Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Insect & Pest Control Newsletter

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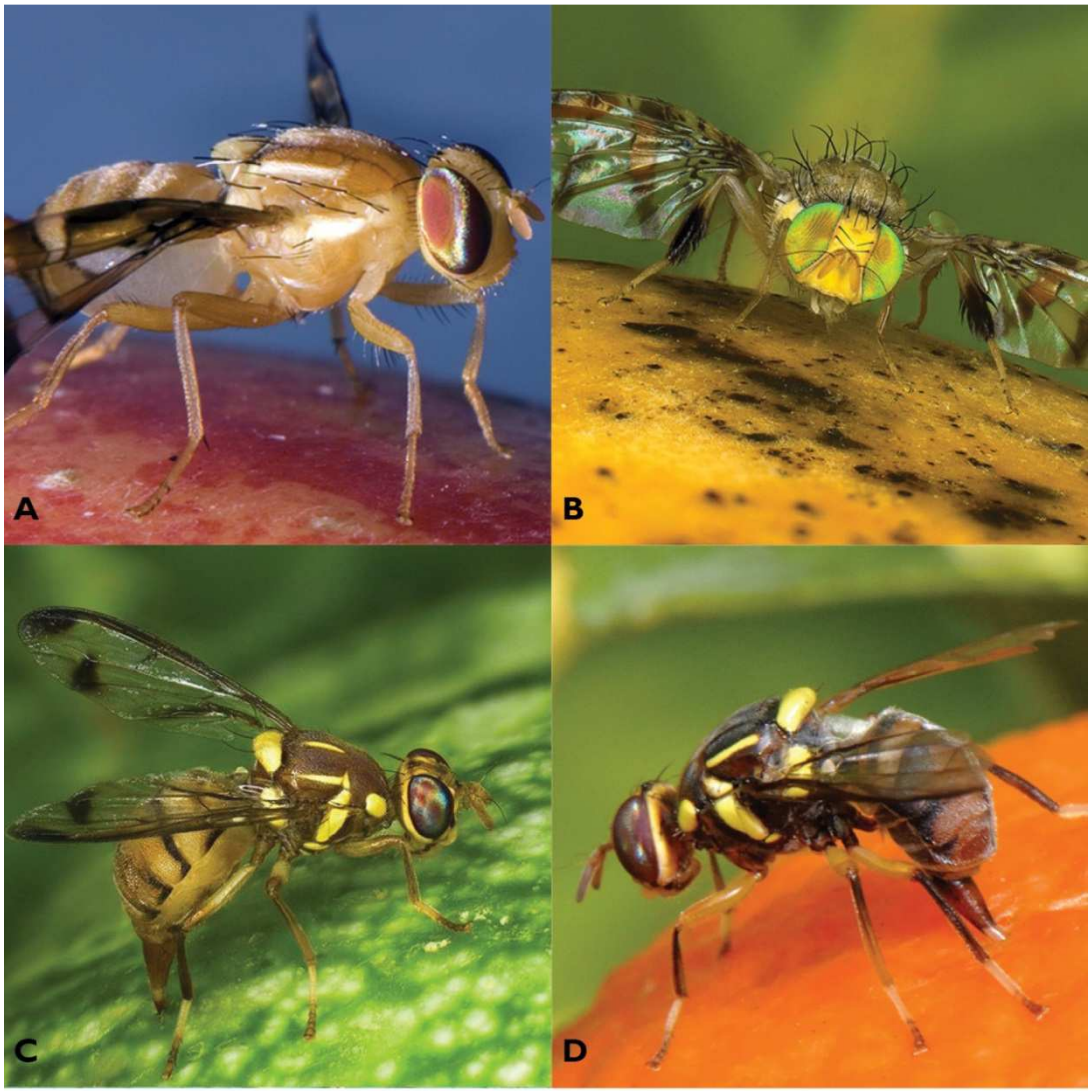
To Our Readers



Images of representatives of each the four tephritid fruit fly cryptic species complexes studied to delimit species boundaries to overcome constraints to Sterile Insect Technique (SIT) application and international trade. A Anastrepha fraterculus, *B* Ceratitis rosa *(R2 type), C* Zeugodacus cucurbitae, *D* Bactrocera dorsalis *(Photo credits: A Michal Hoskovec, B and C Antoine Franck, D Ana Rodriguez).*

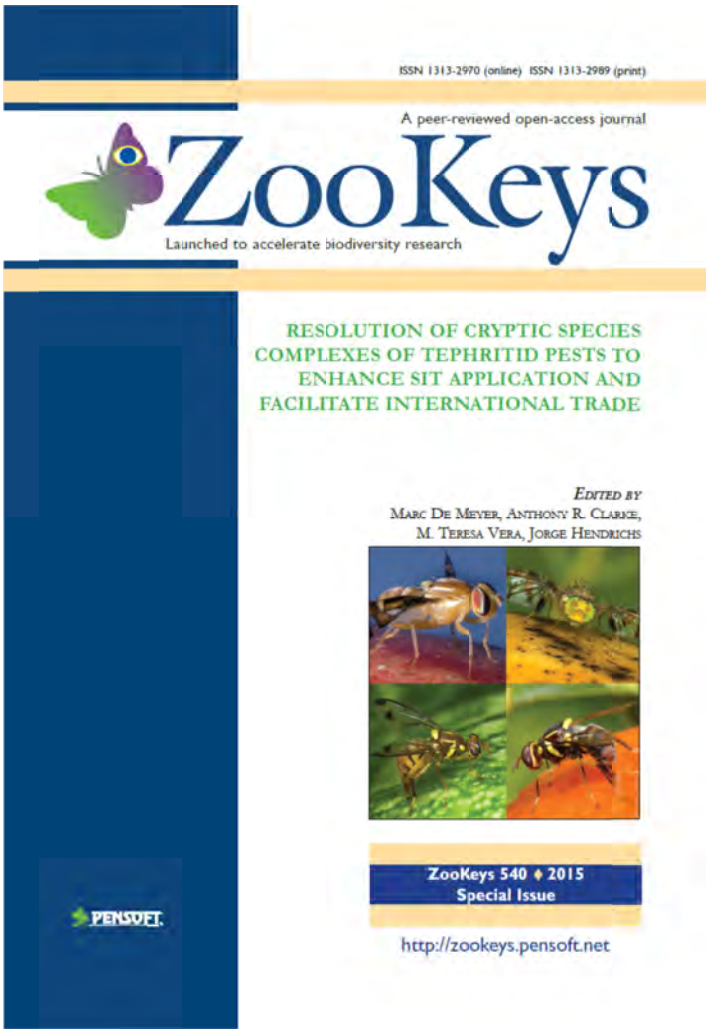
Looking back at 2015, yet another exciting and successful year, I would like to thank all our collaborators in many parts of the world for their support and significant inputs to our joint activities. Also I would like to express my appreciation to the staff at the Insect Pest Control Section at headquarters in Vienna and at the Insect Pest Control Laboratory in Seibersdorf, Austria for their dedication and competence in developing and transferring to FAO and IAEA Member States more environment-friendly and therefore more sustainable insect pest control technologies.

In 2015 we concluded the six-year Coordinated Research Project (CRP) on "Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade". The objective of the CRP was to undertake targeted research into the systematics and diagnostics of taxonomically challenging fruit fly groups of economic importance. Close to 50 researchers from over 20 countries participated in the CRP, conducting coordinated, multidisciplinary research to address, within an integrative taxonomic framework, cryptic species complexes of major tephritid pests. One of the scientific outputs of the CRP was the accurate alignment of some biological species with taxonomic names. The resolution of some of these controversial issues has important applied implications for FAO and IAEA Member States, both in overcoming technical constraints to the application of the Sterile Insect Technique (SIT) against pest fruit flies and in facilitating international agricultural trade.

A Special Issue in the peer-reviewed journal ZooKeys [http://zookeys.pensoft.net/browse_journal_issue_documents.php?issue_id=763] has been published, with 26 research and review articles covering the progress made during the CRP on the four fruit fly complexes studied:

Anastrepha fraterculus complex – Eight morphotypes and their geographic and ecological distributions in Latin America were defined. The morphotypes can be considered as distinct biological species on the basis of differences in karyotype, sexual incompatibility, post-mating isolation, cuticular hydrocarbons, pheromones, and molecular profiles. Discriminative taxonomic tools using linear and geometric morphometrics of both adult and larval morphology were developed that allow the characterisation of the different morphotypes.

Bactrocera dorsalis complex – The genetic, cytogenetic, pheromonal, morphometric, and behavioural data that emanated from research on this complex showed no or only minor variations between the Asian/African pest fruit flies *Bactrocera dorsalis, B. papayae, B. philippinensis* and *B. invadens*. As a result, the latter three species were synonymized with *B. dorsalis*. Of the five target pest taxa studied, only *B. dorsalis* and *B. carambolae* remain as scientifically valid names and distinct taxonomic species. This has significant implications for horticultural international trade between Africa and Asian countries.



Ceratitis FAR Complex (*C. fasciventris, C. anonae, C. rosa*) – Studies on the morphology, morphometry, genetics, genomics, pheromones, cuticular hydrocarbons, ecology, behaviour, and developmental physiology provided evidence for the existence of five distinct entities within this fruit fly complex from the African region. These are currently recognised as *Ceratitis anonae, C. fasciventris* (F1 and F2), *C. rosa* and a new species related to *C. rosa* (R2).

Zeugodacus cucurbitae (formerly *Bactrocera (Zeugodacus) cucurbitae*) – Genetic variability among melon fly populations throughout its geographic range in Africa and the Asia/Pacific region was found to be limited. Cross-mating studies confirmed full mating compatibility and the absence of sexual isolation. Host preference and genetic studies showed no evidence for the existence of host races. It was concluded that the melon fly does not represent a cryptic species complex, neither with regard to geographic distribution nor to host range.

Changing subject I would like to call your attention to a new CRP that will hold its first Research Coordination Meeting in August 2016, and for which we are encouraging the submission of relevant research contract and agreement proposals. This new CRP is entitled "Improved Field Performance of Sterile Moths to Enhance the Application of SIT" and is focused on key Lepidoptera pests that require

control to avoid significant losses in many cropping systems worldwide. The SIT or its derivative the Inherited Sterility (IS) technique is being applied successfully against a number of moth species, however, there are important processes that need to be improved and tied to field performance for a number of major moth pests. In particular optimal quality of the released sterile males is a prerequisite for success in SIT/IS programs, as moth competitiveness and field performance can be significantly degraded during many processes related to the mass-rearing, transport, handling and release of sterile insects. Information to apply for research contracts and research agreements can be found at http://www-naweb.iaea.org/nafa/ipc/crp/new-crps-ipc.html.

