5070). 17–21 October 2016, Buenos Aires, Argentina.

FAO/IAEA meeting of the Regional Latin America Project Strengthening Fruit Fly Surveillance and Control Measures Using the Sterile Insect Technique in an Area-Wide and Integrated Pest Management Approach for the Protection and Expansion of Horticultural Production (under Regional TC Project RLA5070). 21 October 2016, Buenos Aires, Argentina.

Phytosanitary Systems against Agricultural Pests Course. 24–28 October 2016, Tucumán, Argentina.

FAO/IAEA Regional Workshop on Geographical Information Systems (GIS) and Databases for Mediterranean Fruit Fly (under TC Project RAS5076). 7–11 November, 2016, Vienna, Austria.

FAO/IAEA Regional Latin America and Caribbean Training Course on Mass-rearing, and SIT-related Activities for the Control of *Aedes* Mosquitoes, the Major Vectors of dengue, chikungunya and Zika (under Regional TC Project RLA5074). 7–11 November 2016, Juazeiro, Brazil.

5th WHO Vector Control Advisory Group. 2–4 November 2016, Geneva, Switzerland.

88th Annual Meeting of Florida Mosquito Control Association. 13–17 November 2016, Miramar Beach, Florida, USA.

15th Pan African Tsetse and Trypanosomosis Eradication Campaign (PATTEC) Coordinators and Stakeholders Meeting (under TC Project RAF5077). 28–29 November 2016, Addis Ababa, Ethiopia.

FAO/IAEA Regional Workshop on Evaluation and Strategic Planning for Screwworm Prevention and Feasibility for Progressive Control (under TC Project RLA5067). 12–16 December, 2016, Vienna, Austria.

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 four major topics, namely:

- Biocontrol using radiation
- Human disease vectors
- Livestock pests
- Plant pests

Country	Project Number	National Projects	Technical Officer
Angola	ANG5012	Supporting Feasibility Studies for using Sterile Insect Techniques as part of Area-Wide Integrated Pest Management for Control of Tsetse Flies (*G. morsitans centralis*)	Rafael Argiles Herrero
Botswana	BOT5013	Using the Sterile Insect Technique Integrated with Other Suppression Methods for Managing *Bactrocera dorsalis*	Rui Cardoso Pereira
Burkina Faso	BKF5012	Collecting Baseline Data and Implementing Fruit Fly Suppression in Mango Fruit	Rui Cardoso Pereira
Burkina Faso	BKF5018	Improving Agro-Forestry and Agro-Pastoral Production through the Use of Nuclear Technologies	Adly Abdalla Rafael Argiles
China	CPR5020	Integrating the Sterile Insect Technique (SIT) for Area-Wide Integrated Pest Management of Tephritid Fruit Flies	Rui Cardoso Pereira
Ecuador	ECU5029	Improving Integrated Fruit Fly Management in Fruit and Vegetable Production Areas	Walther Enkerlin
Ethiopia	ETH5019	Enhancing Livestock and Crop Production through Consolidated and Sustainable Control of Tsetse and Trypanosomosis to Contribute to Food Security	Rafael Argiles Andrew Parker Adly Abdalla
Fiji	FIJ5001	Examining Options for the Management of Fruit Flies	Rui Cardoso Pereira
Guatemala	GUA5019	Strengthening National Capabilities for the Control of Agricultural Pests Using Nuclear Technologies	Walther Enkerlin
Israel	ISR5020	Developing a Strategy to Counteract *Bactrocera zonata*	Walther Enkerlin
Libya	LIB5011	Enhancing Area-Wide Integrated Management of Fruit Flies	Walther Enkerlin
Marshall Islands	MHL5001	Strengthening national capacities for the early and rapid detection of Zika virus infections in the Marshall Islands	Hanano Yamada Jeremie Gilles Kostas Bourtzis
Mexico	MEX5031	Using the Sterile Insect Technique to Control Dengue Vectors	Kostas Bourtzis Hanano Yamada
Morocco	MOR5035	Implementing the Sterile Insect Technique in the Souss Valley	Walther Enkerlin Carlos Cáceres

Panama	PAN5025	Expanding and Strengthening the Phytosanitary Surveillance System for Fruit Fly, Emphasizing Exotic Species of Quarantine Importance, and Exploring the Use of Nuclear Techniques for Post-Harvest Treatment as a Complementary Action	Walther Enkerlin
Papua New Guinea	PAP5001	Supporting a Feasibility Study on Using the Sterile Insect Technique against the Cocoa Pod Borer	Marc Vreysen
Philippines	PHI5033	Building Capacity in Using the Sterile Insect Technique against Dengue and Chikungunya Vectors	Jeremie Gilles Hanano Yamada
Palau	PLW5002	Improving the Quantity and Quality of Fruits for Exportation and Domestic Consumption Through Area-wide Integrated Pest Management of *Bactrocera* Fruit Flies in Tropical Fruit and Vegetable Production Areas (Phase II)	Rui Cardoso Pereira
South Africa	SAF5014	Assessing the Sterile Insect Technique for Malaria Mosquitos in a South African Setting, Phase II	Hanano Yamada Jeremie Gilles
Senegal	SEN5037	Supporting the National Programme to Control Tsetse and Trypanosomosis	Marc Vreysen Rafael Argiles Andrew Parker
Seychelles	SEY5009	Suppressing Melon Fruit Fly Species through Environment-Friendly Techniques to Enhance Food Security	Rui Cardoso Pereira
Sri Lanka	SRL5047	Establishing a National Centre for Research, Training and Services in Medical and Molecular Entomology for Vector-borne Disease Control	Jeremie Gilles Hanano Yamada
Sudan	SUD5038	Implementing the Sterile Insect Technique for Integrated Control of *Anopheles arabiensis*, Phase II	Jeremie Gilles Hanano Yamada Adly Abdalla
Thailand	THA5052	Developing Sustainable Management of Fruit Flies Integrating Sterile Insect Technique with other Suppression Methods	Rui Cardoso Pereira
Uganda	UGA5036	Demonstrating the Feasibility of a Sterile Insect Technique Component as Part of an Area-Wide Integrated Pest Management Approach to Increase Livestock Productivity	Rafael Argiles Herrero
Viet Nam	VIE5021	Integration of the Sterile Insect Technique with Other Suppression Methods for Control of *Bactrocera* fruit flies in Dragon Fruit Production	Rui Cardoso Pereira
Zimbabwe	ZIM5023	Improving Crop and Livestock Production through the Eradication of Bovine and Human Trypanosomiasis in Matusadona National Park	Rafael Argiles Herrero

		Regional Projects	
Regional Africa	RAF5072	Exploring the Use of Sterile Insect Technique as a Novel Technique for Control of Vector Mosquito for Chikungunya and Dengue (*Aedes albopictus*) in the Indian Ocean Region (PHASE I - 2014-2015)	Jeremie Gilles Hanano Yamada
Regional Africa	RAF5074	Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with Other Suppression Methods	Rui Cardoso Pereira
Regional Africa	RAF5077	Supporting Area-Wide Tsetse and Trypanosomosis Management to improve Livestock Productivity, Phase III	Rafael Argiles Andrew Parker
Regional Asia	RAS5066	Promoting the Sharing of Expertise and Infrastructure for Dengue Vector Surveillance towards Integration of the Sterile Insect Technique with Conventional Control Methods among South and South East Asian Countries	Kostas Bourtzis Hanano Yamada
Regional Asia	RAS5067	Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia	Rui Cardoso Pereira
Regional Asia (ARASIA)	RAS5076	Harmonising and Strengthening Surveillance Systems to Prevent and Control Exotic and Native Fruit Flies Including the Use of the Sterile Insect Technique	Walther Enkerlin Adly Abdalla
Regional Europe	RER5021	Supporting the Management of Fruit Flies in the Balkans and the Eastern Mediterranean	Rui Cardoso Pereira
Regional Europe	RER5022	Establishing Genetic Control Programmes for *Aedes* Invasive Mosquitoes	Kostas Bourtzis Hanano Yamada
Regional Latin America	RLA5067	Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm	Walther Enkerlin
Regional Latin America (ARCAL)	RLA5070	Strengthening Fruit Fly Surveillance and Control Measures Using the Sterile Insect Technique in an Area Wide and Integrated Pest Management Approach for the Protection and Expansion of Horticultural Production (ARCAL CXLI)	Walther Enkerlin
Regional Latin America	RLA5074	Strengthening Regional Capacity in Latin America and the Caribbean for Integrated Vector Management Approaches with a Sterile Insect Technique Component, to Control *Aedes* Mosquitoes as Vectors of Human Pathogens, particularly Zika Virus	Kostas Bourtzis Hanano Yamada Jeremie Gilles
		Interregional Project	
Interregional	INT5155	Sharing Knowledge on the Sterile Insect and Related Techniques for the Integrated Area-Wide Management of Insect Pests and Human Disease Vectors	Jeremie Gilles Hanano Yamada Rui Cardoso Pereira

Highlights of Technical Cooperation Projects

Sharing Knowledge on the Sterile Insect and Related Techniques for the Integrated Area-Wide Management of Insect Pests and Human Disease Vectors (INT5151)

An interregional meeting was held from 4-8 July, 2016 in Tapachula, Mexico entitled "Sharing Knowledge on the Sterile Insect and Related Techniques for the Integrated Area-Wide Management of Insect Pests and Human Disease Vectors". The meeting was held to facilitate networking and information exchange among participating countries and regions, as well as to harmonize activities related to mosquito detection, surveillance and control tactics in response to the demand for new solutions for the increasing risks associated with the spread of human disease vectors, particularly mosquitoes that transmit dengue, chikungunya, malaria, yellow fever and Zika. Due to the transboundry nature of this threat, 53 participants from 44 Member States, numerous local observers and press were present for this meeting, making this the largest meeting of its kind.

Strengthening Regional Capacity in Latin America and the Caribbean for Integrated Vector Management Approaches with a Sterile Insect Technique Component, to Control *Aedes* Mosquitoes as Vectors of Human Pathogens, particularly Zika Virus (RLA5074)

Workshop on Strengthening Regional Capacity in Latin America and the Caribbean for Integrated Vector Management Approaches with a SIT Component, to Control *Aedes* Mosquitoes as Vectors of Human Pathogens, particularly Zika Virus

A regional workshop was held from 9-11 July, 2016 in Tapachula, Mexico, on the fundamentals of SIT as a component of Integrated Vector Management programmes attended by participants from 15 Latin American and Caribbean Member States. Two FAO/IAEA staff members and one international expert as well as local experts provided lectures covering the principles of the SIT, progress in R&D related to the SIT package for *Aedes* mosquitoes, and excursions to field sites, the Moscafrut mass-rearing facility, as well as the mosquito insectary at the National Institute of Public Health. Group discussions were held to identify each country's status and needs, and ideas and recommendations were formulated in regard to inter-country collaborations and the potential role of the World Health Organization (WHO) / Pan American Health Organization (PAHO) in future pilot studies involving sterile male releases.

Following the workshop, the Member States which have been classified into 3 tiers according to their mosquito control/SIT status have received a package of insectary and field equipment for either 1) the collection of entomological baseline data, starting and maintaining a mosquito colony and other laboratory consumables, or 2) mass-rearing equipment for the up-scaling of sterile male production.

Regional Training Course on Mass-rearing, and SIT-related Activities for the Control of *Aedes* Mosquitoes, the Major Vectors of Dengue, Chikungunya and Zika

The regional training course was held at the Biofabrica MOSCAMED facility in Juazeiro, Brazil from the 7-11 of November, 2016, where 21 participants from 12 Member States from the Latin America and Caribbean region, and numerous local participants received hands-on training in the various components of the SIT package for the dengue, chikungunya and Zika vectors *Aedes aegypti* and *Ae. albopictus*. The Health Secretary of the State of Recife, as well as a representative from the Brazilian Ministry of Health, were also present, providing valuable input and also showing considerable interest in the activities of the course.

Participants of the Regional Training Course on "Mass-rearing, and SIT-related Activities for the Control of Aedes *Mosquitoes, the Major Vectors of Dengue, Chikungunya and Zika" (Juazeiro, Brazil).*

Overall, the training course was excellently organized by the host institution and participants found the course, especially the practical information and hands-on activities, highly beneficial and effective in transferring the technology and skills needed to start their respective projects, and

for the Tier 1 (advanced) Member States (Mexico, Cuba, Brazil and Peru) to initiate pilot field trials.

The RLA5074 group had advanced well in terms of networking and planning of joint efforts within the region. It is recommended that the close partnerships continue to grow amongst the Member States and respective national collaborators, and that the decision makers in the region are regularly informed about the project's activities and progress to encourage their support.

Using the Sterile Insect Technique to Control Dengue Vectors (MEX5031)

Three expert missions were implemented for the national project MEX5031, to visit the facilities in Tapachula, Chiapas, discuss the project plan and needs in more detail, and review the overall progress. Two field sites have been selected for pilot studies, and baseline entomological data is being collected in these sites. The procurement of mass-rearing equipment will support the planned amplification of sterile male *Aedes aegypti* production and a new building is to be built for mass-rearing. During the missions, discussions were held with potential collaborators for the development of novel devices for aerial releases of mosquitoes to support the project's trials and future larger scale field studies. Good progress has already been made and this national project is expected to lead in pilot trials in Latin America along with Brazil and Cuba.

Promoting the Sharing of Expertise and Infrastructure for Dengue Vector Surveillance towards Integration of the Sterile Insect Technique with Conventional Control Methods among South and South East Asian Countries (RAS5066)

An evaluation of the mosquito colony and insectary, as well as the selection of potential field sites in Kyaukse, Myanmar was conducted. The project is still in its beginnings, but the mosquito team has already made considerable advances and currently a small colony of *Aedes aegypti* has been established from field-caught material, and standard FAO/IAEA mosquito colony maintenance protocols have been adopted and are being used routinely.

Three potential pilot field sites (3 villages) have also been selected and initial visits to the villages and larval breeding site surveys have indicated the suitability of these sites for small scale trials. Entomological baseline data collection equipment, as well as basic insectary equipment and consumables have been procured and received by the counterparts and have been put to good use.

Sampling of breeding sites in Myanmar for the selection of potential pilot sites (a). Training in dissection techniques/microscopy (dissection of the spermathecae for determination of female insemination) (b). Speaking to the village elders for community engagement and acceptance (c). Establishment of Ae.aegypti *colony (d).*

Also Malaysia has initiated colony amplification, pupal sexing methods, field data collection and quality control methods. The project is very advanced with several mosquito colonies well established, and ample field data collected. The selected "field sites" for initial sterile male releases are high-rise buildings (see picture), where dengue transmission is low, but continuous. *Ae. aegypti* populations breed within these buildings and they pose an interesting and unique setting for pilot release studies.

Pilot site in Malaysia: high-rise buildings where dengue outbreaks occur regularly (a). The interior of the buildings where Ae. aegypti populations breed and transmit disease (b).

Workshop on Sterile Insect Technique-based Approaches to Control Populations of Mosquito Disease Vectors, with Special Reference to Dengue, Chikungunya and Zika Vectors

In the framework of this regional project "Promoting the Sharing of Expertise and Infrastructure for Dengue Vector Surveillance towards Integration of the Sterile Insect Technique with Conventional Control Methods among South

and South East Asian Countries", a workshop was organized in Kuala Lumpur, Malaysia from 5-9 September 2016. Forty-eight participants and six experts from thirty-eight countries attended this workshop. The workshop emphasized the principles of the sterile insect technique and how SIT-based approaches can be used, as a component of integrated vector management programmes, to suppress mosquito populations and mosquito-borne diseases.

Participants of the Regional Asia/Pacific Workshop on "Sterile Insect Technique-based Approaches to Control Populations of Mosquito Disease Vectors with Special Reference to Dengue, Chikungunya and Zika Vectors (Kuala Lumpur, Malaysia).

Lectures were provided by six experts from France, Italy, Sweden, Thailand and United Kingdom, and a technical officer from the Joint FAO/IAEA Division.

During the workshop, the participants also had the opportunity to visit the laboratories of the Institute of Medical Research and Nuclear Malaysia in Kuala Lumpur, as well as the malaria eradication programme and a pilot *Aedes* monitoring programme in Penang Island.

Implementing the Sterile Insect Technique for Integrated control of *Anopheles arabiensis*, Phase II (SUD5038)

The IPC Subprogramme is continuing to support the feasibility study to use the SIT in controlling *Anopheles arabiensis*, the only malaria vector in Northern Sudan through national TC project SUD5038. The current activities of the project that are supported by the Islamic Development Bank, were recently reviewed during the visit of the technical officer of the project to Khartoum, Sudan from 18-22 September 2016.

In addition the construction of the mass-rearing facility, the procurement of an irradiator, and the future work plan were discussed with the National Liaison Officer and the Project Counterpart. The field activities were reviewed during a visit to the pilot release site (see picture), where the behavior of released sterile males is being evaluated.

An. arabiensis *breeding site in Merowe, Northern State, Sudan.*

Building Capacity in Using SIT against Dengue and Chikungunya Vectors (PHI5033)

The laboratory activities at the Philippine Nuclear Research Institute (PNRI) for the colonization and maintenance of colonies of *Aedes aegypti* are being successfully implemented from collections made in Old Balara, Quezon City. The initial rearing procedures have been recently revised and harmonized according to the FAO/IAEA *Aedes* Rearing Guidelines and following results of local experiments and recommendations shared with FAO/IAEA Insect Pest Control Laboratory.

Ongoing mosquito suppression activities in Philippines.

A laboratory structure has been recently renovated to host the mosquito rearing facility with large space for the mosquito colony and laboratory experimentation. The procurement of a new irradiator at the PNRI will be essential to standardise and evaluate the mosquito sterilization pro-

cedures in order to obtain competitive sterile males to be released during future field pilot tests.

The SIT project team in the Philippines is also actively involved in the ongoing FAO/IAEA Coordinated Research Project on "Transport, Handling, Release and Trapping of Mosquitoes" and recent IAEA scientific visits and fellowships have helped in building capacity to successfully implement future activities.

Mosquito population surveillance and evaluation in field pilot sites are under implementation for the integration of the SIT to suppress the dengue mosquito vector. Two sites have been selected for surveillance and a pilot study, including disease surveillance is ongoing as part of a collaboration with the National Research Council of the Philippines. A high level of community support is already in place, public outreach, dengue forums and education of children have been conducted, and a comic was produced to explain disease transmission and mosquito control, as well as breeding site clean-up drives during epidemics.

Improving Agro-Forestry and Agro-Pastoral Production through the Use of Nuclear Technologies (BKF5018)

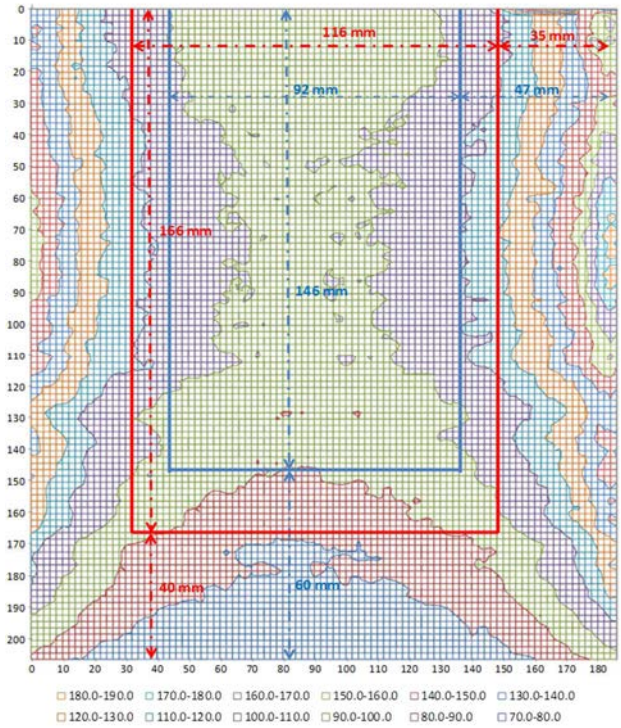
The main entrance of the IBD tsetse mass rearing facility, Bobo-Dioulasso, Burkina Faso.