In response to several requests to consider the possibilities of developing and applying the SIT and related techniques in glasshouses, greenhouses and other confined production areas such as dairies, apiaries, and store houses, we will be holding a Consultants Meeting on "Integration of the SIT with Biocontrol for Greenhouse and Other Confined Insect Pest Management". It will review the potential of initiating a CRP in this area, whose overall objective would be to develop nuclear techniques to complement biocontrol methods to address the increasing demand for low pesticide and sustainable integrated pest management approaches for insect pests in greenhouses and other confined locations. Such confined locations provide ideal conditions for the rapid build-up of pest populations as they are largely protected from abiotic factors and natural enemies. Many of these pests have been exposed to high insecticide pressure over many generations, and resistance has developed in a number of them. Augmentative releases of biocontrol agents are widely used to manage these pests, but not all are well controlled with parasitoids and predators. In case a pest gets out of control it has to be suppressed with insecticides, which then disrupt biocontrol agents and pollinators. In such situations the SIT can be compatible with biological control and could complement the management of those pests that are difficult to control, reducing losses and insecticide residues. This CRP would therefore focus on identifying the constraints to biocontrol in greenhouses and other confined environments and developing complementary approaches to remove these constraints. The Consultants Meeting will take place in the first half of 2016 and we welcome all your suggestions in this new area.

As we are concluding the 2014-2015 cycle of the IAEA Technical Cooperation Programme, a number of technical cooperation projects supporting our Member States are reaching their end. At the same time we are starting the new 2016-2017 cycle with a series of new projects that have been developed together with counterparts in our Member States through a lengthy evaluation process during the last two years and that have been recently approved by the IAEA Board of Governors. On pages 8 and 9 you can find a list of new national, regional and interregional projects that have been funded in the insect pest control area. In addition, there are a number of projects not listed that although approved were unfortunately not funded, and for which extrabudgetary funding is required to be initiated.

We are currently also starting the planning of the programme of activities and budget for the cycle 2018-2019, including all our research, normative and knowledge management activities, and we look forward to receiving input from our readers to continue having a demand-driven approach. In relation to the IAEA Technical Cooperation Programme, we would like to inform our readers that the deadline for our Member States to submit proposals for technical cooperation projects for the financial cycle 2018-2019 is 30 April 2016. These have to undergo first an internal selection process within Member States, where nuclear applications in food and agriculture compete with those in many other fields such as human health, energy, hydrology, industry, marine and terrestrial ecology, etc. and the successful ones are then submitted through official channels to IAEA for evaluation and further development into full projects.

Concerning staff news, we would like to inform you that Jesus Reyes retired in October 2015 after reaching the UN retirement age. Jesus has been a great asset to the Subprogramme, responsible for technology transfer on the control of fruit flies and other plant pests to many Member States, including a number of very successful field programmes. In addition, he participated in standard-setting activities in support of IPPC, developed and updated a series of manuals and guidelines, maintained databases and web pages, and carried out other normative and publishing activities. His advice and dedication are much appreciated, and we will miss him much as a friend and colleague. Jesus has returned to Mexico, and we hope that we will be able to continue relying on his extensive experience for the benefit of FAO and IAEA Member States. He can be reached at jesusreyes20@hotmail.com.

At the same time we also welcome Walther Enkerlin, who has returned to the Joint FAO/IAEA Division, where he served in the same position between 2000 and 2007. Walther holds a PhD from Imperial College in the UK. Between 2007 and 2010 he was the Technical Director of the North American Plant Protection Organization (NAPPO), and subsequently Co-Director in Guatemala of the trinational Guatemala, Mexico, USA Moscamed Programme. He has considerable management and technical experience, including successfully managing this very large SIT programme during the last five years.

Jorge Hendrichs

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
Jorge HENDRICHS	Section Head	J.Hendrichs@iaea.org	21628	Vienna
Rafael ARGILES	Entomologist (Livestock Pests)	R.Argiles-Herrero@iaea.org	-	Addis Ababa
Rui CARDOSO PEREIRA	Entomologist (Plant Pests)	R.Cardoso-Pereira@iaea.org	26077	Vienna
Walther ENKERLIN	Entomologist (Plant Pests)	W.R.Enkerlin@iaea.org	26062	Vienna
Stephen LEAK	Entomologist (Livestock Pests)	S.G.A.Leak@iaea.org	21629	Vienna
Nima MASHAYEKHI-TABRIZI	Programme Assistant	N.Mashayekhi-Tabrizi@iaea.org	21633	Vienna
Enrique NACIF	Team Assistant	E.Nacif@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 (Mosquitoes)	J.Gilles@iaea.org	28407	Seibersdorf
Guy HALLMAN	Entomologist (Post-harvest)	G.J.Hallman@iaea.org	28454	Seibersdorf
Rosemary LEES	Entomologist (Mosquitoes)	R.S.Lees@iaea.org	28429	Seibersdorf
Andrew PARKER	Entomologist (Tsetse)	A.Parker@iaea.org	28408	Seibersdorf
Anita PAVKOVIC	Team Assistant	A.Pavkovic@iaea.org	21632	Seibersdorf

Forthcoming 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.

First RCM on Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes. 22–26 August 2016, Durban, South Africa.

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

Second RCM on Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies.

12–16 December 2016, Panama City, Panama.

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 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.

FAO/IAEA First Coordination Meeting of Regional 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.

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 April, 2016, Vienna, Austria.

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.

FAO/IAEA Regional Training Course on Taxonomy and Identification of Fruit Fly Pest Species for Southeast Asia (under Regional TC Project RAS5067). 25–29 April 2016, Bangkok, Thailand.

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.

Workshop to Standardize Sampling and Bioassay Methods for Assessing Field Performance of Sterile Male Lepidoptera. 19–20 August 2016, Durban, South Africa.

FAO/IAEA First Coordination Meeting of 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). 11–15 July, 2016, Maputo, Mozambique.

FAO/IAEA Regional Workshops on Harmonization of Surveillance Systems Against Non-native Fruit Flies and Emergency Response Capabilities (under Regional TC Project RLA5070). 18–22 July, 2016, Guatemala City, Guatemala.

FAO/IAEA Regional Workshop to Present Respective Experiences with Fruit Fly Activities and Synergize Future Activities (under Regional TC Project RER5021). 25–29 July, 2016, Vienna, Austria.

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

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

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). 15–19 August, 2016, Kuala Lumpur, Malaysia.

Ninth Meeting of the Tephritid Workers of the Western Hemisphere (TWWH), tentatively for October 2016, Buenos Aires, Argentina.

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.

Past Events (2015)

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

Second RCM on Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes. 9–13 March 2015, Juazeiro, Brazil.

Final RCM on Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade. 1–5 June 2015, Saint Pierre, La Réunion, France.

First RCM on Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies. 6–10 July 2015, Vienna, Austria.

Third RCM on Use of Symbiotic Bacteria to Reduce Mass-rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application. 26–30 October 2015, Antigua, Guatemala.

First RCM on Mosquito Handling, Transport, Release and Male Trapping Methods. 23–27 November 2015, Vienna, Austria.

II. Consultants and Expert Meetings

Consultants Meeting on Mosquito Male Trapping Methods to Monitor the Efficacy of SIT Programme in the Field. 16–20 February 2015, Vienna, Austria.

Consultants Meeting on Improved Field Performance of Sterile Moths to Enhance SIT Application. 13–17 April 2015, Vienna, Austria.

Consultants Meeting on A Generic Approach for the Development of Genetic Sexing Strains for SIT Applications. 1–5 June 2015, Vienna, Austria.

Consultants Meeting on Assessment of Semiochemicals to Enhance *Bactrocera* spp. Sterile Male Performance. 25–27 November 2015.

FAO/IAEA Expert Meeting on Harmonization of Post-factory Product Quality Control for Fruit Fly SIT. 30 November – 4 December 2015, Vienna Austria.

III. Other Meetings/Events

FAO/IAEA Regional Training Course on Free Open Source Software for GIS and Data Management applied to tsetse and trypanosomosis control programmes, French edition (under the Regional TC Project RAF5070). 19–30 January 2015, Vienna, Austria.

FAO/IAEA Coordination Meeting of the Africa Regional TC Project RAF5069 on Supporting a Feasibility Study to Eradicate Tsetse from Southern Mozambique, South Africa and Swaziland. 9–10 February 2015, Pretoria, South Africa.

FAO/IAEA Regional Training Course on Fruit Fly Biocontrol in West Africa (under Regional TC Project RAF5061). 2–6 March 2015, Nairobi, Kenya.

Tenth Session of the Commission on Phytosanitary Measures, International Plant Protection Convention, FAO. 16–20 March 2015, Rome, Italy.

FAO/IAEA First Meeting for Central America – Mexico to Strengthen Surveillance and Response to Outbreaks of New World Screwworm (COPEG) (under the Regional TC Project RLA5067). 6–8 May 2015, Panama City, Panama.

FAO/IAEA Regional Training Course on Fruit Fly Monitoring and Suppression, Including MAT and SIT for Indian Ocean (under Regional TC Project RAF5062). 29 June to3 July 2015, Reduit, Mauritius.

FAO/IAEA Regional Meeting on SIT Application, Including Rearing, Irradiation and Release of Fruit Flies (under Regional TC Project RAF5062). 1–3 July 2015 Reduit, Mauritius.

FAO/IAEA Regional Training Course on Free Open Source Software for GIS and Data Management Applied to Fruit Flies in the Balkans and the Eastern Mediterranean (under Regional TC Project RER5020). 27–31 July 2015, Vienna, Austria.

FAO/IAEA Interregional Training Course on The Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests (under Interregional TC Project INT5151). 3–28 August 2015, Metapa, Chiapas, Mexico and Antigua/El Pino, Guatemala.

Meeting of the Technical Panel on Phytosanitary Treatments (TPPT), International Plant Protection Convention, FAO. 31 August – 4 September 2015, Fukushima, Japan.