FAO/IAEA is continuing to support the Pan-African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) project in Burkina Faso under national TC project BKF5018 "Improving Agro-Forestry and Agro-Pastoral Production through the Use of Nuclear Technologies".

The first phase of the rearing facility in Bobo-Dioulasso (IBD) is now complete and equipment has been installed in several rooms so that test rearing can be initiated. Pupae have been supplied from both Centre International de Recherche-Développement sur l'Elevage en zone Subhumide (CIRDES) in Bobo-Dioulasso and from the IPCL, Seibersdorf and these have been reared through two to three generations providing an opportunity to train the new staff and test the facilities and equipment. The inauguration of the IBD facility is planned for February 10th, 2017.

The IBD has procured a Foss Therapy Services 812 60-60 irradiator with approximately 15 kCi initial loading in two sources. This irradiator has three source positions in total that can be independently selected, allowing the dose rate to be adjusted. The chamber is about 200 mm diameter and 270 mm high, with a 194 x 215 mm thin walled aluminium canister held on a turntable.

An expert mission was implemented in October 2016 to provide assistance and training in dosimetry and dose mapping for the new irradiator. Four staff of IBD were trained as a follow-up to their recent fellowships in Bratislava, Slovakia and Seibersdorf, Austria. Dose mapping showed that the dose uniformity is poor (~2.45) in the total canister volume but this can be reduced to 1.2 by restricting the utilized volume as shown to just under 1 litre, leaving adequate capacity for the operational phase.



Dose map of the Foss 812 irradiator at IBD, Bobo-Dioulasso, Burkina Faso. The central dose was 100 Gy, with 10 Gy steps indicated by the colours. The red and blue rectangles indicate the approximate usable volume for a dose uniformity ratio of 1.4 and 1.2, respectively.

Implementing the Sterile Insect Technique in the Souss Valley (MOR5035)

As part of national project MOR5035, a workshop was conducted with plant protection officers from different regions of Morocco on establishment of a national early detection system against non-native fruit flies of quarantine significance (such as *Bactrocera dorsalis* and *B. zonata*) and on emergency response capability to the entry of such pests.

Plant protection officials from ONSSA (Office National de Sécurité Sanitaire des Produits Alimentaires) were trained at the workshop. These officials are directly supporting the project in different parts of the country, including the region of Agadir where commercial citrus production prevails and SIT integration is being expanded. Among the relevant topics was the use of a simple Excel model to assess pest risk at points of entry. The model will be used to determine higher risk points throughout the country requiring traps, as well as the trap densities recommended based on risk level.

Draft protocols on detection survey and emergency response were prepared and discussed together with workshop participants. These will be the basis for establishing the early detection trapping network and emergency response with an initial focus on male annihilation. ONSSA is now in a position to establish and maintain a national early detection system against invasive non-native fruit fly species as well as to react effectively to the entry of such a pest.

Participants of Workshop on "Surveillance systems against non-native fruit fly pests and emergency response capacity", Rabat, Morocco.

The following recommendations were drawn:

1. To establish and operate as soon as possible an early detection system against non-native fruit flies of quarantine significance based on the protocol developed for this purpose during the workshop;

2. To implement emergency response actions to invasive fruit fly species based on the protocol prepared for this purpose during the workshop;

3. To maintain a minimum stock of materials and equipment required to respond to an entry of an invasive fruit fly species.

The ONSSA has a well-equipped emergency response unit that provides coordination and logistic support to pests such as desert locust. This will greatly facilitate implementation of the emergency response required to eliminate a non-native fruit fly entry.

Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia (RAS5067)

National Coordinators Meeting (NCM) of Regional Project Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia

Twenty one NCM participants from 9 countries (China, Fiji, Indonesia, Lao P.D.R., Malaysia, Myanmar, Palau, Thailand and Vietnam), including the project counterparts participated in the meeting, held 14-19 August in Putrajaya, Malaysia.

The NCM was successfully conducted with the following achievements:

- The actual status of the fruit fly work in the 9 participating Member States and their progress made were presented.
- Successful networking through the discussion and exchange of experiences on fruit fly activities in the respective Member States.
- The 2016-2017 project workplan was revised and the upcoming project activities were planned, including group activities such as training courses and participation in the Area-wide Conference in Vienna in May 2017.
- The participants also benefitted from attending sessions of the TAAO meeting (Tephritid Workers of Asia, Australia and Oceania) and from interacting with presenters and other meeting participants.

Participants of the National Coordinators Meeting of Regional Project "Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia" in Putrajaya, Malaysia.

Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with Other Suppression Methods (RAF5074)

National Coordinators Meeting of Africa Regional Project Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with Other Suppression Methods

The First National Coordinators Meeting of this Africa regional fruit fly project RAF5074 took place from 25-29 July, 2016 in Maputo, Mozambique with 30 participants from 18 countries.

The objectives were (i) presenting experiences with fruit fly activities in the respective Member States; (ii) planning project activities, (iii) reviewing case studies on the successful integration of SIT and male annihilation technique (MAT) with other Tephritid fruit fly suppression techniques, and (iv) exploring opportunities for strengthening partnership on management of fruit flies in Africa.

Various external partners participated, including FAO, International Centre of Insect Physiology and Ecology (ICIPE), Royal Museum for Central Africa (RMCA) and USDA-APHIS, presented the various fruit fly control projects and activities ongoing in Africa.

The French Agricultural Research Centre for International Development (CIRAD) and Commission of the Economic Community of West African States of (ECOWAS) were not present but sent presentations to be shared with the participants.

Participants of the National Coordinators Meeting of Africa Regional Project "Enhancing Capacity for Detection, Surveillance and Suppression of Exotic and Established Fruit Fly Species through Integration of Sterile Insect Technique with Other Suppression Methods" (Maputo, Mozambique).

The project RAF5074 is expected to deliver the following outputs:

- Quarantine surveillance system (early warning system) for introduction of exotic fruit fly species.
- Increased awareness of exotic invasive fruit fly pests and improvements of quarantines for fruit flies.
- User friendly database (including GIS maps) containing information on species, host range, seasonal abundances, and geographic distributions.
- Increased technical capacity of national staff in the participating Member States on fruit fly identification, fruit fly management techniques and the development of quarantine treatments.

From all the presentations and discussions it was concluded that all the programmes / projects being implemented / sponsored by the various countries and international organizations should converge on one common expected outcome, namely: to better manage fruit flies of economic importance in order (a) to improve fruit and vegetable production in Africa for better nutrition and food security, as well as (b) to remove phytosanitary restrictions to international trade.

The meeting participants agreed that there is a need to coordinate all the different fruit fly control initiatives in the region to achieve more impacts.

Design of a Fruit Fly Mass-Rearing Facility in Mauritius

The Entomology Division, Agricultural Services, Ministry of Agro-Industry and Food Security of Mauritius has plans to reinforce their control campaigns against the main fruit flies pests, *Bactrocera cucurbitae* and *B. zonata*, by incorporating the sterile insect technique as main component of their integrated area-wide strategy.

Following a request of the Government of Mauritius, FAO/IAEA through regional project RAF5074 provided technical advice to design a small mass-rearing facility to produce 5 million sterile male melon flies per week by using a genetic sexing strain based on pupal colour dimorphism, and 10 million male and females per week of the peach fruit fly by using a standard bisexual strain.

The new facility was designed as a two storey building. Each floor was divided into two wings each of which will rear one of the target species. The ground floor will be dedicated to keeping all heavy rearing equipment, specifically larval and pupal racks and trays, mixer and extruder. The first floor will be dedicated to keeping light equipment like egging cages, filter system, quality control area, and offices. The layout of the facility is about 420 m^2 (28 x 15 m).

The facility will be constructed near the new irradiator so that both buildings can be interconnected to facilitate pupae irradiation and increase biosecurity for this mass-rearing facility.

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

Project Number	Ongoing CRPs	Scientific Secretary
D4.10.24	Use of Symbiotic Bacteria to Reduce Mass-rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application (2012-2017)	Carlos Cáceres
D4.20.15	Enhancing Vector Refractoriness to Trypanosome Infection (2013-2018)	Adly Abd Alla
D4.40.01	Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes (2013-2018)	Jeremie Gilles Kostas Bourtzis
D4.10.25	Dormancy Management to Enable Mass-rearing and Increase Efficacy of Sterile Insects and Natural Enemies (2014-2019)	Rui Cardoso Pereira
D4.20.16	Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies (2015-2020)	Kostas Bourtzis
D4.40.02	Mosquito Handling, Transport, Release and Male Trapping Methods (2015-2020)	Rafael Argiles Jeremie Gilles
D4.10.26	Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes (2016-2021)	Marc Vreysen
D4.30.03	Integration of the SIT with Biocontrol for Greenhouse Insect Pest Management (2017-2022)	Andrew Parker Carlos Cáceres

First RCM of the CRP on *Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes* (31 August–4 September 2016) and Workshop *to Standardise Sampling and Bioassay Methods for Assessing Field Performance of Sterile Male Lepidoptera*. (29-30 August 2016), Durban, South Africa

The South Africa Sugarcane Research Institute (SASRI) hosted this RCM and the related workshop that were attended by participants from Austria, Bangladesh, Canada, Chile, China, Guatemala, India, Israel, Mauritius, New Zealand, Syria, South Africa, Tunisia, and the USA.

During the workshop, the participants brainstormed on the various methods to assess quality of sterile male moths in the laboratory, semi-field settings and in the field. A literature review was initiated as a starting point to develop a document that will outline the detailed protocols or SOP's of these methods. During the workshop, a visit was organised to the *Eldana* moth rearing facility at SASRI, with special emphasis on quality control procedures.

Participants of the First RCM of the CRP on "Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes" (Durban, South Africa).

The first two days of the RCM, the participants made oral presentations and outlined their previous research activities and how these were aligned with the objectives of the Coordinated Research Project. In addition, they provided outlines of their research proposals for the next five years. For the last two days of the RCM, three working groups were established, i.e., (1) false codling moth, codling moth, and oriental fruit moth group, (2) *Lobesia botrana* group, and (3) sugar cane moths group, and within each group, the research proposals were discussed, refined and agreed upon. A field visit was

organised to Eston, where various farmers were visited who practised the "push – pull" strategy of *Eldana* control.

The RCM was very well organised by the local host, Des Conlong. The participants presented strong research proposals that will address a variety of research questions as defined by the consultants meeting. Several collaborative research activities were set up which will enhance the collaboration between the participants.

Third RCM of the CRP on *Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes*. 10-14 October 2016, Tapachula, Mexico

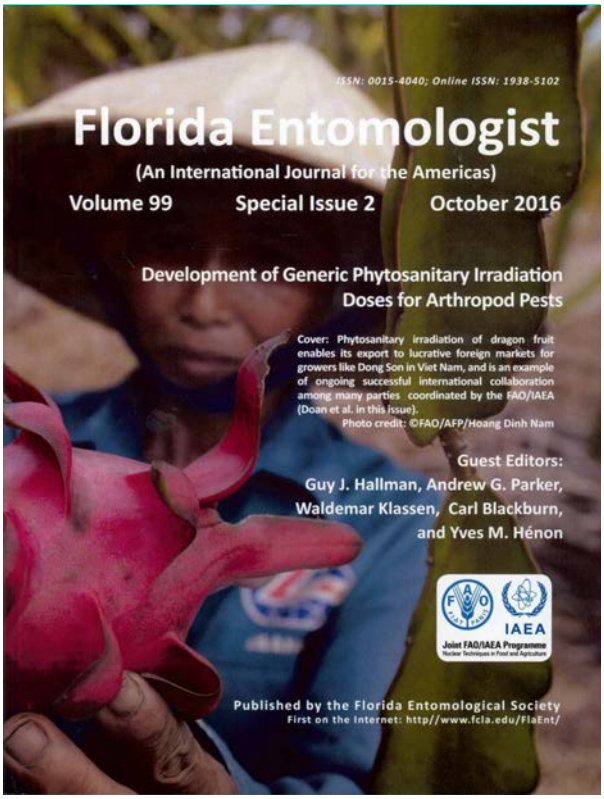
The Third Research Coordination Meeting was held at the Centro Regional de Investigación en Salud Pública (CRISP) and was attended by 17 scientists from Brazil, France, Germany, Italy, Pakistan, South Africa, Spain, Sri Lanka, United Kingdom and United States of America. In addition, eleven observers from Mexico, Spain and United States of America participated in this meeting.

Participants of the Third Research Coordination Meeting of the FAO/IAEA Coordinated Research Project "Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes" visiting Moscamed / Moscafrut facilities (Metapa, Mexico).

Twenty scientific papers on genetic, molecular, mechanical and behavioural methods of sex separation in mosquitoes were presented and reviewed. During the discussion it was concluded that the CRP has been very productive and extremely useful so far since first generation genetic sexing strains, using classical genetic or molecular approaches and new mechanical methods, have been developed. These allow the separation of females from males thus facilitating the application of sterile insect technique-based methods for the integrated control of mosquito vector populations. So far, the sex separation which can be accomplished with these methods is very efficient, but not perfect at certain scales, and achieving further improvements is the major challenge for the future.

Special Issue of the CRP on *Development of Generic Irradiation Doses for Quarantine Treatments*

This special issue of Florida Entomologist with 36 scientific papers presents the accomplishments of the 5 year Coordinated Research Project (CRP): "Development of Generic Irradiation Doses for Quarantine Treatments" that was jointly coordinated by two Subprogrammes of the Joint FAO/IAEA Division: Food and Environmental Protection, and Insect Pest Control. The overarching objective was to develop generic phytosanitary irradiation (PI) treatments for groups of regulated phytosanitary pest species. Generic treatments are applicable to whole groups of regulated pest species, although directly relevant research has been done on only a fraction of them.



Good research practices were instilled in the participants to avoid problems that occurred with previous research, such as inadequate dosimetry, use of artificial infestation techniques without comparison to real-world situations, poor performance by the non-irradiated controls, and lack of large-scale confirmatory testing.

New data was generated on 34 species in 10 families of insects, 3 families of mites and 1 family of snails. Several large-scale confirmatory tests were done supporting PI doses with the high degree of confidence necessary to gain regulatory approval of the treatments. Several new generic doses are supported by these articles, including generic doses for Lepidoptera (moths and butterflies), Pseudococcidae (mealybugs), and Curculionidae (weevils).

Developments at the Insect Pest Control Laboratory (IPCL)

INSECT GENETICS AND MOLECULAR BIOLOGY

Exploiting olive fruit fly and parasitoid gut microbiota for the enhancement of Integrated Pest Management (IPM) approaches with a Sterile Insect Technique (SIT) component

The olive fruit fly (*Bactrocera oleae*) is the major insect pest of commercial olives. The losses caused by this pest are substantial, often reaching 30% of total olive production. In contrast to polyphagous pests such as the Mediterranean fruit fly, *Ceratitis capitata,* which can infest several fruits, the olive fruit fly is specialized and lays its eggs only in ripe and unripe olives. In the fruit, the larvae are able to develop despite the bitter protective substances. There is strong evidence that this ability is achieved by a symbiosis with a bacterial species, *Erwinia dacicola*, living in specialized compartments of the fly's body. For more effective management of this pest, research at IPCL and in other laboratories has been targeted on developing the SIT. Past research efforts have shown that the olive fruit fly can be reared and sterilized by ionizing radiation, and during the 70s several SIT field tests were carried out in Mediterranean olive groves. Although the technique is promising, currently SIT cannot be sustainably applied against *B. oleae* because the mass-rearing is sub-optimal and not cost-effective.

Olive fruit fly, Bactrocera oleae.

In the framework of a European funded Marie Sklodowska Curie network called BINGO (Breeding Invertebrates for Next Generation biOcontrol: www.bingo-itn.eu), PhD student Erica Ras has initiated research efforts to characterize the olive fruit fly gut-associated microbiota. The hypothesis is that when olive fruit flies are taken into an artificial rearing environment, the natural gut microbial communities may change during domestication resulting in the loss of essential symbiotic bacteria such as the beneficial symbiont *Erwinia dacicola*. This could be one of the reasons why not enough olive fruit fly larvae and pupae are produced, despite growing on a very adjusted and relatively expensive diet. Therefore Ms Ras's research efforts attempt to unravel the microbial communities associated with wild flies in order to identify symbiotic bacterial species which could be used as probiotics, comparable to the yoghurt drinks which help to balance or restore gut flora in humans. Our hypothesis is that these bacteria can potentially improve fly quality and quantity and may also replace the expensive components of the diet in a similar way as in our Mediterranean fruit fly-related probiotic studies. In parallel, we are also trying to develop methods which can preserve the naturally associated bacterial species and particularly the major symbiont *Erwinia dacicola*. So far, our research data suggests that, in addition to *Erwinia dacicola*, wild olive fruit flies carry several bacterial species from the Enterobacteriaceae and Pseudomonadaceae families, and we are now looking for the best candidate to test as a probiotic larval diet supplement, initially at small scale rearing conditions.

Dissected gut from olive fruit fly.

In addition to research on the olive fruit fly microbiota, we are also researching its parasitoid wasps. Parasitoids, which target the larva and thus prevent emergence of the fly, are a popular control method for other fruit flies. They are very well applicable, especially in combination with the SIT. Olive fruit fly parasitoids are generally reared on Mediterranean fruit fly or other hosts because rearing them on olive fruit fly is too expensive to produce large numbers of wasps. So improving olive fruit fly rearing would not only benefit the SIT but could also be beneficial for parasitoid rearing thus enhancing IPM approaches. Alternatively, the parasitoids could perhaps be reared more efficiently and cost-effectively on Mediterranean fruit fly. Currently, we are trying to characterize the microbial communities associated with wild and laboratory-reared wasps to see if they also have potential beneficial bacterial species which might be important for their rearing. We have managed to rear wasps from wild olive fruit flies and later on we would like to test if they are performing well on Mediterranean fruit fly as a host, as well as on olive fruit lies reared with probiotics.

Parasitoid species associated with wild olive fruit flies collected in Greece.

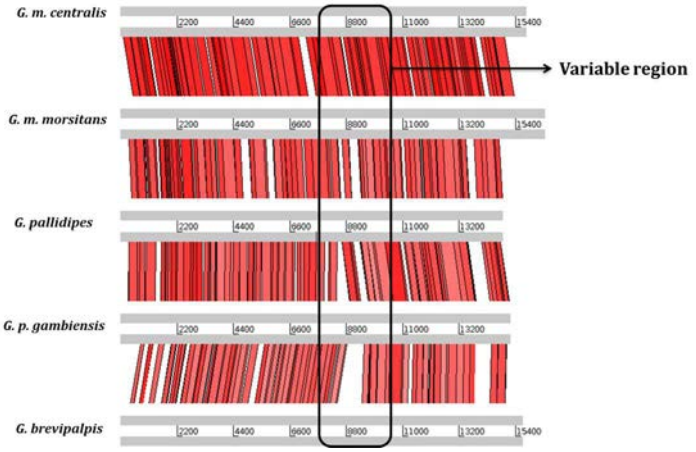
Identification of gut microbiota of tsetse flies and an assessment of their potential to enhance their competitiveness

Tsetse flies are competent vectors of African trypanosomes, parasites that cause a group of neglected tropical diseases that remain a serious problem in much of sub-Saharan Africa despite their decreased prevalence in humans in the last few decades. Tsetse flies harbour three symbiont bacteria (*Wigglesworthia glossinidia*, *Sodalis glossinidius*, and *Wolbachia pipientis*), gut microbiota and a pathogenic virus, i.e. the salivary gland hypertrophy virus (SGHV). The SIT has proven to be an effective method to eradicate isolated tsetse fly populations and involves irradiation-induced sexual sterilization of male flies. This procedure can potentially damage the gut epithelial cells and gut-inhabiting microbiota, and might reduce the sexual performance and competitiveness of the flies, thereby negatively impacting on the success and operational costs of the SIT. Given the beneficial traits conferred by the gut microbiota to their insect hosts, microbial amelioration can improve the quality of the sterile males used in SIT programs. To characterize the tsetse gut microbiota, Henry Kariithi from Kenya joined the IPCL to conduct this work. Both culture-dependent and independent methods will be used to identify cultivable tsetse gut microbiota and assess potential amelioration to improve the quality of sterile males.