FAO/IAEA Regional Training Course on Quarantine and Pest Risk Analysis Applied to Fruit Flies in the Balkans and the Eastern Mediterranean (under Regional TC Project RER5020). 7–11 September 2015, Bucharest, Romania.

FAO/IAEA Regional Training Course on The Use of Population Genetics and GIS to Identify Isolated Tsetse Populations, (under Regional TC Project RAF5070). 21 September – 2 October 2015, Addis Ababa, Ethiopia.

Meeting of the Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies (TPFF), International Plant Protection Convention, FAO. 19–23 October 2015, Vienna, Austria.

Workshop on Microbial and Processing Criteria for Industrial Production of Probiotics or Bacteria as Source of Protein to Improve Fruit Fly Quality and SIT Efficiency. 23–25 October 2015, Guatemala City, Guatemala.

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	Continuing 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*)	Stephen Leak
Burkina Faso	BKF5012	Collecting Baseline Data and Implementing Fruit Fly Suppression in Mango Fruit	Rui Cardoso Pereira
Libya	LIB5011	Enhancing Area-Wide Integrated Management of Fruit Flies	Walther Enkerlin
Mauritius	MAR5019	Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for the Integrated Control of Mosquitoes	Rosemary Lees Jeremie Gilles
Mauritius	MAR5022	Reducing Insecticide Use and Losses to Melon Fly (*Bactrocera cucurbitae*) through Environment-Friendly Techniques to Increase Production in Different Areas, Phase II	Jorge Hendrichs Rui Cardoso Pereira
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	Stephen Leak
		Continuing Regional Projects	
Regional Africa	RAF5069	Supporting a Feasibility Study to Eradicate Tsetse from Southern Mozambique, South Africa and Swaziland	Marc Vreysen Rui Cardoso Pereira
Regional Africa	RAF5070	Supporting Area-Wide Tsetse and Trypanosomosis Management to Improve Livestock Productivity and Enable Sustainable Agriculture and Rural Development (Phase II)	Rafael Argiles Stephen Leak
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 Rosemary Lees
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 Rosemary Lees

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 Latin America	RLA5067	Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm	Walther Enkerlin
		New National Projects to Start in 2016	
Burkina Faso	BKF5018	Improving Agro-Forestry and Agro-Pastoral Production through the Use of Nuclear Technologies	Adly Abdalla Rafael Argiles
Botswana	BOT5013	Using the Sterile Insect Technique Integrated with Other Suppression Methods for Managing *Bactrocera dorsalis*	Rui Cardoso Pereira
Ecuador	ECU5029	Improving Integrated Fruit Fly Management in Fruit and Vegetable Production Areas	Walther Enkerlin Carlos Cáceres
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
Mexico	MEX5031	Using the Sterile Insect Technique to Control Dengue Vectors	Kostas Bourtzis Rosemary Lees
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 Rosemary Lees
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	Rosemary Lees 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 Rosemary Lees
Sudan	SUD5038	Implementing the Sterile Insect Technique for Integrated Control of *Anopheles arabiensis*, Phase II	Jeremie Gilles Rosemary Lees Adly Abdalla
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	Stephen Leak
		New Regional Projects to Start in 2016	
Regional Africa	RAF5077	Supporting Area-Wide Tsetse and Trypanosomosis Management to improve Livestock Productivity, Phase III	Rafael Argiles Andrew Parker
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 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 Rosemary Lees
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
		New Interregional Project to Start in 2016	
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 Rosemary Lees Rui Cardoso Pereira

Highlights of Technical Cooperation Projects

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

FAO/IAEA Interregional Training Course on Use of the Sterile Insect and Related Techniques for the Area-wide Integrated Management of Insect Pests

From combating malaria-carrying mosquitos to protecting fruit from flies, long-term sustainability of insect pest control using nuclear techniques requires a solid technical foundation and strong management skills locally, agreed participants of a recent training course organized by the IAEA in cooperation with the Food and Agriculture Organization of the United Nations (FAO).

The month-long course in Mexico and Guatemala targeted trainees from all regions of the world to train them in developing and managing projects using nuclear and other techniques to control insect pests that affect plants, animals and humans.

The four week course was successfully held in Mexico and Guatemala, from 3-28 August 2015, with 25 participants from 23 countries in Africa, Asia, Australia and Latin America, selected for the course among close to one hundred applicants. The excellent organization and hospitality both in Mexico and Guatemala is much appreciated.

The course was held at the Moscamed/Moscafrut complex in Metapa and Tapachula, Chiapas, Mexico, and in Antigua, El Pino facility and Retalhuleu, Guatemala. It provided a thorough overview and training on all process involved in the application of nuclear-related techniques within the context of area-wide integrated insect pest management programmes to managers of insect control programmes, animal/human health and plant protection officials and applied research entomologists.

The course included visits to three mass-rearing and sterilization facilities, mass-production of parasitoids, release centres, monitoring and other field operations, as well as various hands-on laboratory exercises.

Participants of the interregional training course on Use of the Sterile Insect and Related Techniques for the Area-wide Integrated Management of Insect Pests (Antigua, El Pino and Retalhuleu, Guatemala and Metapa and Tapachula, Mexico).

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)

In the frame of this TC project the training course on the "Strategy and Evaluation of Trials on *Aedes* Mosquito Population Suppression using the Sterile Insect Technique" was organized in Singapore from 16 to 20 November 2015. Twenty-four scientists from twelve countries (Brazil, China, Fiji, Indonesia, Lao PDR, Malaysia, Myanmar, Pakistan, Philippines, Singapore, Sri Lanka and Thailand) as well as four scientists from Singapore attended this training course.

The training course took place in the facilities of the National Environment Agency (NEA) and Singapore Polytechnic. The NEA has an active population control program against *Aedes aegypti*, a major mosquito vector species. Lectures and practical training were provided by NEA staff members, two experts from Australia and French Polynesia, and a technical officer from the Joint FAO/IAEA Insect Pest Control Laboratory.

During the course, the participants also had the opportunity to visit the laboratories of the Environment Health Institute in Biopolis and to attend demonstrations on mosquito-virus interaction experiments as well as on preparation of Gravitraps for field deployment.

Participants of the IAEA TC RAS5066 training course on the Strategy and Evaluation of Trials on Aedes *Mosquito Population Suppression using the Sterile Insect Technique (National Environment Agency, Singapore).*

Reducing Insecticide Use and Losses to Melon Fly (*Bactrocera cucurbitae*) through Environment-friendly Techniques to Increase Production in Different Areas (MAR5022)

Counterparts in Mauritius have received a new Ob-servo Ignis self-shielded cobalt-60 irradiator. The irradiator has been installed in the Entomology Section of the Ministry of Agriculture, and was commissioned in August 2015.

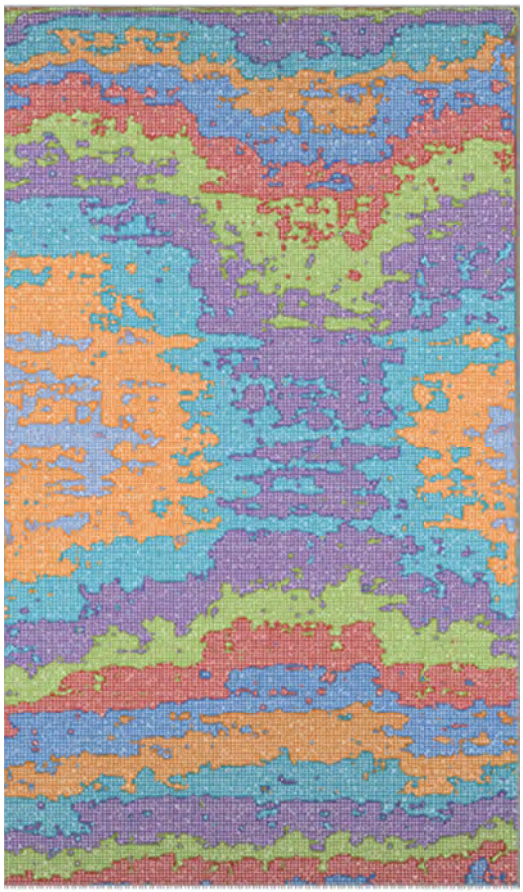
Ob-servo Ignis self-shielded cobalt-60 irradiator.

A training course on dosimetry for the new irradiator was held in Mauritius from 6 to 8 October 2015. The course was attended by 14 participants from the fruit fly control (MAR5022), mosquito control (MAR5019) and plant breeding (MAR5020) projects, as well as from the University of Mauritius.

The course covered the basics of radiation protection, operation of the new irradiator and calibration and use of Gafchromic HD-V2 film for routine dosimetry and for dose mapping.

Participants of the training course on dosimetry for the new irradiator in Mauritius.

The dose mapping exercise showed that the vertical dose uniformity within the exposure chamber is low (see dose map below) and will require that the exposure volume be restricted to avoid approximately the top and bottom 25% of the chamber. Premature rusting of some components of the irradiator also needs to be addressed.



Dose map of a vertical section through the irradiation chamber of the Ob-servo Ignis irradiator installed in Mauritius. Colours represent 5% steps in dose rate.

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 (RAF5072)

A symposium was organised under the framework of project RAF5072 at the invitation of the second annual meeting of the Pan African Mosquito Control Association (PAMCA) in Dar es Salaam, Tanzania, with the title "The Sterile Insect Technique: An additional control technique for mosquitoes in Africa, the Indian Ocean Region, and beyond".

Six presentations were given as part of the symposium, including a lively talk introducing genetic control of mosquito vectors, a second introducing the SIT for mosquito control and lessons learned from historical attempts, and four presentations on the progress made in four feasibility studies from the national counterparts from Reunion, Mauritius, South Africa and Sudan.

The audience comprised a broad range of influential partners from academia (internationally-recognized scientists from the North and the South and students), stakeholders, public health workers and industry representatives. The symposium provided a good overview of genetic control in the context of a conference that was primarily focused on 'conventional' control techniques including larviciding, indoor residual spraying and insecticide treated bednets.

Symposium on the subject of "The Sterile Insect Technique: An additional control technique for mosquitoes in Africa, the Indian Ocean Region, and beyond" presented the achievements of several groups conducting feasibility trials of the SIT against mosquitoes, including Anopheles vectors of disease to a diverse audience at the second annual meeting of the Pan African Mosquito Control Association.