Henry Kariithi characterizing tsetse gut microbiota.

Comparative mitochondrial genome analysis of seven *Glossina* species

Recently, several known molecular markers were used to identify different tsetse species. This involved integration of mitochondrial markers, nuclear marker (ITS1), microsatellite markers and *Wolbachia* infection status. In addition, sequencing of the mitochondrion (mtDNA) genome of tsetse species is an additional step to identify variable regions that can be used to distinguish between species and the sub-species from different geographical locations.



Syntenic map of mtDNA of different tsetse species.

The variable regions can be used to design microsatellite markers for identification of a specific species, sub-species or even haplotypes within a species. Therefore, the mtDNA sequences of different tsetse species are being analyzed by a visiting scientist from Kenya, Irene Meki. The mtDNA sequence of *G. pallidipes, G. m. morsitans, G. m. centralis, G. p. gambiensis, G. f. fuscipes, G. austeni* and *G. brevipalpis* has been completed. This has been followed by a

comparative analysis of the mtDNA of these seven species and identification of variable regions (see figure on previous page) that can be used to design microsatellite markers for the different species.

PLANT PESTS

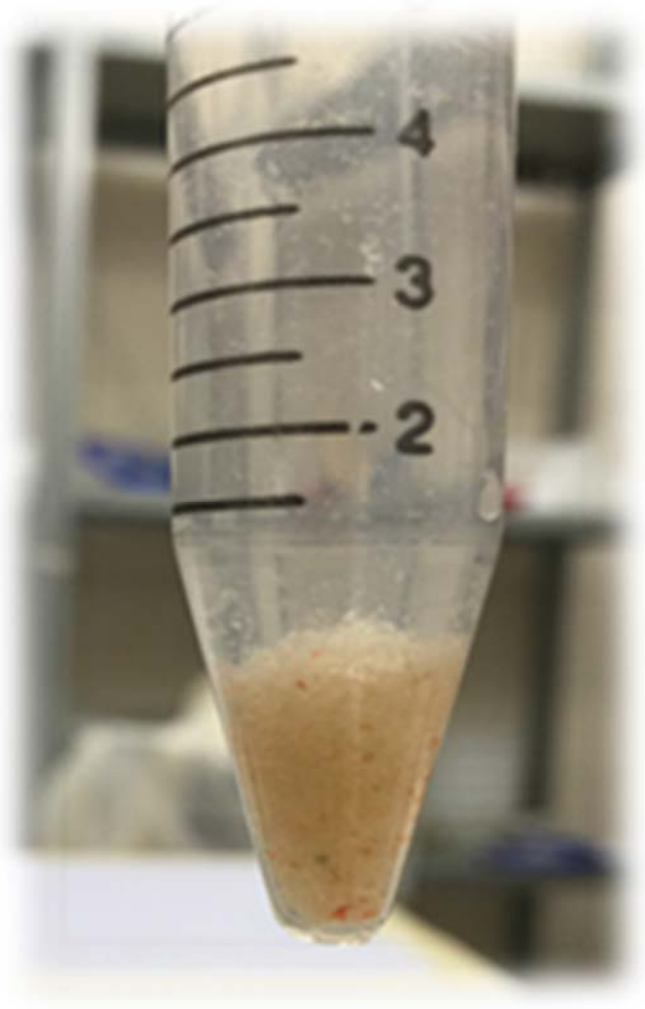
South American fruit fly

Anastrepha fraterculus is a pest that has a major impact on the economy in South America because it attacks several fruit commodities of economic importance in the region. It not only causes direct fruit damage but its presence also impedes trade between infested and non-infested countries due to phytosanitary regulations. Governments and farmers use integrated pest management to control *A. fraterculus* and the SIT could be an additional component to manage this pest on an area-wide basis. The SIT relies on the production and release of sterile males in the target area, but for several reasons, it has not been implemented yet to control *A. fraterculus*. Two visiting scientists, Salvador Meza (Mexico) and Silvana Caravantes (Guatemala), have been developing a genetic sexing strain (GSS) that is based on a pupal color dimorphism (brown-black). The sexing system was constructed by the induction of a reciprocal translocation between the Y chromosome and the autosome carrying the wild type locus of the black pupae (*bp*) gene. The GSS was constructed from a laboratory population of the *aff1*-morphotype, which implies that AW-IPM programmes with an SIT component can be implemented in an area that extends from southern Brazil to central Argentina. Several GSS lines are under evaluation to determine their production and quality control profile.

Phenothype of the Anastrepha fraterculus *GSS, Brown pupae and light normal body colour adult male, black pupae and black body adult female (photos by Salvador Meza).*

Drosophila suzukii

As reported previously, staff of the IPCL have been engaged as a partner in the SUZUKILL project (https://suzukill.univ-rennes1.fr/). One of the objectives of the project is to develop alternative and innovative biological control approaches such as the SIT to control this horticultural pest in greenhouses. Good progress was made with the development of an oviposition system for mass-rearing purposes that is based on a combination of a synthetic netting panel and an artificial larval diet. This system has allowed the production of large number of eggs and pupae which will also allow radiation studies and the development of irradiation protocols.



Sample of Drosophila suzukii *eggs collected in artificial substrate (photo by Gustavo Taret).*

Phytosanitary treatment research

This research is supported under the USDA/IAEA collaborative agreement "Development of phytosanitary treatments for exotic tephritid fruit flies". The overall objective is to develop broadly applicable phytosanitary treatments against fruit infesting tephritids using the tephritid resources available at the IPCL, as well as collaborations with other researchers and institutions worldwide.

Research comparing cold tolerance of populations of *Ceratitis capitata* from Argentina, Australia, and Spain was concluded and the late 3rd instar was found to be the most cold-tolerant for all three populations. In fact, resistance as measured in prevention of subsequent live 3rd instars generally increased as the immatures developed. The three populations did not differ significantly in cold tolerance. This information was used by the Technical Panel on Phytosanitary Treatments of the International Plant Protection Convention to conclude that cold phytosanitary treatments could be established without regard to *C. capitata* population origin and allows for many treatment proposals that had been languishing for lack of this information to move

forward. https://www.ippc.int/en/news/phytosanitary-treatments-on-fruit-fly-can-now-move-forward/

Results of research to develop a cold treatment against *Anastrepha grandis* is in press and has found that the 3rd instar is the most cold-tolerant stage and requires ~18 days at 1°C for a phytosanitary treatment. Before it could be used commercially this treatment would need to be confirmed by large-scale testing against at least 10,000 late 3rd instars with no survivors. This is the first documentation of successful phytosanitary treatment research against this important pest of cucurbits in South America.

Preliminary testing was done to determine tolerance of *A. grandis* to irradiation as a phytosanitary treatment. Although a generic phytosanitary irradiation dose of 150 Gy is accepted globally, a lower dose (70 Gy) has been proposed for the genus *Anastrepha* based on ample research with many economic species showing that ≤ 70 Gy is sufficient. No research had previously been done with *A. grandis*. Zucchini infested via oviposition to the late 3rd instar (most radiotolerant stage) was subjected to a dose range of 30-36 Gy with no adults emerging from a total of 170 3rd instars tested. Adult emergence from non-irradiated controls was 90%. This research demonstrates that *A. grandis* is not more radiotolerant than other species of the genus, supporting a dose of 70 Gy for the entire genus.

The development of broadly applicable vapour heat treatments is also hampered by the uncertainty over whether populations of the same tephritid species differ in heat tolerance. Toward that end, research comparing tolerance to vapour heat among 3 populations of *Bactrocera dorsalis* has been initiated.

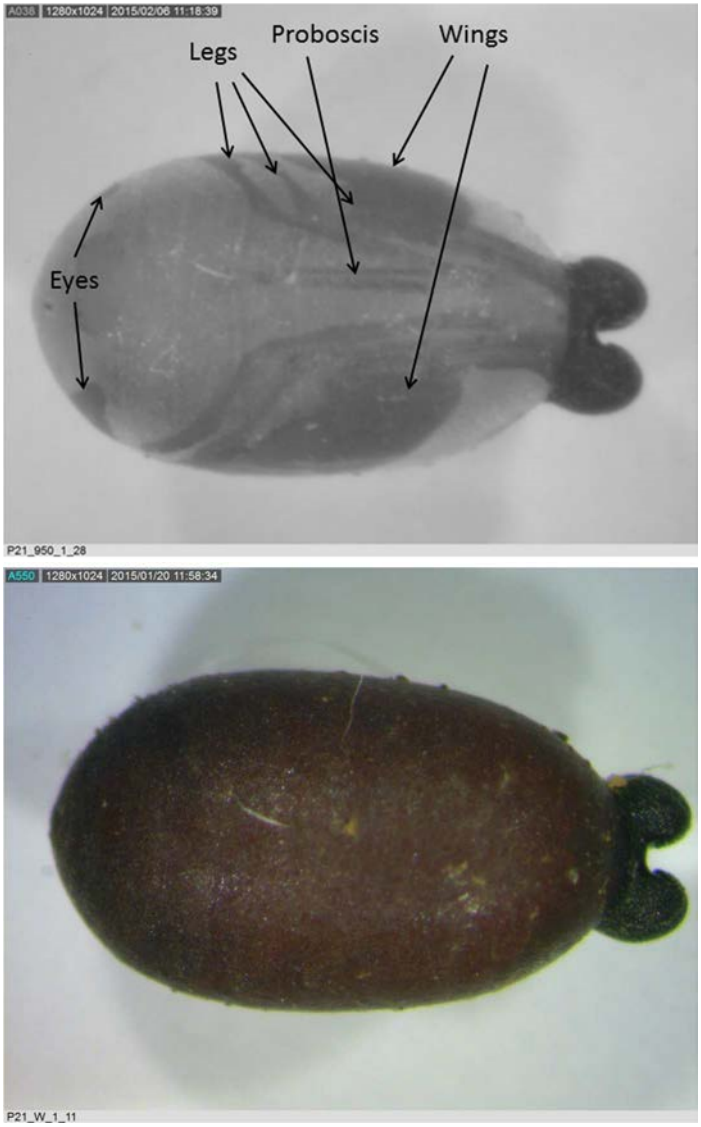
LIVESTOCK PESTS

Near-infrared imaging of tsetse pupal development

Following up on the work reported in Newsletter 85, work was continued on imaging tsetse fly pupal development inside the puparium using near-infrared (NIR) light. Using this technique it has been possible to record all the stages of development, and thus to understand better the processes involved in sorting pupae by sex using the various NIR sorting systems. The critical stage of development, where sorting is most efficient, corresponds to the time when the wings are melanising and becoming dark in the NIR images. But as the wings are wrapped around the ventral side of the abdomen in the pupae, they are only clearly visible in ventral view. A proportion of pupae, therefore, in passing through the NIR sorting systems are in the wrong orientation to produce a clear signal, explaining the poor consistency of the sorting systems.

Work is continuing on designing more efficient sorting systems, now looking mostly at transmitted instead of reflected light as this allows observation of the wing melanisation from most orientations.

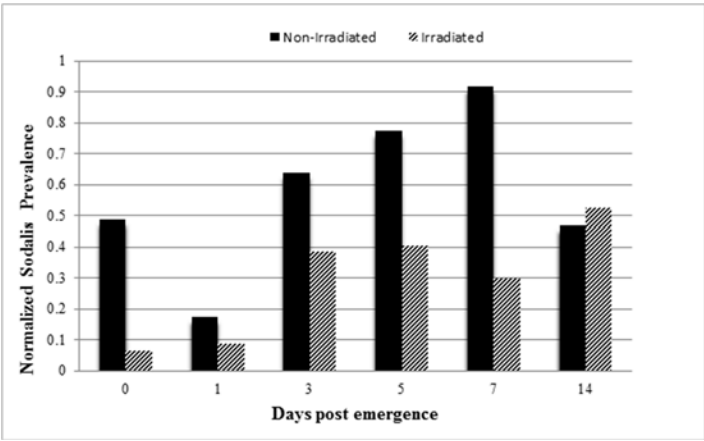
This work has recently been published in the Journal of Insect Science (doi:10.1093/jisesa/iew047), including a link to a time-lapse video of the full pupal development.



A 28-day old tsetse puparium in ventral view under 1060 nm NIR (upper) and white (lower) illumination to illustrate the internal structures that become visible.

Impact of irradiation treatment on tsetse symbionts

To minimize any potential risk that released sterile male tsetse flies might contribute in endemic sleeping sickness areas to increased disease incidence before achieving eradication, they are routinely fed on trypanocide-treated blood before release. However, the development of strategies to produce tsetse strains that are refractory to trypanosome infection is also desirable. One approach is to genetically modify *Sodalis* to produce anti-trypanosome factor(s) in the sterile males that are destined for release. Therefore, the impact of irradiation on *Sodalis* is being analyzed by a visiting scientist from Turkey, Güler Demirbas, and primary results indicate that irradiating male tsetse flies does not increase the mutation rate (SNPs) in the *Sodalis* genome.



Impact of irradiation treatment (110 Gy) of 22-days old G. m. morsitans *pupae on the prevalence of* Sodalis.

The irradiation, however, showed a negative impact on the multiplication of *Sodalis*. To avoid the negative impact of irradiation treatment on *Sodalis* multiplication, several irradiation doses and irradiation at different developmental times were tested and the results indicate that irradiation of 22-days old pupae of *G. m. morsitans* reduced the negative impact of irradiation on *Sodalis* prevalence (see figure). The impact of the irradiation at this developmental stage on the fly sterility is being investigated.

HUMAN DISEASE VECTORS

Impact of recycling of larval rearing water on inorganic chemical characteristics of rearing water and on development and quality of *Anopheles arabiensis* mosquitoes

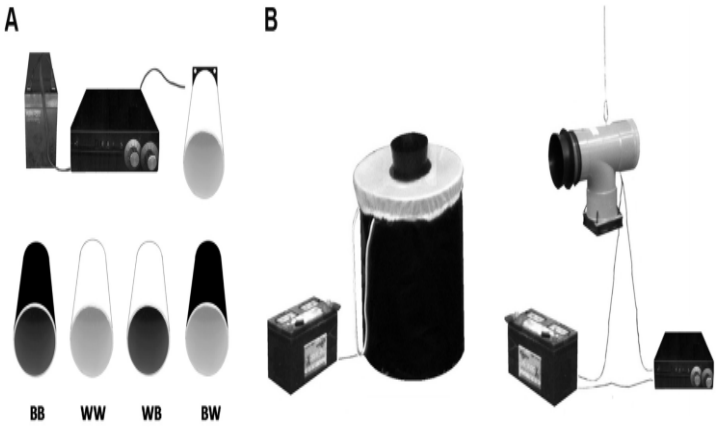
For the SIT and other vector control strategies relying on large-scale production of mosquitoes which includes an aquatic larval phase, the availability of sufficient water of constant and high quality is an essential requirement. Many countries where mosquitoes are endemic are located in arid zones where water provision can be costly or unreliable. The effect of using recycled larval rearing water on mosquito rearing and on the quality of resulting adults was assessed in *Anopheles arabiensis*.

The used rearing water ('dirty water') was collected after the tilting of rearing trays for collection of larvae/pupae after some separation events and was treated with ultrafiltration and reverse osmosis. The quality of a) clean, dechlorinated water, routinely used in rearing, b) dirty water, and c) 'recycled' dirty water treated with reverse osmosis and ultrafiltration was analyzed in terms of inorganic components. Dirty larval water was characterized by high concentrations of ammonium, sulfate, phosphate and lower dissolved oxygen concentrations. This dirty water negatively affected mosquito adult body size and longevity. The recycling process appears to improve water quality by reducing inorganic components and increasing the longevity of the reared adults. This experience has demonstrated that recycled rearing water is a valuable resource in rearing *An. arabiensis* mosquitoes and can effectively replace the clean dechlorinated water routinely used, if the right treatment regime is in place.

A sound trap for *Aedes albopictus* (Skuse) male surveillance: Response analysis to acoustic and visual stimuli.

The monitoring of the abundance, distribution, dispersal and ratio of released sterile and fertile wild males is a fundamental requirement for the successful management of any pest control programme integrating an SIT component. In an attempt to optimize *Ae. albopictus* male catches, we analyzed their response to various sound stimuli in association with visual cues.

The production of frequencies that lie within the typical female sound emission range (500–650 Hz) showed the best results at a volume between 75 and 79 dB and for 3-5 day old mosquito males. The outside black color of the trap (BB and BW) (see figure), however, seemed decisive to attract males in the vicinity of sound traps and the combined effect produced by colour and sound was additive.



Hand-made audio-oscillator with the speaker connected to a PVC plastic tube (A top) and the four different PVC plastic tubes (A bottom) employed in acoustical and visual tests (B=black, W=white). The black BG sentinel trap (B left) and the prototype sound trap model (B right) used in the field tests.

A plastic sound trap prototype that produced the most effective sound for attracting *Ae. albopictus* males was tested in the field in Mauritius (under the TC Project MAR5019). The use of sound and visual stimuli therefore appears to hold promise to increase the catch rate of *Ae. albopictus* males using new or already existing mosquito traps.

Reports

First Symposium of Tephritid Workers of Asia, Australia and Oceania (TAAO) 15-18 August 2016, Putrajaya, Malaysia

The first TAAO symposium, held from 15-18 August in Putrajaya, Malaysia, was successfully organized by University Putra Malaysia in cooperation with TAAO, FAO/IAEA and The World Academy of Sciences (TWAS). In total, 90 delegates from 23 countries participated in the meeting, including 12 student delegates, all presenting their work. The good turnout of delegates for this inaugural TAAO meeting clearly demonstrates the awareness and importance given by national governments, relevant national research institutions and international agencies to this group of economically-important insect pests.

Equally important to the success of this symposium was invaluable financial support made possible from FAO/IAEA, TWAS and several Australian agencies (Department of Agriculture and Water Resources, Australian Aid and Plant Biosecurity Cooperative Research Centre (PBCRC)). A fruit fly photography competition was held and the students' involvement was also recognized through presentation of book prizes (generously contributed by CABI and Mark Schutze) for best photograph, student poster and oral presenters.

Source: Alvin Hee, Universiti Putra Malaysia

Ninth Fruit Fly Meeting of the Western Hemisphere, 16-21 October 2016, Buenos Aires, Argentina

This regional fruit fly meeting was held in Buenos Aires, Argentina, from October 16 to 21, 2016 (see https://www.youtube.com/watch?v=99vOIyeVvnw&feature=share&noredirect=1. It was attended by 313 participants from 26 countries, including researchers from the scientific and academic field, plant protection officers from public agencies, fruit grower representatives and companies providing inputs and services.

The meeting was organized in 11 sessions with 63 oral presentations and 97 posters, ranging from aspects of biology, genetics and taxonomy to the impact of global change and action programs, including the development and use of technological tools as support in making decisions for monitoring, surveillance and control.

One innovation at this meeting was the session on "Political and socio-economic analysis of action programs", consisting of a panel discussion with representatives of the national plant protection agencies and regional organizations (OIRSA, NAPPO, CPHD, COSAVE and IICA). The discussion was focused on the cost-benefit analysis of area-wide IPM action programs, including those with a sterile insect technique component, the importance of public policies for pest control and the interaction and networking among countries to address common fruit fly problems. In addition, representatives of fruit producers and marketers presented their views on their needs and positive impact of fruit fly control programs.

All the topics presented were very interesting, generating much discussion and enriching exchanges between the participants. It is hoped that the new knowledge, technologies and innovations presented will contribute to the improvement of fruit fly management programs in our continent, with a view to increasing the production of healthy fresh fruit for national and international markets.