There was considerable discussion after the presentations, showing that they were well received and sparked interest. Discussion included the hope that advances made in the SIT feasibility studies in the islands of the west-Indian Ocean and in isolated sites in Sudan and South Africa, will

open the way to the potential application of the SIT in other countries of continental Africa. As previous pilot studies have been performed mainly on small scales, this stimulated a question on what would be involved when scaling the technique up to an operational scale to tackle larger areas in African countries.

One discussion point was the use of bovine or human blood for feeding female mosquitoes under mass-rearing conditions, and the methods being used to make sure that the blood used is not contaminated by pathogens which could be detrimental to mosquito production. The different regulatory environment in many countries was also mentioned, which is an important consideration when planning a trial or application requiring mosquito releases.

Following this positive reception of the somewhat unique symposium, the IAEA was approached to consider repeating the exercise at future PAMCA meetings.

Supporting Fruit Flies in the Balkans and the Eastern Mediterranean (RER5020)

Regional Training Course on Free Open Source Software for GIS and Data Management Applied to Fruit Flies in the Balkans and the Eastern Mediterranean

This Regional Training Course was attended by 17 participants from 11 Member States (Albania, Bulgaria, Croatia, Cyprus, Georgia, Greece, Montenegro, Romania, Slovenia, the Former Yugoslav Republic of Macedonia and Turkey). The course was held at the IAEA Headquarters, Vienna, Austria from 27–31 July 2015.

Participants of the regional training course on Free Open Source Software for GIS and Data Management Applied to Fruit Flies in the Balkans and the Eastern Mediterranean (IAEA, Vienna, Austria).

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

- Open Source software
- Using the Live DVD environment and tutorial
- Loading layers, vectors and raster data
- Coordinate systems
- Creating a spatial database
- Adding and editing attribute data from various sources
- Creating database joins and spatial views
- Working with raster data
- Individual practice with country data

Regional Training Course on Quarantine and Pest Risk Analysis Applied to Fruit Flies in the Balkans and the Eastern Mediterranean

This Regional Training Course was attended by 21 participants from 11 Member States (Albania, Bulgaria, Croatia, Cyprus, Georgia, Greece, Montenegro, Romania, Slovenia, the Former Yugoslav Republic of Macedonia and Turkey). The course was held in Bucharest, Romania, from 7–11 September 2015.

Participants of the regional training course on Quarantine and Pest Risk Analysis Applied to Fruit Flies in the Balkans and the Eastern Mediterranean (Bucharest, Romania).

The programme of the training course included a series of lectures, practical sessions and discussions and covered the following main topics:

- Basics of pest risk analysis and pest risk assessment
- Assessing pest establishment, pest spread and pest impact
- Fruit fly pest risk management
- Development of quarantine export strategies for fruit fly hosts
- The regulatory process for market access
- Risk management options and systems approach.

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

The Tsetse Fly Eradication Project in Senegal Wins Award for Best Sustainable Development Practices

The project in Senegal to eradicate tsetse flies that is supported by the FAO/IAEA was selected as one of 18 Best Sustainable Development Practices on Food Security at the EXPO Milano 2015. The project was selected among 749 projects for its contribution to furthering sustainable development of small rural communities in marginal areas: it has successfully improved food security and public health in target areas of Senegal through reducing the tsetse fly population by up to 95% using nuclear and other techniques.

Tsetse flies are blood-sucking insect pests threatening food security in the Niayes, a coastal area south east of Dakar. Their bites jeopardize livestock health, and the flies themselves transmit parasites that carry a life-threatening infection to livestock known as African animal trypanosomosis or nagana. These flies can lower quality of life and lead to a loss of milk and meat provided by livestock, which significantly impacts farmers' livelihoods and stifles local development.

To manage this problem, the Government of Senegal, with the technical cooperation and financial support of the IAEA, the Food and Agriculture Organization of the United Nations (FAO), the French Agricultural Research Centre for International Development (CIRAD) and the USA under the Peaceful Uses Initiative, set out in 2005 to use insecticides and the sterile insect technique (SIT), a form of insect birth control involving ionizing radiation, to eradicate the tsetse fly in the Niayes.

The target area was divided into three blocks, and the project has successfully eradicated the fly population in the first block, and in the second block has reduced the presence of flies by more than 98%. The implementation of the technique was recently initiated in the third block. The overall number of trypanosomosis cases in the region has gone down from 40% to 10%, paving the way for local farmers to replace their lost bovine herds with a more productive and higher yielding breed of cattle.

Tsetse fly eradication team receiving the award for the Best Sustainable Development Practices on Food Security at the EXPO Milano 2015 (Milan, Italy).

The Senegal Minister of Livestock, together with Baba M. Sall of the Directorate of Veterinary Services (SDV) and Momar Seck of the Senegal Institute of Agricultural Research received the award on behalf of the project during the Milan EXPO.

The award is part of a programme to raise awareness and spread the best scientific solutions for improving food security and sustainable development, in conjunction with the 'Feeding the Planet, Energy for Life', EXPO Milano 2015 — a six month international showcase highlighting the importance of food security in developing regions and the application of science to achieve these aims.

"We are honoured to be recognized alongside such diverse and innovative projects as part of this important award programme," said Sall. "This award helps us to raise awareness about how nuclear and other techniques can be used to improve food security worldwide. We hope our success with eradicating tsetse flies in the Niayes area continues and can be a source of scientific solutions and inspiration for Senegal and other African countries to achieve their sustainable development goals."

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 Andrew Parker
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
	New CRP	
D4.10.26	Improved Field Performance of Sterile Male Lepidoptera to Ensure Success in SIT Programmes (2016-2021)	Marc Vreysen

First RCM of the CRP on *Mosquito Handling, Transport, Release and Male Trapping Methods*. 23–27 November 2015, Vienna, Austria

The first RCM of the newest CRP to help develop the SIT package for mosquitoes was attended by 21 scientists from Australia, Brazil, Burkina Faso, China, France, French Polynesia, Germany, Indonesia, Italy, Mauritius, Mexico, Philippines, Senegal, South Africa, Spain, Sweden, Thailand, the United Kingdom and the United States of America. Ten observers from seven countries were also in attendance.

Participants presented their recent and planned research and development activities in the field, followed by more detailed discussion and planning sessions focussing on the two main activities: mosquito release and field monitoring. The proposed research, development and evaluation of methods and equipment in these two areas will be of enormous importance in applying the SIT package against mosquito vectors of disease. Many methods will be applicable in a range of settings and several will be generic for target species and genera, though some specific biological parameters must be considered, for example further investigation and exploitation of *Anopheles* swarming behaviour.

Research is already underway at the IPCL in Seibersdorf to define the critical biological parameters during the whole process. For example, in order to design a release device, it is first necessary to know the specific weight and volume of different batch sizes of immobile males to calculate the maximum load that could be used for an aerial release. A series of preliminary trials have been conducted using *Anopheles arabiensis* to pinpoint the temperature thresholds for immobilisation of adult mosquitoes, around which transport and release should be designed.

Thus far, experiments have investigated the effects of compaction and ventilation upon survival and any interaction, and aimed to define a suitable temperature range for transportation in addition to the maximum duration at which immobilised males could be transported without survival being impacted. Studies have been initiated to explore whether chilled adults generate significant metabolic heat which could, in theory, impact upon the transportation temperature.

Third RCM on *the Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application*. 26–30 October 2015, Antigua, Guatemala

The third RCM was hosted by the Guatemala/Mexico/USA Regional Mediterranean Fruit Fly Program and thirty two participants including six observers from sixteen countries attended the RCM.

The participants reported on the progress made since the last RCM in 2014 in the following three areas:

1. Larval diet and radiation effects
2. Probiotics in adults and
3. Symbionts and novel control tools.

Significant progress has been made with the characterization of gut microflora of larvae and adults of several species of fruit flies of economic importance. Using conventional culture methods and/or biotechnology and DNA sequencing approaches, some bacteria were identified as a potential source of protein or probiotic to enhance sterile insect competitiveness.

One *Enterobacter* species that was isolated from the Mediterranean fruit fly gut has been selected, based on positive results at the experimental scale, to be mass-cultured to assess its potential to replace the costly brewer's yeast as a source of protein in the larval diet. Results presented showed that radiation treatment during the late pupal stage to induce reproductive sterility in fruit flies can disrupt symbiotic associations by favouring some bacterial species and suppressing others.

The presence of the reproductive symbiont *Wolbachia* was reported in *Anastrepha striata, A. obliqua*, and *Bactrocera dorsalis*, while the absence of *Wolbachia* in *Ceratitis capitata* was confirmed from several populations from Brazil and Turkey.

Participants of the Third RCM of the CRP on Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application (Antigua Guatemala, Guatemala).

Workshop on *Microbial and Processing Criteria for Industrial Production of Probiotics or Bacteria as Source of Protein to Improve Fruit Fly Quality and SIT Efficiency*, 23–25 October 2015, Guatemala City, Guatemala

The objective of the workshop was to update de participants on the latest knowledge and techniques of molecular analysis of microbial communities of fruit flies of economic importance, characterization of insect-associated bacteria using biochemical and chemotaxonomic markers, and bioreactors for mass-production of insect-associated bacterial strains. The workshop was held in conjunction with the third RCM of the CRP on symbiotic bacteria.

First RCM on *Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies,* 6–10 July 2015, Vienna, Austria

The First RCM was attended by 23 scientists from Australia, Brazil, China, Germany, Greece, Guatemala, India, Italy, Mexico, Panama, Thailand and USA.

Participants of the First RCM of the CRP on Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies (Vienna, Austria).

Twenty one scientific papers and related scientific presentations on the rearing efficiency and competitiveness of sterile male strains produced by genetic, transgenic or symbiont-based technologies as well as on the development or the refinement of the technologies used in the development of such strains were presented and reviewed.

The CRP can be very productive and extremely useful since SIT programmes will benefit from: (a) the comparative evaluation of the performance and genetic stability of sterile males produced by the different technologies, (b) the refinement of existing technologies for the development and field application of strains for agricultural pests and disease vectors, and (c) the assessment of potential genetic instability and/or horizontal transfer phenomena towards the use of the strains developed by the different platforms.

Developments at the Insect Pest Control Laboratory (IPCL)

INSECT GENETICS AND MOLECULAR BIOLOGY

Towards the development of mosquito genetic sexing strains: the search for mutations in *Aedes albopictus*

The sterile insect technique package for mosquitoes requires the development of efficient and robust genetic sexing strains (GSS) which would ensure the elimination of any females prior to the release of sterile males. This is an absolutely critical step since female mosquitoes are the vectors of major human pathogens causing diseases such as malaria and dengue. For the development of a GSS, morphological and / or conditional lethal mutations (like temperature sensitive lethal) would be extremely helpful. We have therefore initiated an EMS-based mutagenesis screen to isolate such mutations in *Aedes albopictus* (Rimini strain) in collaboration with a scientist from China, Shi Chen.

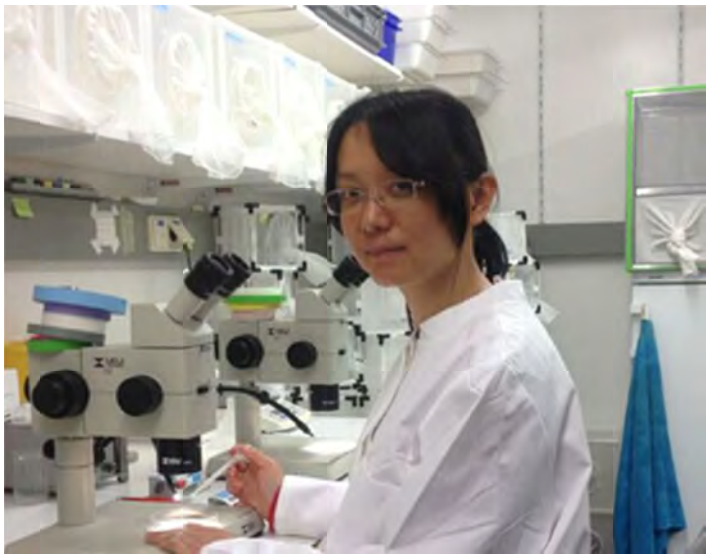
Our initial efforts focused on determining the appropriate experimental conditions as well as a suitable EMS concentration which would result in sufficient viability and fertility and, potentially, the isolation of useful mutations. Candidate morphological mutations have been detected mainly at the larval and pupal stage and the majority of them have been viable and fertile. In parallel, the laboratory colony has been screened for the presence of naturally occurring mutations. In all cases, appropriate crosses were set up to determine the pattern of genetic inheritance for the observed trait. The most suitable mutations will be selected for the construction of classical GSS for this major mosquito vector species.

Effect of irradiation and diet on Mediterranean fruit fly-gut associated bacterial communities

Previous studies by Boaz Yuval and Edouard Jurkevitch's groups revealed the presence of several bacterial species, primarily members of the genera *Klebsiella*, *Enterobacter*, *Providencia*, *Pectobacterium*, *Pantoea*, *Morganella* and *Citrobacter* in the Mediterranean fruit fly. It has also been shown that the Mediterranean fruit fly associated bacterial community is dynamic and may be affected by several factors including developmental stage, environment and genetic background. It has also been suggested that irradiation might induce changes in the adult-associated bacterial community.

Our recent studies showed that the Mediterranean fruit fly VIENNA 8 genetic sexing strain gut-associated community is dominated by the presence of *Enterobacter* sp., *Providencia* sp. and *Acinetobacter* sp. In addition to studies that showed that the use of probiotics in the larval diet can improve productivity and reduce larval rearing duration, we have extended our studies to assessing in more detail the effect of irradiation and diet on the structure and the density levels of the Mediterranean fruit fly gut-associated bacterial communities by using classical microbiological, next generation sequencing and molecular-based approaches.

The ultimate goal of our study is to identify the role different gut-associated bacterial species may play during the process of laboratory adaptation, their potential effect on mass-rearing efficiency and male mating competitiveness, as well as their potential use as probiotics for the enhancement of mass-rearing.



Shi Chen of China engaged in the screening of potential mutations of Aedes albopictus.

PLANT PESTS

As mentioned in a previous newsletter (IPC NL 85), we have been using culture-dependent and culture independent approaches to characterize and exploit the gut associated microbiota of some key fruit fly species. Three different microbiological media have been used to isolate at least three different bacteria species from the guts that were dissected from Mediterranean fruit fly larvae, as well as from female and male adults of different age. Using 16S rRNA gene-based sequencing analysis, it was shown that two out of the three isolated bacteria species belong to the Enterobacteriaceae, which are commonly present in the gut of Tephritidae.

In collaboration with colleagues from the Democritus University of Thrace, Greece, one of these species was selected to be cultured in larger quantities to be used, after

inactivation, as a nutritional supplement in the larval diet of the VIENNA 8 genetic sexing strain of the Mediterranean fruit fly to replace the costly brewer yeast as a source of protein and essential amino acids. The effect of these supplements on different biological parameters was assessed, including survival and development of the immature stages, mating competitiveness, survival with supply of food and under starvation, and flight ability.

Preliminary results suggest that the use of dry biomass of bacteria as a replacement of yeast in the larval diet of the Mediterranean fruit fly has potential as a source of protein and essential amino acids as positive effects were observed with respect to developmental and quality control parameters and sexual behaviour in field cages. We expect to inform our readers about the final results of this study in one of the future issues.

We have continued the collaboration with the Institut de Recherche et de Développement en Agroenvironnement (IRDA) in Québec, Canada to develop rearing methods for the spotted wing Drosophila (*Drosophila suzukii*) and to develop radiation dose response curves. This research is part of an assessment whether the SIT could potentially be integrated with other control tactics in greenhouses against this invasive pest.

Geneviève Lanouette of Canada checking productivity and egg hatch of the experimental Drosophila suzukii *colonies.*

Phytosanitary treatment research

Recent research under the USDA/IAEA collaborative agreement, "Development of phytosanitary treatments for exotic tephritid fruit flies" has recently concentrated on cold treatments. The most cold-tolerant stage of *Bactrocera tau* was identified as the late 3rd instar, and a specific treatment schedule is being confirmed via large-scale testing. Testing to identify the most cold-tolerant stage of *Anastrepha grandis* is well underway. Populations of *Ceratitis capitata* from Argentina, Australia, and Spain are being compared to determine if they differ in cold tolerance. The results of this research guide phytosanitary treatment scheduling at the national and international levels among Member States of FAO and IAEA, as well as the International Plant Protection Convention (IPPC).

LIVESTOCK PESTS

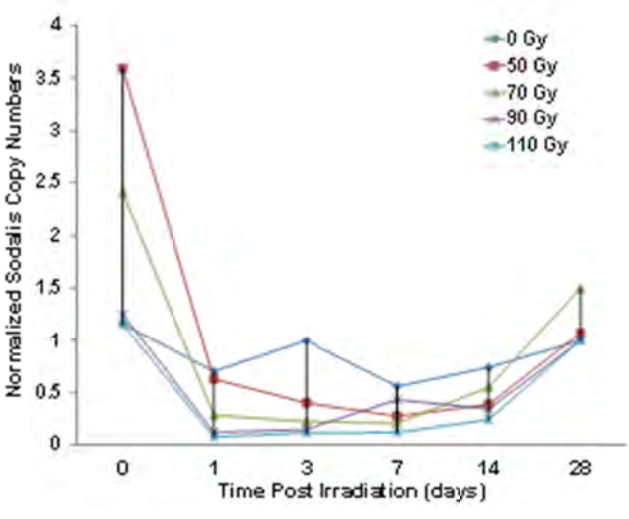
Impact of irradiation on tsetse symbionts

Tsetse flies harbour three symbiont bacteria *Wigglesworthia glossinidia*, *Sodalis glossinidius* and *Wolbachia pipientis*. The SIT has proven to be an effective control tactic to eradicate isolated tsetse fly populations in programmes that are implemented following an area-wide integrated pest management approach.

To minimize or eliminate the risk that sterile male tsetse flies released in endemic sleeping sickness areas might increase the disease incidence before achieving eradication, they are fed blood that has been treated with trypanocidal drugs before being released. However, the development of tsetse strains that are refractory to trypanosome infections would be very practical and desirable.

One approach is to modify the *Sodalis* bacteria so that they would produce anti-trypanosome factor(s) in the sterile males that are destined for release. However, as sterile males are also irradiated before being released, it is necessary to assess the impact of radiation on the *Sodalis* community.

This work is being conducted by a visiting scientist from Turkey, Güler Demirbas, and primary results indicate that irradiating tsetse male flies did not increase the mutation rate in the *Sodalis* genome. The irradiation, however, showed a negative impact on the titre of *Sodalis* as compared with non-irradiated flies (see figure).



Impact of different doses of irradiation on the Sodalis *titre in the tsetse fly* G. nn. morsitans.

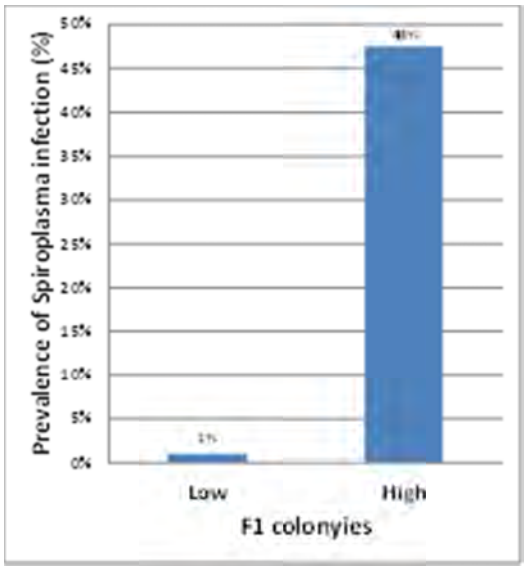
To avoid the negative impact of irradiation treatment on *Sodalis* multiplication, several irradiation doses were tested and the results indicated that the effect of radiation was less severe with lower irradiation doses (< 50 Gy). More work is in progress to further investigate the impact of irradiation on tsetse flies that harbour transgenic *Sodalis* bacteria.

Interaction between tsetse symbionts and SGHV trans-generation transmission

As previously reported, trans-generation transmission of the tsetse pathogenic salivary gland hypertrophy virus (SGHV) seems to be dependent on tsetse microbiota because virus infected females fed on blood supplemented with ampicillin (that removes much of the microbiota) did not produce F_1 progeny with SGH symptoms (unlike untreated control flies).