As a result of the regional meeting, a document was drafted that identifies recommendations that will serve as a reference for all those involved in the problem of fruit flies, and that will guide research and development on priority issues for the coming years. The final version of this document is available on the website of this regional event (http://9twwh.senasa.gob.ar/). In addition, this site includes the abstracts, the pdf version of the posters, and pictures of the 5 days shared by fruit fly workers, including those taken during the technical visits to the fruit production areas of San Pedro (province of Buenos Aires) and Monte Caseros (province of Corrientes).

The tenth Fruit Fly Meeting of the Western Hemisphere will be held in the year 2020. Delegates from Colombia, the Dominican Republic and the United States indicated the interest of their countries to host it. The decision of the next venue will be taken by the TWWH steering committee in 2018, after receiving the formal proposals. This committee was restructured and the new Regional President of the Tephritid Workers of the Western Hemisphere is Dr. Teresa Vera from Argentina.

Source: Pablo Liedo

International Congress of Entomology, 25-30 September 2016, Orlando, Florida, USA

The quadrennial meeting of the International Congress of Entomology took place in Orlando, Florida, USA 25-30 September 2016. There was much information of relevance to the FAO/IAEA in the areas of SIT and phytosanitation. Antony James delivered the Founders' Memorial Award lecture on Edward F. Knipling, winner of the World Food Prize (1992), the Japan Prize (1995), the FAO Medal for Agricultural Science (1991), the President's National Medal of Science (1967) and many other awards. See the video at: (https://www.youtube.com/watch?v=jvSWQ5n1ppg&feature=youtu.be).

At a symposium on regulatory plant protection, considerable interest was expressed in the research being done at the IPCL in Seibersdorf to solve broad international phytosanitary problems. A number of posters with data relevant to the development of phytosanitary irradiation treatments were displayed at different days throughout the week. A short meeting of the Phytosanitary Measures Research Group (PMRG), which collaborates with phytosanitary research done at Seibersdorf, was conducted to update progress and elicit more international collaboration in the group. The annual meeting of the Society for Regulatory Entomology, which discusses and promotes the work of regulatory entomology, including phytosanitation, also took place at the congress.

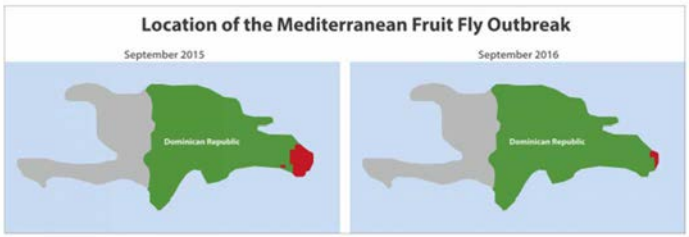
The session entitled "Innovative Strategies of Mosquito Control", organized and chaired by Stephen Dobson from MosquitoMate, provided a series of highly interesting talks on the recent developments and field trial results of the SIT-and related techniques including the *Wolbachia*-based Incompatible Insect Technique, and transgenic approaches. Much interest was expressed by attendants in the FAO/IAEA's presentation on recent developments on the combined SIT/IIT approach, and especially the improvements on mosquito mass rearing technology, which is relevant to all control approaches.

IPPC Technical Panel on Phytosanitary Treatments (TPPT), 29 August – 2 September 2016, Tokyo, Japan

During the 2016 meeting of the Technical Panel on Phytosanitary Treatments of the International Plant Protection Convention (IPPC) in Tokyo 29 August – 2 September, 2016 a total of 13 draft phytosanitary treatments were reviewed and all but one were recommended to the Standards Committee for inclusion in the International Standard Phytosanitary Treatments for Regulated Pests. Most of this progress was made possible after research completed at IPCL demonstrated no significant difference in cold tolerance among populations of Mediterranean fruit fly from 3 continents, thus allowing for global harmonization of the treatments. The inability to decide if all vapour heat treatments could be globally harmonized resulted in research on this issue being initiated at IPCL.

International Technical Advisory Committee Evaluates Mediterranean Fruit Fly Eradication Efforts in the Dominican Republic, 3-7 October 2016, Dominican Republic

As a follow-up to a first review conducted in January 2016, the international Technical Advisory Committee (TAC) met in the Dominican Republic from 3 to 7 October 2016. The aim was to evaluate the overall medfly situation in the country and in particular the eradication actions being conducted in Altagracia Province, located on the eastern side of the country. Eradication efforts have been conducted by the Ministry of Agriculture with the support of international organizations including the FAO, IAEA, IICA, OIRSA and USDA, after the country lost its horticultural export markets as a result of the outbreak. Country-wide surveillance was implemented, starting in March 2015, followed by containment, suppression and eradication actions using an area-wide integrated approach that included since late 2015 the aerial release of sterile males shipped from Guatemala.



The work conducted by the TAC included: (1) Meetings and discussions with the counterparts of the Ministry of Agriculture and programme stakeholders, (2) Review of surveillance and eradication components, and (3) Preparation of a list of recommendations to improve project implementation. In general terms, substantial progress in the medfly eradication campaign was observed. Currently eradication actions are being conducted over an area of 300 km^2 where some localized and isolated medfly outbreaks still remain. To be able to achieve complete eradication it will be necessary to optimize available resources and intensify eradication actions on the remaining medfly hot spots. It is prudent to be cautious about the projected time to achieve full eradication. This can only be done after absence of the pest is confirmed during the most favourable time of the year for the pest, which is from January to April, when abundant primary hosts are present including tropical almond and caya, a native fruit tree. The government of the Dominican Republic through the Ministry of Agriculture, is fully committed to eradicating the medfly and technical staff in the eradication campaign are very dedicated and well trained. In view of the good progress made and as a result of the success in confining the pest to eastern part of the country, USDA again opened its markets to most horti-

cultural products from the Dominican Republic. The support of international organizations and stakeholders to the eradication efforts has been and will continue to be important until the objective is achieved.

Technical Advisory Committee Members reviewing medfly eradication activities in the Dominican Republic.

FAO/IAEA Technical Advisory Committee (TAC) Reviews the Medfly Programme (PROCEM), 24-26 October 2016, Mendoza, Argentina

At the request of the Servicio Nacional de Sanidad y Calidad Agroalimentaria (SENASA) of the Ministry of Agriculture of Argentina, a FAO/IAEA Technical Advisory Committee visited the Province of Mendoza to review the Mediterranean Fruit Fly Control and Eradication Programme (PROCEM). Work done included: 1) Review of the overall programme strategy, 2) Review of mass-rearing and sterilization facility, 3) Sterile fly release systems, and 4) Surveillance systems based on trapping and fruit sampling. The medfly programme that has been operating in Mendoza Province since the 1990s, requires updating in a number of technical aspects of both the mass-rearing facility and field operations.

Technical Advisory Committee, SENASA and ISCAMEN Members during the programme review in Mendoza, Argentina.

This includes: Colony management and mass rearing procedures, upgrading the aerial sterile fly release system from paper bags to chilled adults, and improving the medfly trapping systems and strategy. A report with a comprehensive list of technical recommendations was prepared and delivered to SENASA. The report also presents more general recommendations addressing the entire National Fruit Fly Programme in Argentina, including a thorough review of the current fruit fly strategic plan and implementing benefit cost analyses to support decision making on the future strategies and objectives. The PROCEM Programme in Argentina has full support from the Central Government (SENASA) as well from the Instituto de Sanidad y Calidad Agropecuaria de Mendoza (ISCAMEN), which is the entity operating the programme. Stakeholders such as the fruit growers and exporters are also supportive of upgrading the medfly fly control and eradication programme.

43rd Session of the Committee on World Food Security, and Side Event "Stop Those Pests!", FAO, 17-18 October 2016, Rome, Italy

The side event, organized by the International Plant Protection Organization (IPPC) Secretariat and the Australian Department of Agriculture and Water Resources took place in conjunction with the "43rd Session of the Committee on World Food Security". It included a presentation on "Stop those fruit flies: *Bactrocera dorsalis*, *Bactrocera zonata* and *Ceratitis capitata*" as part of the session on "Plant health and food security in the Mediterranean and Near East" and was followed by a discussion panel.

The focus was on the risk that the established Mediterranean fruit fly (*Ceratitis capitata*) and the exotic Oriental fruit fly (*Bactrocera dorsalis*) and Peach fruit fly (*Bactrocera zonata*) present to the Mediterranean fruticulture. The risks include: (1) reduced quality of the fruits, (2) increased production costs, and (3) increased problems with international trade. In particular the exotic species present a serious threat to fruit trade and the necessity for quarantine measures. The effective inspection and detection systems deployed to allow early detection and rapid response to outbreaks are the most cost-effective strategies to prevent introduction and establishment of fruit flies into a pest free area. All those aspects can be mitigated by the application of the International Standards on Phytosanitary Measures (ISPMs) that have been adopted for fruit flies.

To demonstrate the paramount role of plant health to enhancing food security, improving nutrition and reducing poverty, during the side event a wide range of panelists explained how governments are being supported to focus on pest surveillance as a key activity to control outbreaks and avoid the spread of invasive pests. They shared experiences on national, regional and global levels of surveillance and demonstrated tools that may help stakeholders avoid or respond quickly to pest outbreaks.

International Conference 'Facing the Invasion of Alien Arthropods Species: Ecology, Modelling and Control of their Economic Impact and Public Health Implications', 7-9 November 2016, Trento, Italy

This conference, which addressed the introduction and spread of invasive alien species (IAS) into the territory of the Autonomous Province of Trento, was organized by the Laboratory of Excellence for Epidemiology and Modeling (LexEM). Scientists from around Italy and 13 other countries participated in the meeting. The program of the conference consisted of talks divided into ten sessions over a period of three days. Each day was opened by a keynote talk presented by a senior researcher. A total of 46 oral presentations were given throughout the duration of the conference. The complete book of abstracts can be downloaded at: http://events.unitn.it/sites/events.unitn.it/files/download/lexem2016/BoA_LExEM_2nov.pdf.

Drosophila suzukii *searching for sites to lay eggs.*

An optional guided tour to the Museum of Natural Sciences of Trento (Muse) took place on the last day.

Fabiana Sassu, PhD student at the University of Natural Resources and Life Sciences, Vienna (BOKU) and researcher at the FAO/IAEA Laboratories in Seibersdorf, presented a talk on "Development of the SIT to Manage Confined Populations of *Drosophila suzukii*", and described the main research work plan of the "SUZUKILL" project.

This project has as its main objective to develop and provide biological contributions to the integrated pest management of *Drosophila suzukii*. Among the goals of SUZUKILL project are to identify critical elements of cold tolerance to better control this trait and to assess the genetic changes that occur under laboratory colonization to enable and facilitate any future IIT and SIT application.

20th European Society for Vector Ecology Conference, 3-7 October 2016, Lisbon, Portugal

The 20th European Society for Vector Ecology (E-SOVE) Conference, held 3-7 October 2016 in Lisbon, Portugal focused on the impact and importance of vectors and vector-borne diseases in human environments and how to manage this interaction to improve public health. Different conference sessions dedicated to vector ecology, genetics and genomics of vectors and pathogens they transmit were addressed and discussed with active participation. A final assembly dedicated to advanced technologies on vector control was chaired by A. Crisanti from Imperial College UK and F. Balestrino from FAO/IAEA IPCL, Vienna.

The latest field and laboratory results obtained on the evaluation of methods and technologies for the application of the combined Sterile Insect Technique (SIT) / Incompatible Insect Technique (IIT) were discussed, showing evidence of increased and renewed interest towards the genetic control of mosquitoes for an effective integrated suppression of vector populations and pathogen transmission.

How a Nuclear Technique Helped Save the Western Cape's Orange Industry

Citrusdal, South Africa – Every morning at 7 a.m. a small airplane takes off to swoop around a fertile valley amidst the scenic mountains of Western Cape in South Africa, offloading its cargo of 1 000 000 ready-to-mate moths. The insects have been mass-reared and sterilized using equipment and a gamma irradiator donated by the IAEA in 2007. The result: citrus orchards free of the devastation of false codling moth in the Elephant's River Valley, and an industry, once on the brink of extinction, is now thriving again.

"In just five years the infestation is gone," says Martli Slabber, who grows oranges, clementines and lemons on her 100-hectare farm. "From two infested fruits per tree every week we are down to a single one in the entire orchard per season."

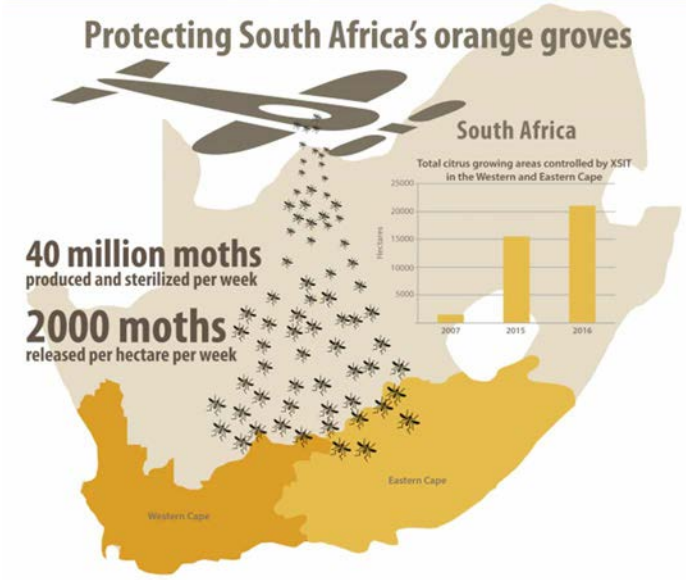
Citrus fruit is the second most important agricultural export commodity in South Africa, with most of the production destined for exports. The industry employs 10% of the country's agricultural labour force. (Photo: M. Gaspar/IAEA).

The suppression of the moth has saved the livelihoods of close to 10,000 people, adds grower Gerrit van der Merwe. "Without citrus, there would be no jobs here."

Slabber and van der Merwe are two of 400 citrus farmers who use the services of XSIT, a company owned by the Citrus Growers' Association, to deal with the false codling moth, which naturally resides in some parts of the country, including the Elephant's River Valley. The moths' larvae feed on citrus fruit, destroying the pulp.

XSIT — named after the nuclear-based sterile insect technique (SIT) — produces and releases 40 million sterile moths every week in an area of over 15 000 hectares in the provinces of Western and Eastern Cape. (See photo essay: https://www.iaea.org/newscenter/multimedia/photoessays/how-a-nuclear-technique-helped-save-the-orange-industry-in-western-cape-south-africa).

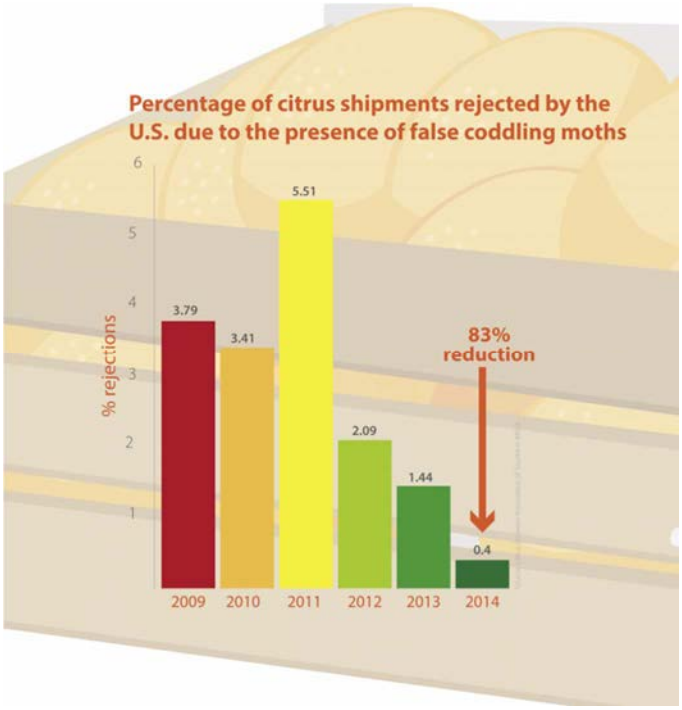
Fed on an optimized diet of maize, wheat germ and milk powder, they are irradiated and released when they are at the height of their sexual potential. The sterile moths mate with wild insects, but this mating does not produce any offspring, thereby diminishing the population over time.



"SIT has allowed us to go green and not use chemicals against the moth anymore," says Piet Smit, who produces 11 000 tons of citrus a year on 250 hectares of land. "We also no longer have problems with insecticide residue levels on the fruit." Thanks to the reduced use of chemicals, wild life has returned to the orchard, van der Merwe adds.

Citrus, the lifeblood of the region's economy: South Africa is the second largest exporter of fresh citrus fruit in the world, with exports worth over US $1.4 billion in 2014. Citrus is the country's second most important agricultural export commodity after wine. The industry employs 10% of South Africa's agricultural labour force.

Back in 2005, the main export market for the region's citrus fruit, the United States, tightened import quality and infestation reduction measures, as U.S. agriculture ties grew concerned about the spread of this moth pest to their country, potentially threatening citrus and cotton industries.



"We were in danger of closing down," van der Merwe says. "The old methods of using insecticides for moth control were no longer working." Farmers in the area used to lose between 10% and 15% of their production to the pests before harvest, but the real losses came from the pest-infested fruits that made it into shipments and were returned by U.S. inspectors. If they found just three larvae in a shipment of 160 000 oranges, they would return the entire consignment. "We were seriously considering alternative crops," Slabber recalls.

Public-private partnership for moth control: Following the success of the IAEA-supported SIT trial, the Citrus Growers' Association and the government co-founded XSIT in order to industrialize the use of the technique. As of last March, the association fully owns XSIT, which charges farmers for its services and runs on a fully commercial basis. The area it serves has increased more than ten-fold since 2007, and it has contracts in place to further expand to a total of 21 000 hectares. At that point, its rearing facility on the edge of Citrusdal will be operating at full capacity, and any further expansion will require a new extension of the factory, or setting up in a new location.

At XSIT, research is ongoing not only to further perfect the technique, but also to make it available in far flung areas of the country. The current method of producing sterile insects in Citrusdal and transporting them to other areas for release works well for neighbouring Eastern Cape, but it is not feasible for faraway provinces. XSIT's researchers, with support from the IAEA and FAO, are working on a technique that involves transporting the pupae, which would then be irradiated at another location in the north eastern part of the country.

XSIT has recently been contacted by growers of other fruits, increasingly infested by the false codling moth.

Source: Gaspar Miklos, OPIC-IAEA

Announcements

IAEA 60 Years *Atoms for Peace and Development*

Set up in 1957 as the world's centre for cooperation in the nuclear field, the International Atomic Energy Agency (IAEA) works with its Member States and multiple partners worldwide, especially in the developing world, to promote the safe, secure and peaceful use of nuclear technologies. In September 2016, the IAEA held its sixtieth regular session of the General Conference, and in recognition thereof, the Secretariat will commemorate its sixtieth anniversary throughout the coming year.

Nuclear technologies continue to provide competitive and often unique solutions to help fight hunger and malnutrition, combat plant and animal diseases and pests, improve agricultural productivity and environmental sustainability and ensure that food is safe. Since 1964, the IAEA and the Food and Agriculture Organization of the United Nations (FAO) have worked in partnership through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture to help Member States use these technologies. safely and appropriately. Throughout this time the programme of the Joint FAO/IAEA Division, with its unique laboratories at Seibersdorf, has continuously evolved to meet the world's changing needs.

In doing so, it has focused on expanding its ongoing contribution to agricultural development and global food security, and proactively embraced and added its expertise to efforts to adapt to and mitigate the effects of climate change, respond to globalization, conserve ecosystem services and broaden biodiversity. Today, it strives to mobilize commitment and concerted action towards meeting the Sustainable Development Goals of the United Nations through the appropriate integration of nuclear and related technologies for sustainable agriculture development and food security.

We take this opportunity to thank our numerous partners worldwide, whether institutions or individuals, for their dedication and continuous support to our mission since 1964.

Call for Submission of Research Proposals for a new FAO/IAEA Coordinated Research Project on Integration of the SIT with Biocontrol for Greenhouse Insect Pest Management

The importance of food production in greenhouses is growing and will become increasingly significant in developing countries in the future. Biological control has been developed very successfully for the control of many of the pests of greenhouses, but there are occasions when an outbreak of a particular pest gets out of control, necessitating the use of chemical pesticides to bring it back under control. The use of pesticides disrupts pollination and biocontrol, leaves residues in the produce and is potentially harmful to the workers.

Three groups of pests have been identified with the potential to disrupt biocontrol in greenhouses: the spotted wing drosophila, *Drosophila suzukii* (see page 19); the cutworms *Spodoptera* and *Helicoverpa*; and the solanaceous pests *Tuta absoluta* and *Neolucinoides elegantalis*. For some of these pests considerable relevant information is already available but the sterile insect technique (SIT) and inherited sterility (IS) have not been developed in greenhouses. For others there is less information available and the SIT and IS need to be developed.

The SIT has been used successfully against some key pest species and offers the possibility of controlling these outbreak pests without the need for chemical pesticides. A new CRP will, therefore, be implemented to investigate and develop the potential of SIT and IS for pest control in greenhouses. This will include:

- Identifying the pest likely to cause disruption to the biocontrol environment
- Identifying the constraints to the adoption of SIT and IS in greenhouses
- Collecting and generating data on rearing, diet, irradiation and utilization for the various potential targets
- Testing SIT and IS in large scale trials and under commercial growing conditions.

The expected duration of the CRP is 5 years (2017-2022) and the first Research Coordination Meeting is planned for **3-7 July 2017 in Vienna, Austria.**

Scientists and researchers who are interested in collaborating in this new CRP should contact Andrew Parker (a.parker@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 **28 February 2017** to Official.Mail@iaea.org.

Interregional Training Course on "The Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests", 31 July–25 August 2017, Metapa de Dominguez, Chiapas, Mexico and Antigua / El Pino, Guatemala

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 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 total populations of major pest insects, although management-intensive and logistically more complex, can contribute in most 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 April 2017).**

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.

Announcement of FAO/IAEA Regional Training Courses

- FAO/IAEA Regional Training Course on "Free Open Source Software for Geographic Information System (GIS) and Data Management Applied to Fruit Flies in Southeast Asia" (under Regional TC Project RAS5067). 6–10 March 2017, Bangkok, Thailand. (**Deadline for nominations: 15 January 2017).**
- FAO/IAEA Regional Training Course on "Non-native Fruit Flies of Quarantine Significance" (under Regional TC Project RAS5076). 3-7 April 2017, Amman, Jordan. **(Deadline for nominations: 31 January 2017).**
- Regional Training Course on "Mosquito Detection, Surveillance, Data Recording and Analysis for Area-Wide Integrated Mosquito Management in the European Area". (under Regional TC Project RER5022). 3–7 April 2017, Valencia, Spain. (**Deadline for nominations: 31 January 2017).**

- FAO/IAEA Regional Training Course on "Fruit fly Detection, Surveillance, and Databases and Data Analysis in Africa" (under Regional TC Project RAF5074). 24–28 July 2017, Nairobi, Kenya. **(Deadline for nominations: 30 April 2017).**
- FAO/IAEA Regional Training Course on "Quarantine and International Standards for Phytosanitary Measures for Fruit Flies in Southeast Asia" (under Regional TC Project RAS5067). 16–20 October 2017, Hanoi, Viet Nam. **(Deadline for nominations: 31 July 2017)**

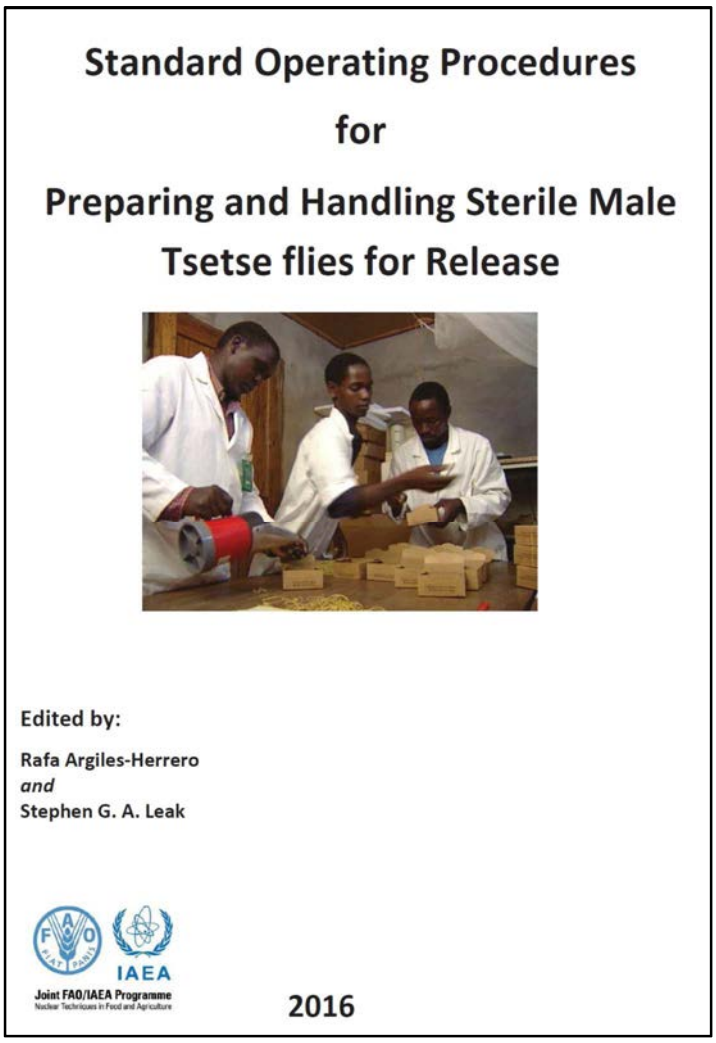
Application procedure: Nominations should be submitted on the standard IAEA application form for training courses/workshops (downloadable from: http://www-tc.iaea.org/tcweb/participion/astrainee/default.asp).

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 or email (official.mail@iaea. org) are welcome.

Standard Operation Procedures Manual for Preparing and Handling Sterile Male Tsetse Flies for Release

This manual describes the standard procedures involved in preparing tsetse flies reared and sterilized in a mass-rearing facility for release in the field when applying the SIT as a component of Area-wide Integrated Pest Management (AW-IPM) programmes. Following the procedures outlined will help to ensure that the released sterile male tsetse flies are of optimal quality. The manual can be downloaded at: http://www-naweb.iaea.org/nafa/ipc/SOP-sterile-male-tsetse-shipment-handling-release.pdf.



In Memoriam

Idrissa Kabore (1956-2016)

It is with great sadness that we have to announce that Mr Idrissa Kabore passed away on 16 October 2016 at the age of 60 after a short illness in a hospital in Ouagadougou, Burkina Faso. Idrissa is survived by his wife and 4 children.

Idrissa Kabore was born in 1956 in the village of Silmissin, Department of Komsilga, located in the centre of Burkina Faso in West Africa. He attended primary schools in Ouahigouya and Gaoua and secondary schools in Ouagadougou, where it was already apparent that he was a brilliant student. This allowed him to obtain a University Diploma in Biological Sciences from the University of Ouagadougou in 1978, and a diploma of "Engineer in Rural Development (Animal Production)" in 1982 from the same university.

In 1982, he started an assignment at the "Centre de Recherche sur les Trypanosomoses Animales" (CRTA), an institute that was amongst the pioneers in using the Sterile Insect Technique (SIT) against tsetse flies. Idrissa Kabore was instrumental in the development and maintenance of colonies of three species of tsetse flies, i.e. *Glossina palpalis gambiensis*, *Glossina tachinoides*, and *Glosssina morsitans submorsitans* that provided the sterile males for an SIT pilot project in Sidéradougou. Idrissa's contributions were key to the success of the project that culminated in 1983 in the eradication of populations of the 3 species from 3500 km^2 of agro-pastoral land. The project proved that the SIT was a valid and robust technology that could be integrated with other control tactics for the eradication of tsetse flies. After the CRTA was renamed "Centre International de Recherche-Développement sur l' Elevage en zone Sub-humide" (CIRDES), and for many years, Idrissa provided critical assistance to numerous scientists with their research on tsetse flies.

Between 2006 and 2014, he carried out several assignments as a consultant for the FAO/IAEA Insect Pest Control Laboratory (IPCL), where he conducted research on automated tsetse feeding and maintenance systems, and developed protocols for the long distance shipments of irradiated male tsetse pupae. The latter research was carried out in support of the tsetse eradication project in the Niayes of Senegal, and ensured that the project could be supplied with sterile male flies of good quality.

In 2014-2015, he was appointed "Chargé d'Etudes" of the General Secretariat of the Ministry of Animal Resources, in Burkina Faso and in 2016 the FAO/IAEA recruited him again to assist with the rearing of tsetse at the CIRDES, again in support of the tsetse eradication project in Senegal. The passing away of Idrissa Kabore is not only a great loss to the tsetse community, the CIRDES, the FAO/IAEA, and the farmer community in Africa, but also to all his friends and colleagues. We will greatly miss his friendship, kindness, knowledge on tsetse rearing and his sense of humour. May his soul rest in peace.

Dave Duman Chadee (1954-2016)

It is with great sadness that we report the passing away on 21 June 2016 of Professor Dave Chadee, 62, long-time friend of the Insect Pest Control Section, Professor of Environmental Health at the University of the West Indies (UWI), St. Augustine, and Adjunct Associate Professor both at the Department of Tropical Medicine, School of Public Health and Tropical Medicine, Tulane University, New Orleans and at the Department of Epidemiology and Public Health, University of Miami.

Dave's contribution to the field of mosquito control alone was prodigious, as a long-term member of the American Society of Tropical Medicine and Hygiene, the Royal Society of Tropical Medicine and Hygiene, Royal Entomological Society of London, the Society for Vector Ecology, and the American Mosquito Control Association, and as expert on panels for the World Health Organization (WHO) and the Pan American Health Organization (PAHO), as well as for the FAO/IAEA. His more than 250 papers and book chapters are testament to a research career spanning, among many other fields, the biology and control of insect vectors of disease, insecticide resistance mechanisms, novel management strategies and the impact of climate change on public health. In all his research work the focus was always on practical application, for example applying the great understanding of *Aedes* vectors in Trinidad and Tobago to reducing local transmission of dengue, chikungunya and recently Zika in the Caribbean. He also developed a PCR method for xenomonitoring for lymphatic filariasis, a pupal index for dengue epidemiology and control, and conducted invaluable field and laboratory studies into the periodicity and other elements of *Aedes* behavior, crucial to development of vector control programs with a Sterile Insect Technique component.

This work was recognized in many local and international awards, including an award from the Caribbean Public Health Agency (CARPHA) for his "Outstanding Contribution in the Area of Public Health including Vector Control" in 2015, and most recently the award for Most Outstanding International Research Project at the 2016 UWI-NGC Research Awards. This latter award was in recognition of a Special Issue of Acta Tropica, "Biology and behaviour of male mosquitoes in relation to new approaches to control disease transmitting mosquitoes", guest edited alongside colleagues from the Insect Pest Control (IPC) and resulting from an FAO/IAEA Coordinated Research Project which ran from 2007 to 2013 and in which Dave was a key participant. His involvement with the IPCL also included participation in Consultants Meetings on mosquito trapping and surveillance and on methods for sex separation in mosquitoes, and in numerous Technical Cooperation-supported workshops, most recently at an international experts' meeting to address the Zika outbreak in Brazil and a regional Asia workshop in China. Dave acted as supervisor and external examiner of PhD students, and has been a source of much support, advice and inspiration for the Human Disease Vectors group of the IPCL, since its start.

Anyone who met Dave will forever remember his lively presence in meetings, his enthusiasm and boundless ideas during group discussions, great sense of humor and generosity of time and encouragement. Our sympathies are with his wife Joan, family, friends and colleagues at UWI and worldwide

Other News

The New Fruit-Fly Mass-rearing Facility at Thailand Institute of Nuclear Technology

Located at the headquarter of Thailand Institute of Nuclear Technology in Nakhon Nayok, Thailand, the new facility is designed for mass-rearing of the oriental fruit fly, *Bactrocera dorsalis* (Hendel). Its maximum production capacity will be 100 million sterile flies per week. The building contains 4 adults rearing rooms, 4 larval rearing rooms, 4 pupal storage rooms, 1 quality control room and 1 irradiation room. Each room is temperature- and humidity–controlled, and light intensity can also be adjusted in the adult rearing rooms. Most of the equipment in this facility is modified from the Seibersdorf Laboratory designs including adult cages, larval rearing shelves, pupal separators, etc. The facility also houses a RadSource RS2400V X-irradiator with a capacity of 15 liters of pupae per round of irradiation.

Thailand Institute of Nuclear Technology new mass-rearing facility with the capacity of producing 100 million Oriental fruit flies per week.

The new facility is located adjacent to the old mass-rearing facility which will now be used for research and development focusing on genetic-marker strains as well as genetic-sexing strains of the Oriental fruit fly. The old facility is equipped with a BRIT GC-5000 gamma irradiator, which can be used in addition to the new X-irradiator.

Source: Kanokporn Boonsirichai, Thailand Institute of Nuclear Technology.

IPPC Technical Panel for Phytosanitary Treatments (TPPT) Annual Meeting

The Technical Panel for Phytosanitary Treatments (TPPT) annual meeting that took place from 29 August to 2 September 2016, reviewed scientific data from a recent study carried out by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture under the technical supervision of Mr Guy Hallman to understand if populations of *Ceratitis capitata* from different geographical regions of the world responded differently to phytosanitary cold treatments. Experts from some countries had concerns that cold treatment schedules developed in various geographical regions may set varying requirements. These concerns have delayed the international adoption of several standards (phytosanitary treatments) by the Commission on Phytosanitary Measures, which in turn slows down the international harmonization of cold treatments. The TPPT assessed the findings and concluded that the data clearly demonstrate that there is no evidence to support that there are significant differences in cold tolerance among populations of *C. capitata* from geographically separate regions. The TPPT noted that different methodologies in developing treatment schedules might result in different outcomes but that this does not provide evidence for variations in the responses to these cold treatments by different populations. This is ground breaking progress for the international harmonization of cold treatments, which is an important phytosanitary measure used worldwide to prevent the entry and spread of regulated pests and diseases.

Source: FAO-IPPC website at https://www.ippc.int/en/news/phytosanitary-treatments-on-fruit-fly-can-now-move-forward

Efficient Sex Separation in Mosquitoes Using Image Analysis and Elimination of Females by Laser Beams

The sterile insect technique is an increasingly important component of area-wide integrated vector management programmes for key insects such as mosquitoes. However, a critical bottleneck has been the lack of a system that could efficiently separate them by sex, as the females must be eliminated given that they are the vehicles for transmitting diseases to humans through their bites.

Nowadays, there are only artisanal mechanical methods of separation based on size dimorphism between male and female *Aedes* pupae that require much labour and increased efficiency to be able to reach the operational level at a large scale.

The Spanish public company TRAGSA, participating since 2013 in the FAO/IAEA Coordinated Research Project (CRP) *"Exploring Genetic, Molecular, Mechanical and Behavioral Methods of Sex Separation in Mosquitoes"*, has developed a system based on image analysis capable of separating the mosquitoes by sex and killing the females using a laser beam device.

By identifying and measuring the pupae of both sexes by artificial vision software, a laser beam is directed to the females to kill them. In this way, only the male *Aedes* mosquitoes survive and after their irradiation they can be released in the target areas. A prototype able to process a million male pupae per day has been developed.

The preliminary results are very promising as 99.7% of females were removed and the recovery of males of *Aedes albopictus* can reach up to 80%. These results are very satisfactory compared with those obtained by the current mechanical systems. Moreover the device is completely automatic, reducing the variability and the cost of the process considerably.

Currently TRAGSA in collaboration with the FAO/IAEA and CRP partners is working to further improve the system, to test its use for other *Aedes* species like *Ae. aegypti and Ae. Polynisiensis* as well as to deploy it in open field pilot trials.

Source: Ignacio Pla Mora and Carles Tur Lahiguera (TRAGSA)

Millions of Sterile Screwworm Flies Released and Counting

As Key deer deaths stemming from New World screwworms slow down, the number of sterile screwworm flies being released goes up on Big Pine Key and neighboring islands of the Florida Keys. Vessels containing sterile screwworm flies unable to produce the parasitic larvae have been placed in 25 wooded locations. Twice a week, 76,000 pods containing screwworm pupae are placed in each container.

Florida Commissioner of Agriculture Adam H. Putnam said Thursday morning at a release site on Big Pine that since Oct. 11, when the first release took place, 13 million flies have been released. The releases take place on Tuesdays and Thursdays, after the chambers have been cleaned and the empty pods left behind by the pupae are emptied.

In the wild, flies hatch from their casing in the ground, search for a mate and lay their eggs in the open wounds of warm-blooded animals. Then the maggots feed for five days, after which they fall to the ground and pupate, repeating the cycle. But the eggs resulting from sterile flies never hatch, as they have been sterilized with radiation. The sterile insect technique was created by the U.S. Department of Agriculture in the 1950s.

Screwworm flies have also been confirmed by entomologists with the U.S. Department of Agriculture on Summerland, Big Torch, Middle Torch, Little Torch, Cudjoe and Ramrod Keys. Chambers carrying sterile flies from the USDA breeding location in Panama have been placed in all locations. Putnam said he does not know how long it will take before the screwworms that feed on live tissue in warm-blooded animals are eradicated. Earlier in the month, he and other USDA officials said it could take six months.

The Key deer population was estimated at about 1,000 before the deaths and euthanizations of infected deer started. The deer, just 3 feet high, are found only in the Florida Keys and are on the Endangered Species List. Since the screwworm infestation was confirmed on Big Pine and No Name Keys on Sept. 30, 119 Key deer have had to be euthanized.

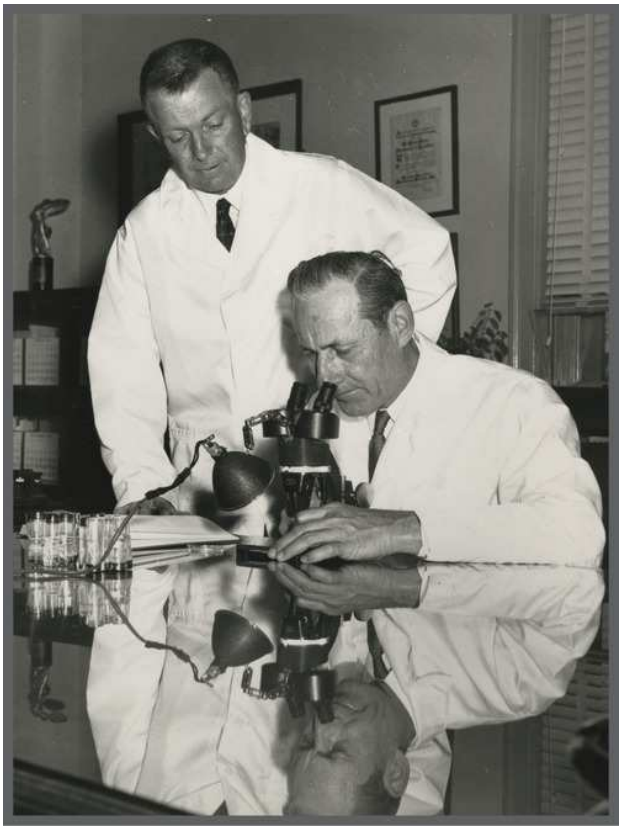
Officers and volunteers at the National Key Deer Refuge on Big Pine have been treating as many deer possible with doramectin, an antiparasitic medicine that serves as a preventive measure and treatment for screwworm. It has been helping, as the number of Key deer having to be euthanized has been dropping.