To identify which bacterial agents might play a role in the transmission of the virus, a selective *Sodalis* specific antibiotic, i.e. streptozocin, was tested for its impact on *Sodalis* density and consequently of the SGHV trans-generation transmission. The preliminary results indicated that SGHV-injected females that were fed on blood with a high concentration of streptozocin had a reduced *Sodalis* count and their F_1 progeny showed a significant reduction in SGH prevalence as compared with virus injected flies that were fed on blood without the antibiotic.

These preliminary results seem to suggest that *Sodalis* plays an important role in the vertical transmission of the SGHV. Additional results however, indicated that feeding flies with a high concentration of streptozocin significantly reduced the flies' productivity, possibly due to interference with important biological processes for which *Sodalis* might be responsible or due to toxicity of the streptozocin.



Prevalence of Spiroplasma *infection in* F_1 G. f. fuscipes *descendants from parental flies that had a low and high titre of Spiroplasma infection, indicating that the low and high infections are inherited.*

The impact of Spiroplasma infection on *G. fuscipes fuscipes*

George Tsiamis from the Department of Environmental and Natural Resources Management University of Patras Agrinio, Greece recently detected the presence of *Spiroplasma* spp. in the tsetse fly *G. fuscipes fuscipes*. Therefore, we have initiated studies to assess the effect of the presence of these *Spiroplasma* on the performance of the *G. f. fuscipes* colony. This work is carried out by Inessa Kalantarow who established two *G. f. fuscipes* colonies, i.e. one with a low and one with a high density of *Spiroplasma*. The evaluation of effect of the infection on performance of the adult flies is in progress.

HUMAN DISEASE VECTORS

MosquitoCopter – fighting malaria from a new perspective

In 2014, Bill Gates declared that the most dangerous animal in the world was not sharks, snakes or even humans.… but the mosquito! Far more deadly than sharks, crocodiles and snakes combined, 725,000 people are estimated to be killed every year by the diseases carried by female mosquitoes. Male mosquitoes feed only on natural sugar sources like nectar, but female mosquitoes feed on blood to get the proteins they need to produce eggs. In this way they spread the agents causing malaria, dengue, Chikungunya, yellow fever, zika fever, elephantiasis and many other diseases.

Mosquitoes are spreading diseases that threaten people around the globe. Approximately 40% of the human beings on the planet are at risk of malaria alone! From the arid riverbanks of Sudan, to the remote homesteads of South Africa, from the modern apartment blocks of Singapore to the crowded favelas of Brazil, these mosquitoes are wreaking havoc in many very hard to reach places.

With conventional control methods losing effectiveness or not being applicable for new invasive species, new genetic control methods such as the SIT are being developed to combat disease spreading mosquitoes. Male mosquitoes will be produced in large numbers in factories and made sterile using innovative technologies. They are released to find the wild female mosquitoes, which they mate with but who then produce no offspring, reducing the population in the next generation. But somehow these sterile males have to get to the hiding places of the females, often beyond the reach of ground release.

What if drones could be used to scale those tower blocks, reach those distant villages and traverse the deserts of Sudan? Collaboration between the IPCL and HEIGHT TECH, a German company specialising in robust and stable unmanned aerial vehicles (UAVs) for civilian use, aims to do just that. Especially developed UAV with enhanced payload capabilities and elongated flight times are being combined with release devices developed to

automatically release male mosquitoes in positions and at rates guided by specialised GPS software. With a payload of half a million chilled adult mosquitoes (500g) and a flight time of up to 30 minutes a square kilometre could be covered by these sterile males. Releases can be tailored to the target female population on a very fine scale.

Unmanned aerial vehicle (UAV) also known as drone that can potentially be used on the release of sterile mosquitoes.

Coverage of a target area by drone release could be either homogeneous or carefully focused on areas with the highest density of mosquitoes, no matter what the ground cover or available infrastructure. The cost-benefit improvement on current ground release techniques would be huge, and the regions which could now be treated with new genetic control techniques would be vastly increased, leading to an efficient method of fighting the world's deadliest animal.

Some of the poorest people in the world could be reached by this combination of high tech drone technology and biological know-how, relieving their disease burden and improving their quality of life.

See also the video on: https://www.youtube.com/watch?v=XfReYHQQ_S0&feature=youtu.be

Evaluation of the potential to reuse dirty larval water for the rearing of *Anopheles arabiensis*

Mass-production of mosquitoes demands large volumes of water; an estimated 250 litres of water is required to raise 200,000 eggs in one larval rearing rack. Many arid and semi-arid countries face difficulties of acute water shortage, deterioration of water quality, and other environmental constraints. It is estimated that by 2025, 1800 million people will be living in countries or regions with absolute water scarcity, and two thirds of the world's population will likely be under water stress.

For other water-intensive activities there has been increasing interest in treatment and reuse of waste water in many parts of the world, and the option of reusing water to rear successive generations of larvae is attractive to reduce water usage and running costs, and in order to help to make this control method viable.

Therefore, we have initiated work at the IPCL to assess whether dirty water is a suitable rearing medium that could replace the 'clean' dechlorinated water that is currently routinely used. A series of 3 experiments were carried out to evaluate the effect of dirty water on several parameters of insect quality: hatch rate, larval development time, pupation, adult emergence, body size, and adult longevity. Preliminary results indicate that reusing dirty water seems suitable in terms of egg hatch, larval development time and survival to adulthood. But when reared from first-instar larvae in dirty water, adult longevity and wing length are reduced.

Rearing mosquitoes in this mass rearing rack system uses large quantities of water, but the environmental footprint could be reduced if water could be reused.

Further research into the potential causes (low oxygen concentration, bacterial infection, and pollution) of the reduced quality of adults reared in dirty water is being carried out. Moreover, we will investigate the potential of affordable options to recycle water such as filtration, boiling and autoclaving water and assess the impact of such treated water on key fitness parameters of malaria vector mosquitoes.

Reports

The National Environment Agency's *Wolbachia* Workshop for *Aedes* Mosquito Population Control in Singapore, 20–22 July 2015, Singapore

A *Wolbachia* workshop was organized by the Environment Health Institute (EHI) of the National Environment Agency (NEA) in Singapore on 21 July 2015. The objective of the workshop was to engage the scientific community on strategic research for mosquito population control by facilitating networking and, particularly, by exploring possibilities of using *Wolbachia*-carrying males alone or combined with radiation to suppress *Aedes* mosquito populations. Lectures were provided by several NEA staff members, experts from the National University of Singapore, two international experts and a technical officer from the Joint FAO/IAEA Insect Pest Control Laboratory. Discussions on collaborative opportunities, visiting of EHI's laboratories and facilities, field site visits also took place on 20 and 22 July 2015.

First Meeting of the Phytosanitary Measures Research Group, 17–20 August 2015, Nelspruit, South Africa

The first meeting of the Phytosanitary Measures Research Group (PMRG) was held in Nelspruit, South Africa. The PMRG is an international, interdisciplinary, informal research group devoted to solving problems related to phytosanitary measures impacting trade and invasive pest species. It functions in an advisory capacity to the Technical Panel on Phytosanitary Treatments (TPPT) of the International Plant Protection Convention (IPPC); therefore, results of research and analysis of the PMRG may influence TPPT recommendations and IPPC decisions. The formation of this group was a key recommendation arising from a December 2013 Expert Consultation on Cold Treatments (ECCT) sponsored by the IPPC.

Participants of the Phytosanitary Measures Research Group (PMRG) (Nelspruit, South Africa).

The meeting was initiated with discussion of the outcomes of two previous IPPC expert consultations that lead to the creation and reaffirmation of this group which was initially called the Phytosanitary Temperature Treatments Expert Group (PTTEG). During this meeting the name was changed to PMRG to encompass other phytosanitary measure concerns besides the initial concern with cold and then heat treatments.

Updates of the initial work plan established at the ECCT in 2013 were reported and discussed. Key issues are whether cultivars of fruit may affect cold treatment efficacy and whether populations of the same pest may differ significantly in cold tolerance. These issues are preventing acceptance of some treatment proposals under review by the TPPT. The opinion of the PMRG is that variety/cultivar does not affect cold treatment efficacy, and a supporting document is being prepared. Existing cold treatment schedules and research are being examined for the possibility of making treatments more broadly applicable across pest and commodity species; and another document is being prepared on this topic.

New issues were discussed and work assignments made. Research guidelines for the combination of heat-modified atmosphere treatments will be devised. Modelling of phytosanitary treatments will be investigated. Guidelines for heat, fumigation, and modified atmosphere treatments will be developed and phytosanitary systems will be examined. Measures of efficacy that is less than complete, acute mortality, will be explored. The possibility of treating mixed loads of fruits and regulatory responses to finding live non-target organisms after treatment will be studied.

Meeting of the Technical Panel on Phytosanitary Treatments of the International Plant Protection Convention, 31 August – 4 September 2015, Fukushima, Japan

The Technical Panel on Phytosanitary Treatments (TPPT) held its annual meeting in Fukushima, Japan to advance issues delegated to the TPPT by the International Plant Protection Convention (IPPC). These issues include evaluation of phytosanitary treatment proposals by member countries and preparation of documents on phytosanitary treatment themes.

The IPPC has tasked the TPPT with writing four new International Standards on Phytosanitary Measures (ISPM) and revising ISPM 18, *Guidelines for the Use of Irradiation as a Phytosanitary Measure*. The new ISPMs are for temperature, fumigation, modified atmosphere, and chemical treatments.

A phytosanitary irradiation treatment against European corn borer, *Ostrinia nubilalis*, was recommended for inclusion in ISPM 28, *Phytosanitary Treatments for Regulated Pests*. Research for this treatment was conducted as part of a previous FAO/IAEA Coordinated Research Project. A vapour heat treatment against the tephritids *Bactrocera melanotus* and *B. xanthodes* was also recommended for approval. Once these two treatments are scheduled, 16 of 21 total treatments in ISPM 28 will be based on phytosanitary irradiation, with major input for these irradiation treatments provided from the FAO/IAEA.

Participants of the Technical Panel on Phytosanitary Treatments (TPPT) (Fukushima, Japan).

After extensive studies it was concluded that there are not significant differences among cultivars and varieties of citrus for efficacy of cold treatments against the Mediterranean fruit fly, *Ceratitis capitata*. This problem had hampered the progress of several treatment proposals. Work by the phytosanitary treatment project at the IPCL in Seibersdorf, Austria was instrumental in reaching this conclusion. Advancement of several cold treatment proposals awaits further research at Seibersdorf on whether efficacy of cold treatments differs among populations of Mediterranean fruit fly.

Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies (TPFF), 19–23 October 2015, Vienna, Austria

The TPFF of the International Plant Protection Convention (IPPC) is composed of 10 international fruit fly experts and includes a representative of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, which also hosted the meeting. Chairperson for the TPFF was Ms Ana Lilia Montealegre Lara (Mexico). The collaboration between the IAEA and the IPPC-FAO on fruit flies is an excellent example of inter-agency and international cooperation to create a solid scientific basis for IPPC standards, as well as a forum for discussion on the implementation of fruit fly International Standards for Phytosanitary Measures (ISPMs).

The TPFF made proposals for the reorganization of the fruit fly ISPMs to avoid duplication and further harmonize the guidance provided. The major change proposed was to include ISPM 30 (*Establishment of Areas of Low Pest Prevalence for Fruit Flies (Tephritidae)*) as an annex of ISPM 35 (*Systems Approach for Pest Risk Management of Fruit Flies (Tephritidae)*) because of the connection and subordinate nature of ISPM 30 to ISPM 35. The panel concluded its work reflecting on future needs within the fruit fly community, such as technical documents to support the National Plant Protection Organizations (NPPOs) on the implementation of fruit fly ISPMs.

Participants of the Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies (TPFF) (Vienna, Austria).

Workshop on Developing a Strategic Plan for Sterile Insect Technique Application in China, 3–6 November 2015, Fuzhou, China

This national workshop was organized by the Chinese Academy of Agricultural Sciences, the Fujian Agriculture and Forestry University, the Agricultural Department of the Chinese Academy of Engineering, and the Fujian Association for Science and Technology and was held at the Fujian Agriculture and Forestry University. The workshop was chaired by Prof. Kongming Wu, of the Chinese Academy of Agricultural Sciences and the Chinese Academy of Engineering. The workshop was attended by several prominent scientists from China, representatives of the governments of each province, and numerous students.

After the first two days of open presentations, a select group of Chinese scientists and the internationally invited speakers discussed potential target pests and regions, and started to develop a document that was to become the outline for a strategic plan on the potential use of the SIT in China. Three working groups (Lepidoptera, fruit flies and mosquitoes) focused on various technical aspects of key pests of crops and human diseases. Five key pest insects were identified as potential candidates for SIT integration:

Lepidoptera: 1. codling moth (proven technology, lots of expertise available, this invading pest is approaching the large apple growing areas in Xinjiang province and SIT could be used to eliminate outbreaks in provinces free of this pest), 2. the cotton bollworm (large cotton belts, use a combination of Bt cotton and sterile insects that would act as refugia to prevent the development of resistance against Bt, rearing technology available for virus production), 3. the tobacco budworm (most difficult moth pest, mosaic distribution, lots of secondary hosts, significant R&D requirements in terms of radiation biology and rearing technologies). The key technical issues and R&D requirements were identified for the 3 pests.

Fruit flies: top candidate is *Bactrocera dorsalis*, which is present throughout all provinces of southern China and attacks many fruit and vegetable crops; the available technology could be applied in an initial pilot project focused on major citrus production areas.

Mosquitoes: although *Aedes aegypti* has started expanding in some southern provinces, top candidate species for SIT-based population control is *Aedes albopictus*, which is the main dengue vector in China and is present in many provinces. An SIT-IIT pilot project has been initiated against *Aedes albopictus* in Guangzhou province.

Participants of the National Workshop on Developing a Strategic Plan for Sterile Insect Technique Application in China (Fuzhou, China).

Consultants Meeting on Assessment of Semiochemicals to Enhance *Bactrocera* spp. Sterile Male Performance, 25–27 November 2015, Vienna, Austria

The simultaneous use of Male Annihilation Technique (MAT) and Sterile Insect Technique (SIT) may be compromised by elimination of sterile males by exposure to MAT formulations. However, studies of multiple *Bactrocera* species show that pre-release exposure of sterile males to semiochemicals dramatically reduces their response to MAT formulations. This result in "male replacement": sterile males will remain in the field while their wild counterparts are removed by MAT. Furthermore, it has been shown that feeding on semiochemicals [e.g., methyl eugenol (ME), raspberry ketone] can significantly increase male activity, improves male mating success, and accelerates sexual development of some *Bactrocera* species.

The development of cost-effective semiochemical treatments that improve sterile male sexual performance and reduce their response to MAT formulations is highly desirable. Even though the incorporation of semiochemical supplements for *Bactrocera* species appears feasible, practical procedures to implement them at an operational scale still need to be developed. Nevertheless exploring the potential of such an approach appears essential in view that the simultaneous application of MAT and SIT has considerable potential to drastically increase sterile to wild male overflooding ratios and therefore SIT cost-effectiveness. The combination of male replacement plus male enhanced performance increases what can be achieved with the same number of sterile flies: treating a wider area or enabling more rapid progress. Furthermore, due to the increased cost-effectiveness, decisions to invest in SIT may be facilitated in situations where this would not otherwise be feasible.

The participants of the meeting recommended the following:

- Exposure of some *Bactrocera* species to semiochemicals leads to earlier sexual maturation and significant improvement of male sexual performance. In

addition, there is ca. 70% reduction in trapping of males of some species that have been exposed to a semiochemical before release. Attempts need to be made to increase the percentage of non-responding males while also maintaining the benefits of pre-release treatment. This work can be performed in the laboratory or in field cages.

- Evaluation of key parameters in large field cages such as wild fly sex ratio, degree of lure response of sterile flies, sterile:wild over-flooding ratio and bisexual release to determine their influence on the effectiveness of simultaneous MAT and SIT.
- Field evaluation of simultaneous MAT and SIT within a pilot or operational setting that includes compatible management practices.

Participants of the Consultants Meeting on Assessment of Semiochemicals to Enhance Bactrocera *spp. Sterile Male Performance (Vienna, Austria).*

Expert Meeting on Harmonization of Post-factory Product Quality Control for Fruit Fly SIT, 30 November – 4 December 2015, Vienna, Austria

Measuring insect quality and performance under semi-natural conditions or in the field as post-factory product quality control (QC) is the only comprehensive way to provide the feedback to mass-rearing and fly emergence and release facilities so that they can modify or improve rearing protocols and handling procedures to maintain or improve insect quality. This is also key information to guaranty the success of sterile fly release operations, allowing them to adjust and refine release rates and procedures.

A comprehensive QC programme for the mass-reared sterile males (end product) should contain a full scope of tests designed to assess behaviours and performance to establish fly competitiveness. Tests that are used must be tailored to, and appropriate for, the individual species. To that end, post-factory product QC tests should ideally be capable of measuring quality parameters at each stage of the process, starting with the irradiated product leaving the mass-rearing facility, packing, shipping, arrival at the fly emergence and release facility, handling, chilling, collection and following release. Fly emergence and release facilities are responsible for the final steps to assure an effective field application of the SIT. The correct conditions and handling of sterile insects at this stage is crucial to deliver to the field, sexually mature, robust and sufficient sterile insects to conduct the predicted feral population control.

The Product Quality Control for Sterile Mass-Reared and Released Tephritid Fruit Flies manual (FAO/IAEA/USDA, 2014: http://www-naweb.iaea.org/nafa/ipc/public/sterile-mass-reared-v6.pdf) was reviewed and updated in recent years and a new section of tests to be used at the fly emergence and releases facilities was included to be conducted at the different stages, including after the release of sterile insects in the field. All of these evaluations, when compared, should allow determining if there are losses in sterile insect quality, at which phase of the process they are occurring, and in turn, this would allow taking corrective measures. Standardization of these procedures on a global basis also allows information exchange and comparisons of sterile insect performance amongst fly emergence and release facilities. However, some of the tests added were not extensively tested before they were included in the manual.

Tasks performed during this expert meeting in Vienna included:

- Review of routine post-factory product QC tests to be conducted, with the goal of further harmonizing procedures at fly emergence and release facilities worldwide.
- Review of recently introduced periodic QC tests and analyse the validation conducted.
- Basic set of routine and periodic tests to be performed and indices to be used so that actions programmes can use a standard format to determine sterile insect survival, dispersal and sexual competitiveness under semi-natural conditions.

Participants of the Expert Meeting on Harmonization of Post-factory Product Quality Control for Fruit Fly SIT (Vienna, Austria).

Announcements

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

Background: The successful implementation of area-wide pest control programmes integrating the use of sterile insects with other control technologies against a number of key plant, veterinary, and medical insect pests, such as various species of fruit flies, moths, screwworms, and tsetse flies and mosquitoes, clearly demonstrates a peaceful application of nuclear technology. Over the last 50 years, FAO and IAEA have played, and will continue to play, a critical role in supporting their Member States in the development and application of these environment-friendly pest control methods.

The concept of area-wide integrated pest management (AW-IPM), in which the total population of a pest in an area is targeted, is central to the effective application of the Sterile Insect Technique (SIT) and is increasingly being considered for related genetic, biological and other pest control technologies. Insect movement, occurring sometimes over long distances, is generally underestimated. As a consequence, most conventional pest control can be described as localized or field by field, un-coordinated action against segments of a pest population, resulting very often in an unsustainable spiral of insecticide application and eventual resistance of the pest against the used pesticides. However, an AW-IPM approach adopts a preventive rather than a reactive strategy, whereby all individuals of the pest population are targeted in time and space, requiring fewer inputs and resulting in more cost-effective and sustainable pest management.

In June 1998 and May 2005 FAO and IAEA sponsored respectively the First and the Second International Conferences on Area-Wide Control of Insect Pests Integrating the Sterile Insect and Related Nuclear and other Techniques with the participation of ca. 350 participants from close to 70 Member States and 5 international organizations. Both events greatly increased awareness about area-wide approaches for managing important insect pests. Since then, many new technical innovations have been developed and are being implemented, and a better regulatory framework is being adopted for integrating the SIT with other pre- and post-harvest pest management methods.

Area-wide insect pest control programmes are logistically complex and managerially intensive, and thus require a broad coalition of stakeholders committed to ensure success. These critical, but largely non-technical issues often determine success or failure of area-wide programmes.

This Third Conference will therefore address not only the technical but also the managerial and socio-economic components of operational area-wide programmes.