Kevin Lowry, chief public information officer with the U.S. Fish and Wildlife Service at the National Key Deer Refuge, said officials had been euthanizing multiple deer a day earlier in the month. Now, they are putting down between two and zero deer per day. Still, Lowry said residents are not reporting deer because they're afraid it will result in euthanization. "That couldn't be further from the truth. We want people to know that if there are early signs, those deer can be treated and the only reason we put them down is if we absolutely have to," Lowry said.

Source: www.flkeysnews.com (29 October 2016)

2016 Golden Goose Award: The Sex Life of the Screwworm Fly (Awardees: Edward F. Knipling and Raymond C. Bushland)

You just can't castrate enough flies" their colleagues said. Edward F. Knipling and Raymond C. Bushland, scientists with the USDA Agricultural Research Service, proposed their "Sterile Insect Technique" for pest control in the late 1930s to skepticism and even ridicule. But their work has since been called "the greatest entomological achievement of the 20th century."



Raymond C. Bushland (standing) and Edward F. Knipling (seated at microscope). Photo courtesy of World Food Prize Foundation.

In 1954, Knipling and Bushland carried out the first successful test of their technique, eradicating the screwworm fly from the small island of Curaçao. USDA, with help from State Governments and ranchers themselves, would go on to eradicate the pest throughout the USA by 1982, and in collaboration of Mexico and Central American Governments down to Panama by 2006, where today USDA together with the Panama Government helps maintain a barrier zone to prevent re-infestation from South America.

The eradication of the screwworm fly in North and Central America is estimated to have saved livestock producers and consumers billions of dollars over the past half century. And Knipling's and Bushland's Sterile Insect Technique continues to inform ongoing fights against disease vector and agricultural pests including various species of mosquitos, moths, fruit flies, and tsetse flies.

Source: USDA (22 June 2016)

Why Scientists are Rearing Bird-Killing Parasites on Chicken Blood

Raising maggots may not sound glamorous, but that doesn't mean it's not important. In the latest issue of the Journal of Insect Science, Paola Lahuatte, a junior researcher at the Charles Darwin Foundation for the Galapagos Islands, and her colleagues reveal how they used chicken blood to rear the larvae of the parasitic fly *Philornis downsi* in the laboratory. This protocol may be the first to effectively rear an avian blood-feeding fly from egg to adult in the absence of its host. More importantly, it may prove to be a crucial tool in the fight to save endemic birds in the Galapagos islands, including the critically endangered mangrove finch.

Adult *P. downsi* feed on fruit, but as larvae they parasitize baby birds, usually small songbirds. The female fly lays its eggs in bird nests. Once hatched, first-instar larvae crawl into the nostrils of the nestling birds, where they feed on both blood and tissue. Larger, second-instar larvae leave the confined space of the nostrils and hide out in nest material during the day. They come out at night to continue feeding on the chicks. *P. downsi* infestation takes a serious toll on nestlings. In some cases, all of the young in an infested nest are killed by the parasites.

This is a medium ground finch (Geospiza fortis) nestling that was killed by Philornis downsi *larvae. Damage due to parasitism is visible at the nestling's nostril (Photo by P. Lahuatte).*

P. downsi is not native to the Galapagos Islands. The species was likely introduced accidentally in the 1960s via imported fruit and has since wreaked havoc on the islands' endemic bird populations. Parasitism is the leading cause of nestling mortality for at least one species of Darwin's finch, and some believe it is the main cause of decline of landbirds in the Galapagos Islands.

One method that has been proposed to control *P. downsi* is the "sterile insect technique" or SIT. This method produces large numbers of artificially sterilized insects (usually males) that are released into the wild population. Females that mate with sterile males produce no offspring, thus re-

ducing the size of the next generation. SIT has been used to successfully eradicate populations of screwworm flies and has been useful in the control of certain species of fruit fly and moth pests.

However, the ability to rear large numbers of flies in the laboratory is essential for this technique, which is difficult with *P. downsi* because it would require raising large numbers of songbirds for them to feed on. Keeping captive songbirds in the laboratory to play host to these lethal parasites would not only be cruel, but also logistically difficult.

The chicken-blood diet developed by Lahuatte and her colleagues may be the first major step in making SIT control of *P. downsi* conceivable because it would make possible the rearing of large numbers of flies without songbird hosts.

Source: Entomological Society of America (4 August 2016)

Fruit fly outbreak cost growers $4.1 million; could have been much worse

University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS) economists estimate the Oriental fruit fly outbreak last year caused at least $4.1 million in direct crop damages in Miami-Dade County, but the damage could have been far worse, UF/IFAS researchers say.

In the new report, UF/IFAS researchers and the chief economist for the Florida Department of Agriculture and Consumer Services (FDACS), compiled three scenarios for crop losses: optimistic, mid-range and pessimistic. So, although the optimistic scenario reports direct crop damage at $4.1 million, the pessimistic one shows that the loss could have been $23 million.

Edward "Gilly" Evans, a UF/IFAS Professor of food and resource economics, said the $4.1 million loss that he and his colleagues estimated was a conservative one and does not reflect the full economic impact on the economy due to the multiplier effect. In addition to these costs, approximately $1.5 million was spent by state and local agencies in a joint effort to control the outbreak.

The direct crop losses came as a result of the quarantine protocol and a potential non-planting response by growers in Miami-Dade County. But UF/IFAS faculty credit quick, decisive actions by FDACS, UF/IFAS and the U.S. Department of Agriculture for limiting the reach of the fruit fly. Among other things, the UF/IFAS Tropical Research and Education Center provided logistics, acting as the hub for the entire operation, Evans said.

"Although there was certainly a cost to growers in the regulated area, all of Florida agriculture would have been negatively impacted if the pest had expanded its reach," said Amanda Hodges, Associate Extension Scientist in the UF/IFAS Entomology Department. "Other states and countries would have stopped outgoing shipments of Florida's agricultural products. At the very least, this pest would have cost millions if not billions of dollars if it had made a home here.

"Although many insects and diseases will not result in an eradication program, fruit flies generally will," said Hodges, director of the UF/IFAS doctor of plant medicine program. "In fact, the state of Florida and the USDA have personnel who monitor fruit flies throughout the year. The state of Florida and USDA are the lead agencies for eradication programs in Florida, and fruit fly eradication efforts here are among the most successful in the world."

In addition to the crop loss, the new UF/IFAS report says the fruit fly outbreak caused between $10.7 million and $58.5 million in overall economic losses. Evans, a faculty member at the UF/IFAS Tropical Research and Education Center, in Homestead, Florida, outlines the findings in this new extension document, http://bit.ly/28KHfcA.

Here's how the damage occurs. The fruit fly feeds on more than 400 crops, including many grown in Florida. Once established, the insect may cause 25 to 50 % losses in food-crop harvests. In August 2015, fruit flies began to appear in south Miami-Dade County monitoring traps, prompting FDACS to impose a temporary quarantine on 99 square miles that include an agriculture-dependent area known as The Redland. Altogether, the county's agricultural activities generate $1.6 billion in revenues each year.

UF/IFAS economists estimate the Oriental fruit fly outbreak last year caused at least $4.1 million in direct crop damages in Miami-Dade County, but the damage could have been far worse (Photo: Scott Bauer).

Blair Siegfried, Professor and Chair of the UF/IFAS Entomology Department, said there is little anyone can do to prevent another outbreak other than to be vigilant in detection efforts and prepare for an outbreak if it's detected. "Each potential invading species has a unique set of circumstances related to the pest biology and the environment where it is detected," Siegfried said. "In some cases, eradication may be possible, while in others, learning to manage the pest may be the best we can do."

Source: IFAS News: http://news.ifas.ufl.edu (5 July 2016)

Relevant Published Articles

Acceptability and suitability of *Tuta absoluta* eggs from irradiated parents to parasitism by *Trichogramma nerudai* and *Trichogramma pretiosum* (Hymenoptera: Trichogrammatidae)

Cynthia L. Cagnotti[1], Carmen M. Hernández[1], Andrea V. Andormo[1], Mariana Viscarret[1], María Riquelme[2], Eduardo N. Botto[1] and Silvia N. López[1]

[1]*Insectario de Investigaciones para Lucha Biológica-IMYZA-CNIA-INTA, Castelar, Buenos Aires, Argentina.*

[2]*Department of Zoology, Laboratorio de Zoología Agrícola, Universidad Nacional de Luján, Luján, Buenos Aires, Argentina.*

Abstract

1. *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the most devastating pests of tomato crops. We studied the acceptability and suitability of eggs laid by irradiated *T. absoluta* pairs to parasitism by the parasitoids *Trichogramma nerudai* and *Trichogramma pretiosum*.

2. *Trichogramma absoluta* pupae were irradiated with X-radiation (20834 R) and the emerged adults were separated into couples according to the crosses: ♂U × ♀U, ♂I × ♀U, ♂U × ♀I (where 'U' is untreated and 'I' is irradiated). In a no-choice experiment, 40 eggs from each cross were exposed to a female parasitoid for 24 h.

3. All *T. absoluta* eggs were accepted for oviposition by *T. nerudai* and were suitable for its development. However, eggs from irradiated females were significantly less parasitized than those from untreated females. *Trichogramma pretiosum* showed low parasitism on eggs from all crosses. In a choice experiment, both *T. nerudai* and *T. pretiosum* showed no differences in the parasitism of eggs from irradiated (n=40) and non-irradiated female moths (n=40).

4. These results indicate that eggs laid by irradiated parents were acceptable for oviposition and suitable for the development of these parasitoids, and also support the idea that the inherited sterility technique could be used in an integrated approach with egg parasitoids to control *T. absoluta*.

Keywords: Biological control, egg parasitoid, inherited sterility, natural enemies,tomato leafminer, X rays.

The full paper was published in: Agricultural and Forest Entomology (2016), 18, 198–205.

Sterilization of *Hulecoeteomyia japonica japonica* (=*Aedes japonicus japonicus*) (Theobald, 1901) by high-energy photon irradiation: implications for a sterile insect technique approach in Europe

F. Balestrino[1,2] A. Mathis[1], S. Lang[3] and E. Veronesi[1]

[1]*National Centre for Vector Entomology, Institute of Parasitology, Faculty of Veterinary Science (Vetsuisse), University of Zurich, Switzerland.*

[2]*Vector Biology and Control Division, Ministry of Health and Quality of Life, Curepipe, Mauritius.*

[3]*Radiation Oncology Clinic, University Hospital, Zurich, Switzerland.*

Abstract

Hulecoeteomyia japonica japonica (=*Aedes japonicus japonicus*) (Diptera: Culicidae) (Theobald 1901), a container-breeding invasive species in North America and Europe, is attracting particular attention for its high local abundances and possible roles in the transmission of human and animal pathogens. The preferential habitats of this species are forested and bushy areas, which renders control measures extremely inefficient.

Use of the sterile insect technique (SIT) may contribute to the implementation of area-wide integrated pestmanagement strategies, as has been successfully proven with other aedine mosquito species. The present study investigates the effects of irradiation at a dose of 40 Gy on fitness parameters in *H. j. japonica*. Irradiation was performed on 16–24-h-old pupae from a colonized strain (PA) using a True-Beam linear accelerator.

Males from the PA strain were crossed with females of the same colony or with field-collected females. Irradiation induced a slight increase in mortality in male pupae, but did not alter the survival and mating abilities of emerging adult males. Rates of blood feeding and fertility were lower when PA strain males were kept with field-collected females rather than PA females. Irradiated males induced reductions in fertility (residual fertility: 2.6%) and fecundity in mated females. The data indicate that the SIT is a suitable technique to enhance the control of this species.

Keywords: Colonization, fitness, genetic control, mating competitiveness, strain inbreeding, vector control.

The full paper was published in: Medical and Veterinary Entomology (2016) 30, 278–285.

Papers in Peer Reviewed Journals

In Press

BAKRI, A., J. REYES, R. PEREIRA and J. HENDRICHS. How can we better communicate among fruit fly fans? Proceedings of the 9th International Symposium on Fruit Flies of Economic Importance (in press).

BJELIŠ, M., L. POPOVIČ, M. KIRIDZIJA, G. ORTIZ and R. PEREIRA. Suppression of Mediterranean fruit fly using the Sterile Insect Technique in Neretva River Valley of Croatia. Proceedings of the 9th International Symposium on Fruit Flies of Economic Importance (in press).

DOHINO, T., G.J. HALLMAN, T.G. GROUT, A.R. CLARKE, R. PEREIRA et al. Phytosanitary treatments against *Bactrocera dorsalis* (Diptera: Tephritidae): Current situation and future prospects. Journal of Economic Entomology (in press).

ENKERLIN, W., P. RENDÓN, A. VILLASEÑOR, Á. VALLE and R.CASTAÑEDA. Integrating bait stations as an IPM component in area-wide fruit fly operational programmes. Proceedings of the 9th International Symposium on Fruit Flies of Economic Importance (in press).

ENKERLIN, W., A. VILLASEÑOR, S. FLORES, D. MIDGARDEN, E. LIRA et al. Descriptive analysis of the factors affecting population fluctuation of the Mediterranean fruit fly (*Ceratitis capitata* Wied.) in coffee areas located in Guatemala and its implications in IPM Strategies. Proceedings of the 9th International Symposium on Fruit Flies of Economic Importance (in press).

HALLMAN, G.J. Process control in phytosanitary irradiation of fresh fruits and vegetables as a model for other phytosanitary treatment processes. Food Control (in press).

HALLMAN, G.J., E.I. CANCIO MARTÍNEZ, C.E. CÁCERES, M.J.B. VREYSEN, V. WORNOAYPORN et al. Phytosanitary cold treatment against *Anastrepha grandis* (Macquart) (Diptera: Tephritidae). Florida Entomologist (in press).

KHANH. L.D., L.Q. KHAI, N.T.T, HIEN, V.V. THANH, R. PEREIRA et al. Area-wide suppression of *Bactrocera* fruit flies in dragon fruit orchards in Binh Thuan, Viet Nam. Proceedings of the 9th International Symposium on Fruit Flies of Economic Importance (in press).

MCINNIS, D.O., J. HENDRICHS, T. SHELLY, N. BARR, W. ENKERLIN et al. Can polyphagous invasive tephritid pest populations escape detection for years under favorable climatic and host conditions? American Entomologist (in press).

MYERS, S.M., E. CANCIO-MARTINEZ, G.J. HALLMAN, E.A. FONTENOT and M.J.B. VREYSEN. Relative tolerance of six *Bactrocera* (Diptera: Tephritidae) species to phytosanitary cold treatment. Journal of Economic Entomology (in press).

SUCKLING, D.M., J. E. CARPENTER, D. CONLONG, P. RENDON, M.J.B. VREYSEN et al. Global range expansion of pest Lepidoptera requires socially acceptable solutions. Biological Invasions (in press).

2016

ABD-ALLA, A.M., H.M. KARIITHI, F. COUSSERANS, A.G. PARKER, M.J.B. VREYSEN et al. (2016). Comprehensive annotation of the *Glossina pallidipes* salivary gland hypertrophy virus from Ethiopian tsetse flies: A proteogenomics approach. Journal of General Virology 97:1010-1031.

AHMAD, S., I.U. HAQ, P. REMPOULAKIS, C. CÁCERES, M.J.B. VREYSEN et al. (2016). Artificial rearing of the olive fruit fly *Bactrocera oleae* (Rossi) (Diptera: Tephritidae) for use in the Sterile Insect Technique: improvements of the egg collection system. International Journal of Industrial Entomology 33(1):15-23.

AUGUSTINOS, A.A., I. UL HAQ, C. CACERES, K. BOURTZIS A.M. ABD-ALLA et al. (2016). Cryopreservation of embryos of the Mediterranean fruit fly *Ceratitis capitata* Vienna 8 genetic sexing strain. PLoS One 11(8):e0160232.

BALESTRINO, F., F. SCHAFFNER, D.L. FORGIA, A.I. PASLARU, P.R. TORGERSON et al (2016). Field evaluation of baited traps for surveillance of *Aedes japonicus japonicus* in Switzerland. Medical and Veterinary Entomology 30(1):64-72.

BALESTRINO, F., A. MATHIS, S. LANGS and E. VERONESI (2016). Sterilization of *Hulecoeteomyia japonica japonica* (= *Aedes japonicus japonicus*) (Theobald, 1901) by high-energy photon irradiation: implications for a sterile insect technique approach in Europe. Medical and Veterinary Entomology 30:278-285.

BALESTRINO, F., D.P. IYALOO, K.B. ELAHEE, A. BHEECARRY, F. CAMPEDELLI et al. (2016). A sound trap for *Aedes albopictus* (Skuse) male surveillance: Response analysis to acoustic and visual stimuli. Acta Tropica 164:448-454.

BARCLAY, H.J., R. STEACY, W. ENKERLIN and P. VAN DEN DRIESSCHE (2016). Modeling diffusive movement of sterile insects released along aerial flight lines. International Journal of Pest Management. 62(3): 228-244.

BOURTZIS, K., R.S. LEES, J. HENDRICHS and M.J.B. VREYSEN (2016). More than one rabbit out of the hat: Radiation, transgenic and symbiont-based approaches for sustainable management of mosquito and tsetse fly populations. Acta Tropica 157:115-130.

BOUYER, J., F. CHANDRE, J. GILLES and T. BALDET (2016). Alternative vector control methods to manage the Zika virus outbreak: more haste, less speed. The Lancet. Global health 4(6):e364.

DE BEER, C.J., G.J. VENTER, K. KAPPMEIER GREEN, J. ESTERHUIZEN, M.J.B. VREYSEN et al. (2016). An update of the tsetse fly (Diptera: Glossinidae) distribution and African animal trypanosomosis prevalence in north-eastern KwaZulu-Natal, South Africa. Onderstepoort Journal of Veterinary Research 83(1):a1172.

DOGAN, M., F. GUNAY, A. PUGGIOLI, F. BALESTRINO, C. ONCU et al. (2016). Establishment of a satellite rearing facility to support the release of sterile *Aedes albopictus* males. I. Optimization of mass rearing parameters. Acta Tropica 159:62-68.

FLORES, S., P. MONTOYA, L. RUIZ-MONTOYA, A. VILLASEÑOR, W. ENKERLIN et al. (2016). Population fluctuation of *Ceratitis capitata* (Diptera: Tephritidae) as a function of altitude in eastern Guatemala. Environmental Entomology 45(4):802-811.

GARIOU-PAPALEXIOU, A., M.C. GIARDINI, A.A. AUGUSTINOS, C. CACERES, K. BOURTZIS et al. (2016). Cytogenetic analysis of the South American fruit fly *Anastrepha fraterculus* (Diptera:Tephritidae) species complex: Construction of detailed photographic polytene chromosome maps of the Argentinian *Af. sp.1* member. PLoS One 11(6):e0157192.

HALLMAN, G.J. (2016). Phytosanitary irradiation of the invasive herbivorous terrestrial snail *Cornu aspersum* (Stylommatophora: Helicidae). Florida Entomologist 99(S2):156-158.

HALLMAN, G.J. (2016). Phytosanitary irradiation of *Heliothis virescens* and *Helicoverpa zea* (Lepidoptera: Noctuidae). Florida Entomologist 99(S2):178-181.

HALLMAN, G.J. (2016). Generic phytosanitary irradiation treatment for "true weevils" (Coleoptera: Curculionidae) infesting fresh commodities. Florida Entomologist 99(S2):197-201.

HALLMAN, G.J. (2016). Generic phytosanitary irradiation dose of 300 Gy for the Insecta excluding pupal and adult Lepidoptera. Florida Entomologist 99(S2):206-210.

HALLMAN, G.J. and C.M. BLACKBURN (2016). Phytosanitary irradiation. Foods 5:8.

HALLMAN, G.J. and D.L. CHAPA (2016). Phytosanitary irradiation of *Diaphorina citri* (Hemiptera: Liviidae). Florida Entomologist 99(S2):150-152.

HALLMAN, G.J. and P. LOAHARANU (2016). Phytosanitary irradiation – Development and application. Radiation Physics and Chemistry 129:39-45.

HALLMAN, G.J., Y.M. HÉNON, A.G. PARKER and C.M. BLACKBURN (2016). Phytosanitary irradiation: An overview. Florida Entomologist 99(S2):1-13.

HALLMAN, G.J., D. ZHANG and V. ARTHUR (2016). Generic phytosanitary irradiation dose for phytophagous mites (Sarcoptiformes: Acaridae; Trombidiformes: Eriophyidae, Tarsonemidae, Tenuipalpidae, Tetranychidae). Florida Entomologist 99(S2):202-205.

HALLMAN, G.J., J.C. LEGASPI and DARMAWI (2016). Phytosanitary irradiation of *Diatraea saccharalis*, *D. grandiosella*, and *Eoreuma loftini* (Lepidoptera: Crambidae). Florida Entomologist 99(S2):182-185.

HAQ, I., M.J.B. VREYSEN, M. SCHUTZE, J. HENDRICHS and T. SHELLY (2016). Effects of Methyl eugenol feeding on mating compatibility of Asian population of *Bactrocera dorsalis* (Diptera: Tephritidae) with African population and with *B. carambolae*. Journal of Economic Entomology 109(1):148-153.

KARIITHI, H.M., S. BOEREN, E.K. MURUNGI, J.M. VLAK and A.M.M. ABD-ALLA (2016). A proteomics approach reveals molecular manipulators of distinct cellular processes in the salivary glands of *Glossina m. morsitans* in response to *Trypanosoma b. brucei* infections. Parasites & Vectors 9:424.

KARIITHI, H.M., I.A. INCE, S. BOEREN, I.K. MEKI, A.M.M. ABD-ALLA et al. (2016). Comparative analysis of salivary gland proteomes of two *Glossina* species that exhibit differential hytrosavirus pathologies. Frontiers in Microbiology 7:89.

KHOURY, H.J., K. MEHTA, V.S. DE BARROS, P.L. GUZZO and A.G. PARKER (2016). Dose assurance service for low energy X ray irradiators using an alanine-EPR transfer dosimetry system. Florida Entomologist 99(S2):14-17.

MAÏGA, H., D. DAMIENS, A. DIABATÉ, R.S. LEES J.R.L. GILLES et al. (2016). Large-scale *Anopheles arabiensis* egg quantification methods for mass-rearing operations. Malaria Journal 15:72.

MAMAI, W., R.S. LEES, H. MAIGA and J.R.L. GILLES (2016). Reusing larval rearing water and its effect on development and quality of *Anopheles arabiensis* mosquitoes. Malaria Journal 15:169.

MORAN, Z.R. and A.G. PARKER (2016). Near infrared imaging as a method of studying tsetse fly (Diptera: Glossinidae) pupal development. Journal of Insect Science 16(1):72.

MUNHENGA, G., B.D. BROOKE, J.R. GILLES, K. SLABBERT, A. KEMP et al. (2016). Mating competitiveness of sterile genetic sexing strain males (GAMA) under laboratory and semi-field conditions: Steps towards the use of the Sterile Insect Technique to control the major malaria vector *Anopheles arabiensis* in South Africa. Parasites & Vectors 9:122.

PAGABELEGUEM, S., S. RAVEL, A.H. DICKO, M.J. VREYSEN, A. PARKER et al. (2016). Influence of temperature and relative humidity on survival and fecundity of three tsetse strains. Parasites & Vectors 9:520.

PAGABELEGUEM, S., G. GIMONNEAU, M.T. SECK, M.J.B. VREYSEN, B. SALL et al. (2016). A molecular method to discriminate between mass-reared sterile and wild tsetse flies during eradication programmes that have a sterile insect technique component. PLoS Neglected Tropical Diseases 10(2):e0004491.

PAPANICOLAOU A., M.F. SCHETELIG, P. ARENSBURGER, P.W. ATKINSON, K. BOURTZIS et al. (2016). The whole genome sequence of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), reveals insights into the biology and adaptive evolution of a highly invasive pest species. Genome Biology 17:192.

REMPOULAKIS, P., G. TARET, I.U. HAQ, V. WORNOAYPORN, S. AHMED, U.S. TOMAS, T. DAMMALAGE, K. GEMBINSKY, G. FRANZ, C. CACERES and M.J.B. VREYSEN (2016). Evaluation of quality production parameters and mating behavior of novel genetic sexing strains of the Mediterranean fruit fly *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). PLoS One 11(6):e0157679.

SCHETELIG, M.F., A. TARGOVSKA, J.S. MEZA, K. BOURTZIS and A.M. HANDLER (2016). Tetracycline-suppressible female lethality and sterility in the Mexican fruit fly, *Anastrepha ludens*. Insect Molecular Biology 25(4):500-508.

SCOLARI, F., J.B. BENOIT, V. MICHALKOVA, E. AKSOY, A.M.M. ABD-ALLA et al. (2016). The spermatophore in *Glossina morsitans morsitans*: Insights into male contributions to reproduction. Scientific reports 6:20334.

VAN NIEUWENHOVE, G.A., A.V.F. OVIEDO, Y.M. DALTO, J. PEREZ, G.J. HALLMAN et al. (2016). Gamma radiation phytosanitary treatment against *Trialeuroides vaporariorum* (Hemiptera: Aleyrodidae). Florida Entomologist 99(S2):130-133.

VAN NIEUWENHOVE, G.A., A.V. OVIEDO, J. PEREZ, M.J. RUIZ, G.J. HALLMAN et al. (2016). Gamma radiation phytosanitary treatment for *Hemiberlesia lataniae* (Hemiptera: Diaspididae). Florida Entomologist 99(S2):134-137.

VREYSEN, M.J.B., W. KLASSEN and J.E. CARPENTER (2016). Overview of technological advances toward greater efficiency and efficacy in sterile insect-inherited sterility programs against moth pests. Florida Entomologist 99(S1):1-12.

ZHANG, D., R.S. LEES, Z. XI, K. BOURTZIS and J.R.L. GILLES (2016). Combining the Sterile Insect Technique with the Incompatible Insect Technique: III-Robust mating competitiveness of irradiated triple *Wolbachia*-Infected *Aedes albopictus* males under semi-field conditions. PLoS One 11(3):e0151864.

2015

AHMADI, M., H. MOZDARANI and A.M.M. ABD-ALLA (2015). Comparative toxicity and micronuclei formation in *Tribolium castaneum*, *Callosobruchus maculatus* and *Sitophilus oryzae* exposed to high doses of gamma radiation. Applied Radiation and Isotopes 101: 135-40.

AUGUSTINOS, A.A, E. DROSOPOULOU, A. GARIOU-PAPALEXIOU, C. CÁCERES-BARRIOS, K. BOURTZIS et al. (2015). Cytogenetic and symbiont analysis of five members of the *B. dorsalis* complex (Diptera, Tephritidae): no evidence of chromosomal or symbiont-based speciation events. Zookeys 540: 273-298.

AUGUSTINOS, A.A., G.A. KYRITSIS, A. ABD-ALLA, C. CÁCERES-BARRIOS, K.BOURTZIS et al. (2015). Exploitation of the medfly gut microbiota for the enhancement of sterile insect technique: use of *Enterobacter* sp. in larval diet-based probiotic applications. PLoS ONE 10(9): e0136459.

BOUYER, J., A.H. DICKO, G. CECCHI, S. RAVEL, M.J.B. VREYSEN et al. (2015). Mapping landscape friction to locate isolated tsetse populations that are candidates for elimination. PNAS 112 (47): 14575-14580.

BOUYER, J., M.T. SECK, B. SALL and M.J.B. VREYSEN (2015). New insights on the use of the sterile insect technique against vectors. The international Society for Neglected Tropical Diseases, 2015 Conference Handbook: 23-25.

BUSTOS-GRIFFIN, E., G.J. HALLMAN and R.L. GRIFFIN (2015). Phytosanitary irradiation in ports of entry: a practical solution for developing countries. International Journal of Food Science and Technology 50:249-255.

CECCHI, G., M. PAONE, R. ARGILES-HERRERO, M.J.B. VREYSEN, O. DIALL et al. (2015). Developing an atlas of the distribution and trypanosomal infection of tsetse flies (*Glossina* species). Parasites & Vectors 8:284.

DE BEER, C.J., G.J VENTER and M.J.B VREYSEN (2015). Determination of the optimal mating age of colonised *Glossina brevipalpis* and *Glossina austeni* using walk-in field cages in South Africa. Parasites & Vectors 8:467.

ENKERLIN, W., J.M GUTIÉRREZ-RUELAS, A.V. CORTES, E.C., ROLDAN, J. HENDRICHS, et al. (2015). Area freedom in Mexico from Mediterranean fruit fly (Diptera: Tephritidae): A review of over 30 years of a successful containment program using an integrated area-wide SIT approach. Florida Entomologist 98(2): 665-81.

FACCHINELLI, L., L.VALERIO, R.S. LEES, C.F. OLIVA, T. PERSAMPIERI et al. (2015). Stimulating *Anopheles gambiae* swarms in the laboratory: application for behavioural and fitness studies. Malaria Journal 14(1): 271.

HAQ, I., M.J.B. VREYSEN, C. CÁCERES-BARRIOS, T.S. SHELLY and J. HENDRICHS (2015). Optimizing methyl eugenol aromatherapy to maximize post-treatment effects to enhance mating competitiveness of males *Bactrocera carambolae* Drew & Hancock (Diptera: Tephritidae). Insect Science 22: 661-669.

HEE, A.K.W., S.L. WEE, R. NISHIDA, H. ONO, J. HENDRICHS et al. (2015). Historical perspective on the synonymization of the four major pest species belonging to the *Bactrocera dorsalis* species complex (Diptera, Tephritidae). Zookeys 540: 323-338.

HENDRICHS, J., M.T. VERA, M. DE MEYER and A.R. CLARKE (2015). Resolving Cryptic Species Complexes of Major Tephritid Pests. ZooKeys 540: 5-39.

JUÁREZ, M.L., C. CÁCERES-BARRIOS, M.J.B. VREYSEN, J. HENDRICHS and M.T. VERA (2015). Evaluating mating compatibility within fruit fly cryptic species complexes and the potential role of sex pheromones in pre-mating isolation. Zookeys 540: 125-155.

KAPANTAIDAKI, D.E., I. OVČARENKO, N. FYTROU, K.E. KNOTT, K. BOURTZIS et al. (2015). Low levels of mitochondrial DNA and symbiont diversity in the worldwide agricultural pest, the greenhouse whitefly *Trialeurodes vaporariorum* (Hemiptera: Aleyrodidae). Journal of Heredity 106 (1): 80-92.

KHOURY, H.J., E.J. DA SILVA, K. MEHTA, V.S. DE BARROS, A.G. PARKER et al. (2015). Alanine-EPR as a transfer standard dosimetry system for low energy X radiation. Radiation Physics and Chemistry 116: 147-150.

LEBLANC, L., H. FAY, F. SENGEBAU, M. SAN JOSE, R. PEREIRA et al.(2015). A Survey of Fruit Flies (Diptera: Tephritidae: Dacinae) and their Opiine Parasitoids (Hymenoptera: Braconidae) in Palau. Proceedings of the Hawaiian Entomological Society 47: 55-66.

LEES, R.S., J.R.L. GILLES, J. HENDRICHS, M.J.B. VREYSEN and K. BOURTZIS (2015). Back to the future: The Sterile Insect Technique against mosquito disease vectors. Current Opinion in Insect Science 10: 156-162.

MATTIOLI, R.C., G. CECCHI, M. PAONE, R. ARGILES-HERRERO, P.P. SIMARRO et al. (2015). The programme against African trypanosomosis: An institutional international entente. The international Society for Neglected Tropical Diseases, 2015 Conference Handbook: 3-4.

PAGABELEGUEM, S., M.T. SECK, B. SALL, M.J.B. VREYSEN, I. SIDIBÉ et al. (2015) Long distance transport of *Glossina palpalis gambiensis* pupae and its impact on sterile male yield. Parasites & Vectors 8(1): 259.

SCHUTZE, M.K., T. DAMMALAGE, A. JESSUP, M.J.B. VREYSEN, V. WORNOAYPORN et al. (2015). Effects of laboratory colonization on *Bactrocera dorsalis* (Diptera, Tephritidae) mating behaviour: 'what a difference a year makes'. Zookeys 540: 360-383.

SCHUTZE, M.K., K. BOURTZIS, C. CÁCERES-BARRIOS, J. HENDRICHS, J. REYES, et al. (2015). Synonymization of key pest species within the *Bactrocera dorsalis* species complex (Diptera: Tephritidae): taxonomic changes based on 20 years of integrative morphological, molecular, cytogenetic, behavioral, and chemoecological data. Systematic Entomology 40: 456-471.

SCHUTZE, M.K., K. MAHMOOD, A. PAVASOV, W. BO, J. NEWMAN, et al. (2015). One and the same: integrative taxonomic evidence that *Bactrocera invadens* (Diptera: Tephritidae) is the same species as the Oriental fruit fly *Bactrocera dorsalis*. Systematic Entomology 40: 472-486.

SECK, M.T., S. PAGABELEGUEM, M.D. BASSENE, A.G. FALL, A.G. PARKER et al. (2015). Quality of sterile male tsetse after long distance transport as chilled, irradiated pupae. PLoS Negl. Trop. Dis. 9(11): e0004229.

SOLÓRZANO, J.A., J.R.L. GILLES, O. BRAVO, C. VARGAS, Y. GOMEZ-BONILLA et al. (2015). Biology and Trapping of Stable Flies (Diptera: Muscidae) Developing in Pineapple Residues (*Ananas comosus*) in Costa Rica. Journal of Insect Science 15(1): 145.

TSOUMANI, K.T., E. DROSOPOULOU, K. BOURTZIS, A. GARIOU-PAPALEXIOU, P. MAVRAGANI-TSIPIDOU, et al. (2015). *Achilles*, a new family of transcriptionally active retrotransposons from the olive fruit fly, with Y chromosome preferential distribution. PLoS ONE 10(9): e0137050.

YAMADA, H., M.J.B. VREYSEN, K. BOURTZIS, W. TSCHIRK, J.R.L. GILLES et al. (2015). The *Anopheles arabiensis* genetic sexing strain ANO IPCL1 and its application potential for the sterile insect technique in integrated vector management programmes. Acta tropica 142: 138-144.

ZHANG, D., X. ZHENG, Z. XI, K. BOURTZIS and J.R.L. GILLES (2015). Combining Sterile Insect Technique with Incompatible Insect Technique: I-impact of *Wolbachia* infection on the fitness of triple and double - infected strains of *Aedes albopictus*. PLoS ONE 10(4): e0121126.

ZHANG, D., R.S. LEES, Z. XI, J.R.L. GILLES and K. BOURTZIS (2015). Combining the Sterile Insect Technique with *Wolbachia*-based approaches: II- A safer approach to *Aedes albopictus* population suppression programmes, designed to minimize the consequences of inadvertent female release. PLoS ONE 10(8): e0135194.

ZHENG, M.L., D.J. ZHANG, D.D. DAMIENS, H. YAMADA and J.R.L. GILLES (2015). Standard operating procedures for standardized mass rearing of the dengue and chikungunya vectors *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) - I - Egg quantification. Parasites & Vectors 8: 42.

ZHENG, M.L., D.J. ZHANG, D.D. DAMIENS, R.S. LEES and J.R. GILLES (2015). Standard operating procedures for standardized mass rearing of the dengue and chikungunya vectors *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) - II - Egg storage and hatching. Parasites & Vectors 8: 348.

2014

ABD-ALLA, A., C. MARIN, A. PARKER and M. VREYSEN (2014). Antiviral drug valacyclovir treatment combined with a clean feeding system enhances the suppression of salivary gland hypertrophy in laboratory colonies of *Glossina pallidipes*. Parasites & Vectors 7(1): 214.

ADAM, Y., J. BOUYER, G-K. DAYO, M.J.B. VREYSEN, A.M.M. ABD-ALLA et al. (2014). Genetic comparisons of *Glossina tachinoides* populations in three river basins of the Upper West region of Ghana and consequences for tsetse control. Infection, Genetics and Evolution 28: 588-595.

AGEEP T.B., D. DAMIENS, B. ALSHARIF, R.S. LEES, J.R.L. GILLES et al. (2014). Participation of irradiated *Anopheles arabiensis* males in swarms following field release in Sudan. Malaria Journal 13: 484.

AHMAD, S., V. WORNOAYPORN, I.U. HAQ, C. CÁCERES-BARRIOS, M.J.B. VREYSEN et al. (2014). Hybridization and use of grapes as an oviposition substrate improves the adaptation of olive fly *Bactrocera oleae* (Rossi) (Diptera: Tephritidae) to artificial rearing conditions. International Journal of Industrial Entomology. 29(2): 198-206.

AKSOY, S. G. ATTARDO, M. BERRIMAN, K. BOURTZIS et al. International Glossina Genome Initiative (2014). Genome sequence of the tsetse fly (*Glossina morsitans*): vector of african trypanosomiasis. Science 344(6182): 380-386.

ASSOGBA, B.S., L. DJOGBÉNOU, J. SAIZONOU, A. DIABATÉ, J.R.L. GILLES, et al. (2014). Characterization of swarming and mating behaviour between *Anopheles coluzzii* and *Anopheles melas* in a sympatry area of Benin. Acta Tropica 132 Suppl. S53-S63.

AVGUSTINOS, A.A., A.K. ASIMAKOPOULOU, C.A. MORAITI, P. MAVRAGANI-TSIPIDOU, K. BOURTZIS et al. (2014). Microsatellite and *Wolbachia* analysis in *Rhagoletis cerasi* natural populations: Population structuring and multiple infections. Ecology and Evolution 4: 1943-1962.

AVGUSTINOS, A., E. DROSOPOULOU, A. GARIOU-PAPALEXIOU, K. BOURTZIS, P. MAVRAGANI-TSIPIDOU et al. (2014). The *Bactrocera dorsalis* species complex: comparative cytogenetic analysis in support of Sterile Insect Technique applications. BMC Genetics, 15 (Suppl. 2): S16.

AVTZIS. D.N., V. DOUDOUMIS, and K. BOURTZIS (2014). *Wolbachia* infections and mitochondrial diversity of two chestnut feeding *Cydia* species. PLoS ONE 9(11): e112795.

BALAGAWI, S., K. JACKSON, I. HAQ, R. HOOD-NOWOTNY, C. RESCH et al. (2014). Nutritional status and the foraging behaviour of *Bactrocera tryoni* with particular reference to protein bait spray. Physiological Entomology 39(1): 33-43.

BALESTRINO, F., A. PUGGIOLI, R. BELLINI, D. PETRIC and J.R.L. GILLES (2014). Mass production cage for *Aedes albopictus* (Diptera:Culicidae). Journal Medical Entomology 51(1): 155-163.

BALESTRINO, F., A. PUGGIOLI, J.R.L. GILLES and R. BELLINI (2014). Validation of a new larval rearing unit for *Aedes albopictus* (Diptera: Culicidae) mass-rearing. PLoS ONE 9(3): e91914.

BARCLAY, H and J. HENDRICHS (2014). Modeling trapping of fruit flies for detection, suppression, or eradication. In: T. Shelly et al. (eds.) Trapping and the Detection, Control, and Regulation of Tephritid Fruit Flies. Springer, the Netherlands, pp 379-420.

BARCLAY, H.J. and J. HENDRICHS (2014). Models for assessing the male annihilation of *Bactrocera* spp. with methyl eugenol baits. Annals of the Entomological Society of America 107(1): 81-96.

BARCLAY, H.J., D.O. MCINNIS and J. HENDRICHS (2014). Modeling the area-wide integration of male annihilation and the simultaneous release of methyl-eugenol-exposed *Bactrocera* spp. sterile males. Annals of the Entomological Society of America 107(1): 97-112.

BELLINI, R., A. PUGGIOLI, F. BALESTRINO, P. BRUNELLI, A. MEDICI, et al. (2014). Sugar administration to newly emerged *Aedes albopictus* males increases their survival probability and mating performance. Acta Tropica 132 Suppl. S116-S123.

BO, W., S. AHMAD, T. DAMMALAGE, U. STO TOMAS, V. WORNOAYPORN, I. UL HAQ, C. CÁCERES-BARRIOS, M.J.B. VREYSEN, J. HENDRICHS et al. (2014). Mating compatibility between *Bactrocera invadens* and *Bactrocera dorsalis* (Diptera: Tephritidae). Journal of Economic Entomology 107: 623-629.

BOURTZIS, K., S. DOBSON, Z. XI, J.L. RASGON, M. CALVITI, J.R.L. GILLES et al. (2014). Harnessing mosquito-*Wolbachia* symbiosis for vector and disease control. Acta Tropica 132 Suppl. S150-S163.

BOUYER, F., M.T. SECK, A. DICKO, B. SALL, M.J.B. VREYSEN et al. (2014) Ex-ante benefit-cost analysis of the eradication of a *Glossina palpalis gambiensis* population in the Niayes of Senegal. PLOS Neglected Tropical Diseases 8(8): e3112.

BRELSFOARD, C., G. TSIAMIS, M. FALCHETTO, L. GOMULSKI, K. BOURTZIS et al. (2014). Presence of extensive *Wolbachia* symbiont insertions discovered in the genome of its host *Glossina morsitans morsitans*. PLoS Neglected Tropical Diseases 8(4): e2728.

CÁCERES-BARRIOS, C., J. HENDRICHS and M.J.B. VREYSEN (2014). Development and improvement of rearing techniques for fruit flies (Diptera: Tephritidae) of economic importance. International Journal of Tropical Insect Science 34: (S1) S1-S12.

CARVALHO, D.O., A.L. COSTA-DA-SILVA, R.S. LEES and M.L. CAPURRO (2014). Two step male release strategy using transgenic mosquito lines to control transmission of vector-borne diseases. Acta Tropica 132 Suppl. S170-S177.

CECCHI, G., M. PAONE, U. FELDMANN, M.J.B. VREYSEN, O. DIALL et al. (2014). Assembling a geospatial database of tsetse-transmitted animal trypanosomosis for Africa. Parasites & Vectors 7: 39.

CHADEE, D.D. and J.R.L. GILLES (2014). The diel copulation periodicity of the mosquito, *Aedes aegypti* (L.) (Diptera: Culicidae) at indoor and outdoor sites in Trinidad, West Indies. Acta Tropica 132 Suppl. S91-S95.

CHADEE, D.D., J.M. SUTHERLAND and J.R.L GILLES (2014). Diel sugar feeding and reproductive behaviours of *Aedes aegypti* mosquitoes in Trinidad: With implications for mass release of sterile mosquitoes. Acta Tropica 132 Suppl. S86-S90.

DABIRÉ, K.R., P.S. SAWADOGO, D.F. HIEN, R.S. LEES, J.R.L. GILLES et al. (2014). Occurrence of natural *Anopheles arabiensis* swarms in an urban area of Bobo-Dioulasso city, Burkina Faso, West Africa. Acta Tropica 132 Suppl. S35-S41.

DEVESCOVI, F., S. ABRAHAM, A.K.P. RORIZ, N. NOLAZCO, C. CÁCERES-BARRIOS et al (2014). Ongoing speciation within the *Anastrepha fraterculus* cryptic species complex: the case of the Andean morphotype. Entomologia Experimentalis et Applicata 152: 238-247.

DICKO, A.H., R. LANCELOT, M.T. SECK, L. GUERRINI, M., M.J.B. VREYSEN et al. (2014). Using species distribution models to optimize vector control in the framework of the tsetse eradication campaign in Senegal. Proceedings of the National Academy of Sciences 111(28): 10149-10154.

DONG, Y.C., L. WAN, R. PEREIRA, N. DESNEUX and C.Y. NIU (2014). Feeding and mating behavior of Chinese citrus fly *Bactrocera minax* (Diptera: Tephritidae) in the field. Journal of Pest Science 87: 647–657.

ESTES, A.M., D.F. SEGURA, A. JESSUP, V. WORNOAYPORN and E.A. PIERSON (2014). Effect of the symbiont *Candidatus Erwinia dacicola* on mating success of the olive fly *Bactrocera oleae* (Diptera: Tephritidae). International Journal of Tropical Insect Science 34: (S1) S123-S131.

FELDMANN, U. and P.D. READY (2014). Applying GIS and population genetics for managing livestock insect pests: Case studies of tsetse and screwworm flies Acta Tropica. 138: (Suppl.) S1-S5.

GILLES, J.R.L., M. SCHETELIG, F. SCOLARI, G. FRANZ, K. BOURTZIS et al. (2014). Towards mosquito Sterile Insect Technique programmes: exploring genetic, molecular, mechanical and behavioural methods of sex separation in mosquitoes. Acta Tropica 132 Suppl. S178-S187.

HAQ, I., M.J.B. VREYSEN, C. CÁCERES-BARRIOS, T.E. SHELLY and J. HENDRICHS (2014). Methyl eugenol aromatherapy enhances competitiveness of male *Bactrocera carambolae* Drew & Hancock (Diptera: Tephritidae) mating competitiveness. Journal of Insect Physiology 68: 1-6.

HAQ, I., M.J.B. VREYSEN, P.E.A. TEAL and J. HENDRICHS (2014). Methoprene application and diet protein supplementation to male melon fly, *Bactrocera cucurbitae*, modifies female remating behaviour. Insect Science 21: 637-646.

IYALOO D.P., K.B. ELAHEE, A. BHEECARRY and R.S. LEES (2014). Guidelines to site selection for population surveillance and mosquito control trials: A case study from Mauritius. Acta Tropica 132 Suppl. S140-S149.

JANG, E.B., W. ENKERLIN, C. MILLER and J. REYES-FLORES (2014). Trapping related to phytosanitary status and trade. In: T. Shelly et al. (Eds.) Trapping and the Detection, Control, and Regulation of Tephritid Fruit Flies. Springer, the Netherlands, pp 589-608.

JUAN-BLASCO, M., B. SABATER-MUÑOZ, I. PLA, R. ARGILÉS, P. CASTAÑERA, et al. (2014). Estimating SIT-driven population reduction in the Mediterranean fruit fly, *Ceratitis capitata*, from sterile mating. Bulletin of Entomological Research 104: 233-242.

LEES, R.S., B. KNOLS, R. BELLINI, M.Q. BENEDICT, J.R.L. GILLES et al. (2014). Review: Improving our knowledge of male mosquito biology in relation to genetic control programmes. Acta Tropica 132 Suppl. S2-S11.

MADAKACHERRY, O., R.S. LEES and J.R.L. GILLES (2014). *Aedes albopictus* (Skuse) males in laboratory and semi-field cages: release ratios and mating competitiveness. Acta Tropica 132 Suppl. S124-S129.

MAÏGA, H., A. NIANG, S. SAWADOGO, R.S. LEES, J.R.L. GILLES et al. (2014). Role of nutritional reserves and body size in *Anopheles gambiae* males mating success. Acta Tropica 132 Suppl. S102-S107.

MAÏGA H., D. DAMIENS, A. NIANG, R.S. LEES, J.R.L. GILLES et al. (2014). Mating competitiveness of sterile male *Anopheles coluzzii* in large cages. Malaria 13: 460.

MARTINEZ J., B. LONGDON, S. BAUER, Y. CHAN, K. BOURTZIS et al. (2014). Symbionts commonly provide broad spectrum resistance to viruses in insects: a comparative analysis of *Wolbachia* strains. PLoS Pathogens 10(9): e1004369.

MAVRAGANI-TSIPIDOU P., A. ZACHARO-POULOU, E. DROSOPOULOU, A.A. AUGUSTINOS, K. BOURTZIS and F. MAREC (2014). Protocols for cytogenetic mapping of arthropod genomes: Tephritid fruit flies of economic importance. In: I. Sakharov ed. Protocols for cytogenetic mapping of arthropod genomes. CRC Press, Taylor and Francis Group, LLC, Florida, USA pp. 1-62.

MEHTA K., A. PARKER and F. TESSIER (2014). Gafchromic® film dosimetry for low energy X radiation. Radiation Measurements 67: 48-54.

MUBARQUI, R., R.C. PEREZ, R.A. KLADT, J.L. ZAVALA LOPEZ, A. PARKER et al. (2014). The smart aerial release machine, a universal system for applying the sterile insect technique. PLoS ONE 9(7): e103077.

MUTIKA, G.N., I. KABORE, A.G. PARKER and M.J.B. VREYSEN (2014). Storage of male *Glossina palpalis gambiensis* pupae at low temperature: effect on emergence, mating and survival. Parasites & Vectors 7(1): 465.

NDO C., H. YAMADA, D.D. DAMIENS, S. N'DO, J.R.L. GILLES et al. (2014). X ray sterilization of the *An. arabiensis* genetic sexing strain 'ANOIPCL1' at pupal and adult stages. Acta Tropica 131: 124–128.

OLIVA, C.F., D. DAMIENS and M.Q. BENEDICT (2014). Male reproductive biology of *Aedes* mosquitoes. Acta Tropica 132 Suppl. S12-S19.

OLIVA, C.F., M.J.B. VREYSEN, S. DUPÉ, J.R.L. GILLES, R.S. LEES, et al. (2014). Current status and future challenges for controlling malaria with the sterile insect technique: technical and social perspectives. Acta Tropica 132 Suppl. S130-S139.

PAPASOTIROPOULOS, V., G. TSIAMIS, C. PAPAIOANNOU, P. IOANNIDIS, K. BOURTZIS, et al. (2014). A molecular phylogenetic study of aphids (Hemiptera: Aphididae) based on mitochondrial DNA sequence analysis. Journal of Biological Research Thessaloniki 20: 195-207.

REMPOULAKIS, P., S. AHMAD, T. DAMMALAGE, U.S. TOMAS, M.J.B. VREYSEN, et al. (2014). Conserved metallomics in two insect families evolving separately for a hundred million years. BioMetals 27: 1323-1335.

SAWADOGO, S., P.M. NAMOUNTOUGOU, K.H. TOÉ, R.S. LEES, J.R.L. GILLES, et al. (2014). Swarming behaviour in natural populations of *Anopheles gambiae* M and S forms: Review of 4 years survey in rural areas of sympatry, Burkina Faso (West Africa). Acta Tropica 132 Suppl. S42-S52.

RESILVA, S.S and R. PEREIRA (2014). Age and temperature related pupal eye colour changes in various tephritid fruit fly species with a view to optimizing irradiation timing. International Journal of Tropical Insect Science 34: (S1) S59-65.

VREYSEN, M.J.B., K. SALEH, F. MRAMBA, A. PARKER, U. FELDMANN, et al. (2014). Sterile insects to enhance agricultural development: the case of sustainable tsetse eradication on Unguja Island, Zanzibar, using an area-wide integrated pest management approach. PLoS Neglected Tropical Diseases, 8(5): e2857.

YAHOUÉDO G.A., L. DJOGBÉNOU, J. SAÏZONOU, J. GILLES, H. MAÏGA et al. (2014). Effect of three larval diets on larval development and male sexual performance of *Anopheles gambiae* s.s. Acta tropica 132, Suppl. S96–S101.

YAMADA, H., A.G. PARKER, C.F. OLIVA, F. BALESTRINO and J.R.L. GILLES (2014). X ray-induced sterility in *Aedes albopictus* and male longevity following irradiation. Journal of Medical Entomology 51 (4): 811-816.

YAMADA, H., M.J.B. VREYSEN, J.R.L. GILLES, G. MUNHENGA and D. DAMIENS (2014). The effects of genetic manipulation, dieldrin treatment, and irradiation on the mating competitiveness of male *Anopheles arabiensis* in field cages. Malaria Journal 13: 318.

ZEPEDA-CISNEROS, C.S., J.S.M. HERNÁNDEZ, V. GARCÍA-MARTÍNEZ, J. IBAÑEZ-PALACIOS, G. FRANZ et al. (2014). Development, genetic and cytogenetic analyses of genetic sexing strains of the Mexican fruit fly, *Anastrepha ludens* Loew (Diptera: Tephritidae). BMC Genetics, 15 (Suppl. 2): S1.

Other Publications

2016

FAO/IAEA (2016). Guidelines for the Use of Mathematics in Operational Area-Wide Integrated Pest Management Programmes Using the Sterile Insect Technique with a Special Focus on Tephritid Fruit Flies. Barclay H.L., Enkerlin W.R., Manoukis N.C. and Reyes-Flores J. (eds.), Food and Agriculture Organization of the United Nations. Rome, Italy. 95 pp. (http://www-naweb.iaea.org/nafa/ipc/public/tephritid-fruit-flies-manual.pdf).

FAO/IAEA (2016). Standard Operating Procedures for Preparing and Handling Sterile Male Tsetse Flies for Release. Argiles-Herrero R. and Leak S. (eds.). Joint FAO/IAEA Programme, Vienna, Austria. 37 pp. (http://www-naweb.iaea.org/nafa/ipc/SOP-sterile-male-tsetse-shipment-handling-release.pdf).

FLORIDA ENTOMOLOGIST (2016). Volume 99, Special Issue 1. Toward Greater Efficiency and Efficacy in Sterile Insect-Inherited Sterility Programs against Moth Pests. Vreysen M.J.B., Klassen, W. and Carpenter J.E. (eds.). Florida Entomological Society. (http://journals.fcla.edu/flaent/issue/view/4271).

FLORIDA ENTOMOLOGIST (2016). Volume 99, Special Issue 2. Development of Generic Phytosanitary Irradiation Dose for Arthropod Pests. Hallman G.J., Parker A., Klassen W., Blackburn C. and Hénon, Y.M. (eds.). Florida Entomological Society. (http://journals.fcla.edu/flaent /issue/view/4278).

GUILLEN-AGUILAR J.C., L.L. MUÑOZ, E.P. ESPINOZA, E.F. LÓPEZ VILLALOBOS, V.H. MARROQUÍN SOLÓRZANO et al. (2016). Manual to Differentiate Wild Mediterranean Fruit Flies *Ceratitis capitata* (Wied.) from non-irradiated (Fertile) and Irradiated (Sterile) VIENNA Temperature Sensitive Lethal Strain Flies (Ed. by J. Reyes-Flores). IAEA, Vienna, Austria. 60 pp. (http://www-naweb.iaea.org/nafa/ipc/public/Cc-Differentiation.pdf).

2015

ZOOKEYS (2015). Volume 540, Special Issue of FAO/IAEA Coordinated Research Project on Resolving Cryptic Species Complexes of Major Tephritid Pests to Enhance SIT Application and Facilitate International Trade. J. Hendrichs, M.T. Vera, M. De Meyer and A.R. Clarke (eds.). Pensoft Publishers, Sofia, Bulgaria. (http://zookeys.pensoft.net/browse_journal_issue_documents.php?issue_id=763).

2014

BMC GENETICS (2014). Volume 15 (Suppl. 2), Special Issue of an FAO/IAEA Coordinated Research Project on Development and Evaluation of Improved Strains of Insect Pests for Sterile Insect Technique Applications. Bourtzis, K. and Hendrichs J. (eds.).

(http://www.biomedcentral.com/bmcgenet/supplements/15/S2).

INTERNATIONAL JOURNAL OF TROPICAL INSECT SCIENCE (2014). Volume 34, Supplement 1:S1-S153. Special Issue of an FAO/IAEA Coordinated Research Project on Development of Mass-Rearing for African, Asian and New World Fruit Fly Pests in Support of the Sterile Insect Technique. Vreysen, M.J.B., Hendrichs J. and Cáceres C. (eds.).

(http://journals.cambridge.org/action/displayIssue?decade=2010&jid=JTI&volumeId=34&issueId=S1&iid=9377479).

ACTA TROPICA (2014). Volume 138 Supplement: S1-S93. Special Issue of an FAO/IAEA Coordinated Research Project on Applying GIS and Population Genetics for Managing Livestock Insect Pests: Case Studies on Tsetse and Screwworm Flies. Ready, P.D., Feldmann U. and Berzins K. (eds.).

(http://www.sciencedirect.com/science/journal/0001706X/138/supp/S).

SHELLY, T., N. EPSKY, E.B. JANG, J. REYES-FLORES and R.I. VARGAS (eds.). (2014). Trapping and the Detection, Control, and Regulation of Tephritid Fruit Flies: Lures, Area-Wide Programs, and Trade Implications. Springer, The Netherlands, 638 pp.

FAO/IAEA/USDA (2014). Product Quality Control for Sterile Mass-Reared and Released Tephritid Fruit Flies, Version 6.0. IAEA, Vienna, Austria. 164 pp. (http://www-naweb.iaea.org/nafa/ipc/public/QualityControl.pdf).

ACTA TROPICA (2014). Volume 132, Supplement: S1-S187. Special Issue of an FAO/IAEA Coordinated Research Project on Biology and Behavior of Male Mosquitoes in Relation to New Approaches to Control Diseases Transmitting Mosquitoes. Lees, R.S., Chadee D.D. and Gilles J.R.L. (eds.).

(http://www.sciencedirect.com/science/journal/0001706X/132/supp/S).

2013

FAO/IAEA (2013). Using Open Source GIS Techniques in Insect Pest Control Programmes. Tutorial DVD. IAEA, Vienna, Austria.

ABD-ALLA, A.M.M. and ARIF B. (eds.) (2013). Special Issue of an FAO/IAEA Coordinated Research Project on Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens Improvement of Codling Moth SIT to Facilitate Expansion of Field Application. Journal of Invertebrate Pathology. 112 (Supplement 1): S1-S147. (http://www.sciencedirect.com/ science/journal/00222011/ 112/supp/S1).

CÁCERES-BARRIOS, C., P. RENDÓN and A. JESSUP, (2013). The FAO/IAEA Spreadsheet for Designing and Operation of Insect Mass-Rearing Facilities. FAO, Rome, Italy. 48 pp.

HENDRICHS, J. and R. PEREIRA, (eds.) (2013). Special Issue of an FAO/IAEA Coordinated Research Project on Improving Sterile Male Performance in Fruit Fly Sterile Insect Technique (SIT) Programmes. Journal of Applied Entomology 137 (Supplement 1): S1-S259. (http://onlinelibrary.wiley.com/doi/10.1111/jen.2013.137.issue-s1/issuetoc).

2012

IAEA. 2012. Quality control for expanded tsetse production, sterilization and field application. IAEA-TECDOC-1683. IAEA, Vienna, Austria.

2011

FRANZ, G. (ed.) (2011). Proceedings of an FAO/IAEA Coordinated Research Project on Molecular Technologies to Improve the Effectiveness of the Sterile Insect Technique. Genetica Vol. 139 (1).

2010

DYCK, V.A., HENDRICHS J., ROBINSON A.S. (eds.) (2010) Sterile Insect Technique. Principles and practice in area-wide integrated pest management [in Chinese]. China Agricultural Science and Technology Press, Beijing, China. 955 pp.

DYCK, V.A. (2010). Rearing Codling Moth for the Sterile Insect Technique. FAO, Roma, Italy. 197 pp.

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

2009

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

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

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

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

For copies of unpriced publications, please contact Nima Mashayekhi-Tabrizi (N.Mashayekhi-Tabrizi@iaea.org), or the Insect Pest Control Subprogramme, Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, IAEA (http://www-naweb.iaea.org/nafa/ipc/index.html).

Impressum

Insect & Pest Control Newsletter No. 88

The Insect & Pest Control Newsletter is prepared twice per year by the Insect Pest Control Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and FAO/IAEA Agriculture and Biotechnology Laboratory, Seibersdorf

International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Printed by the IAEA in Austria, January 2017

16-48521