Objective: The conference has the objective to expose Member State representatives to new developments, trends and challenges in the field of insect pest control, and to foster a broad exchange of information between sanitary and phytosanitary regulatory authorities, operational programme managers, scientists, animal and plant protection specialists, pest control experts, public health practitioners, as well as the private sector.

The conference and its deliberations and conclusions will also provide useful feedback to the Joint FAO/IAEA Division and its future programme to address Member States' needs in this rapidly evolving field of insect pest control exposed to the above described drivers, but will also highlight the challenges they face such as new emerging pest problems, and outbreaks of invasive species in new regions.

The structure of the conference programme will be based on selected plenary lectures, theme specific sessions with keynote addresses, contributions to oral presentations and posters, as well as a panel discussion forum. A limited amount of space will be available for commercial vendors' displays/exhibits during the Conference.

Scope and issues to be addressed: The Conference will include issues faced by the international community dealing with area-wide and trans-boundary insect pest problems. The Conference will be open for papers and posters contributing to operational area-wide programmes, management issues of pest control programmes, socio-economic impact, commercialisation, public health, biodiversity, biotechnology, and regulatory and trade issues. Invited speakers, supported by contributed papers and posters, will review the following topics and their interactions:

1. Advances in Area-Wide Control since the 2st International Conference
2. Experiences in Management of Area-Wide Programmes: Successes and Failures
3. Non-Technical Requirements for Successful Area-Wide Programmes
4. Commercialisation and the Role of Agro-industry

5. Economic and Environmental Assessments, Decision Making Tools
6. Integration with Augmentative Biological Control, Mating Disruption or other Environment-Friendly Technologies
7. Mass Trapping, Bait Stations and other Suppression Techniques
8. Use of GIS, RS and other spatial tools for the development and management of AW-IPM programmes
9. Mother Colony Maintenance, Mass Rearing, Shelf-life, Dormancy Management
10. Radiation Biology, Dosimetry, Dose Optimization
11. Fly Emergence and Sterile Male Supplements and Probiotics
12. Packing and Release Systems, Aerial Release, Guiding Systems
13. Attractants, Surveillance including Detection and Monitoring
14. Behaviour, Ecology, Quality Control, Compatibility and Competitiveness
15. Population Genetics, Cryptic Species Complexes
16. Genetics, Molecular Biology
17. Hybrid Sterility, Inherited Sterility
18. Incompatible Insect Technique, *Wolbachia* and the role of symbionts
19. Invasive Species in relation to Climate Change and Globalization
20. Regulatory Control, Trade Issues, Systems Approaches
21. Socio-economic impact of AW-IPM

Announcement of FAO/IAEA Regional Training Courses

- Regional Training Course on *Taxonomy and Identification of Fruit Fly Pest Species for Southeast Asia* (under Regional TC Project RAS5067). 25-29 April 2016, Bangkok, Thailand. (**Deadline for nominations: 15 February 2016).**
- FAO/IAEA Regional Workshop on Harmonization of Surveillance Systems Against Non-native Fruit Flies and Emergency Response Capabilities (under Regional TC Project RLA5070). 18–22 July, 2016, Guatemala City, Guatemala. (**Deadline for nominations: 29 April 2016).**

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

Completed forms should be endorsed by and submitted through the official channels established (either the Ministry of Foreign Affairs, the National Atomic Energy Authority, the Office of the United Nations Development Programme, the Office of the FAO Resident Representative or the Ministry of Agriculture).

The completed forms must be submitted to the International Atomic Energy Agency, Vienna International Centre, P.O. Box 100, 1400 Vienna, Austria. Advance nominations by facsimile (+43-1-26007) or email (official.mail@iaea. org) are welcome.

In Memoriam

Roger Allen Leopold (1937-2015)

Roger Allen Leopold, Ph.D. was born March 23, 1937 in the family farmhouse outside of Redwood Falls, Minnesota (MN), USA. He graduated from Redwood Falls High School in 1955 and went on to study Biology at Concordia College in Moorhead, MN. Besides academics, he was also an excellent wrestler, football player and even dabbled in gymnastics. He graduated from Concordia in 1962 and proceeded to University of Montana, Bozeman, Montana to earn his Ph.D. in Entomology.

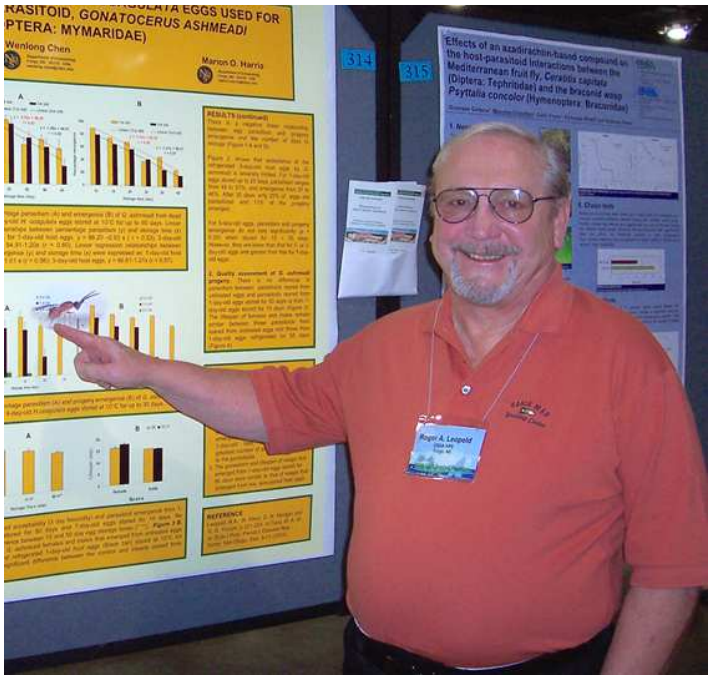
After a brief stint as an instructor at the North Dakota State University, Fargo, North Dakota, he joined the United States Department of Agriculture – Agricultural Research Service (USDA-ARS), Fargo, ND as a Research Entomologist in 1967. For 44 years, Dr. Leopold worked with the USDA studying the reproductive physiology of insects, primarily, the accessory gland physiology in dipterans.

In the 1990s, Dr. Leopold proposed a research plan to preserve insect germplasm using cryopreservation. This was to aid one of USDA's major pest control program namely, the sterile insect production and release (Sterile Insect Technique, SIT) to control screwworm flies in the United States. At that time, it was not easy to cryopreserve biomaterials larger than a few cells.

Dr. Leopold suggested that such storage of insect embryos would not only aid in protecting the SIT program from sudden loss of the colony but also to safely store dozens of insect strains, including mutant and transgenic strains that were reared in various laboratories for research purposes. Dr. Leopold's research in cryopreservation has resulted in preservation protocols for over half-a-dozen insect pests including the new world screwworm (*Cochliomyia hominivorox*), Mediterranean fruit fly (*Ceratitis capitata*), Mexican fruit fly (*Anastrepha ludens*), etc. The technique is currently used at major insect mass rearing centers and research facilities around the world.

Although Dr. Leopold retired from the USDA-Agricultural Research Service in 2011, he continued to show keen interest in disseminating his research. As of 2015, Dr. Leopold had published over 90 scientific articles, reviews and book chapters in both reproductive physiology and cryobiology. He spent most of his time enthusiastically discussing science and the rest of his time with his family and/or fishing the lakes of Minnesota.

Dr. Roger Leopold passed away at the age of 78 on Wednesday, September 9th, 2015, at a hospital in Fargo, ND surrounded by his family. He is survived by his wife, two sons, three stepdaughters, and 13 grandchildren.



Source: Arun Rajamohan, ARS-USDA, Fargo, ND, USA

Other News

Sterile Insect Technique Could Help Thwart Navel Orangeworm Pest in Pistachios and Almonds in California

The Sterile insect technique (SIT) has been a critical component towards the eradication of the pink bollworm (PBW) insect (*Pectinophora gossypiella*) in Far West and Southwest cotton fields.

This method in turn could help pistachio and almond growers combat the destructive navel orangeworm pest, *Amyelois transitella*.

The navel orangeworm pest in pistachio and almond orchards could be partially thwarted by sterile insect technology

The cotton industry is working with various groups to possibly use a section of the Pink Bollworm Rearing Facility building in Phoenix, Arizona to rear and sterilize navel orangeworm insects for release in California pistachio and almond orchards.

The rearing facility is owned by California cotton growers with oversight by the California Department of Food and Agriculture.

"Navel orangeworm is an extremely devastating pest in pistachios and almonds," said Clyde Sharp of Roll, Arizona, a state and national cotton leader and advocate of SIT in PBW eradication.

Sharp says some California tree nut growers spend up to $250 per acre annually controlling the navel orangeworm.

Source: http://westernfarmpress.com (13 July, 2015).

Optimising Tsetse Fly Eradication Using Satellite Imagery and Genetics

Isolated populations of tsetse flies constitute the best targets for eradication campaigns, but they are difficult to detect. By combining analysis of satellite images and genetics, researchers at CIRAD and their partners have developed a methodology for identifying these populations at the continental level. This innovative approach, the result of eight years of work, could be applied to the targeting of other vectors of disease, as well as to the protection of endangered species.

The reinfestation problem: In sub-Saharan Africa, tsetse flies spread parasitic diseases, trypanosomoses, which not only present a threat to human health but also ravage agriculture. For example, nagana, or animal African trypanosomiasis, kills more than 3 million head of cattle every year, resulting in losses exceeding 4 billion dollars.

Eradication campaigns are essential tools to control these diseases. Unfortunately, they are very costly and relatively ineffective: so far, they have been successful in less than 2% of infested areas. "Often, eradication campaigns target fly populations that are not truly isolated from one another. Cleared zones are therefore gradually reinfested by tsetse flies from neighbouring areas", explains Jérémy Bouyer, a researcher at CIRAD who led this study.

Geographers come to the rescue: Targeting isolated populations therefore helps to ensure their eradication will be definitive. But how can they be identified? Generally, to do so, researchers analyse genetic exchange between fly populations. But this approach requires costly tsetse capture campaigns in zones that are often very difficult to reach, which prevents its systemisation. To avoid this problem, researchers at CIRAD and their French, African and European partners have developed another method based on the concept of "landscape friction". Borrowed from geographers, who use it in particular to model traffic flows, in biology this term defines the way in which the landscape elements modulate the movement of animal species.

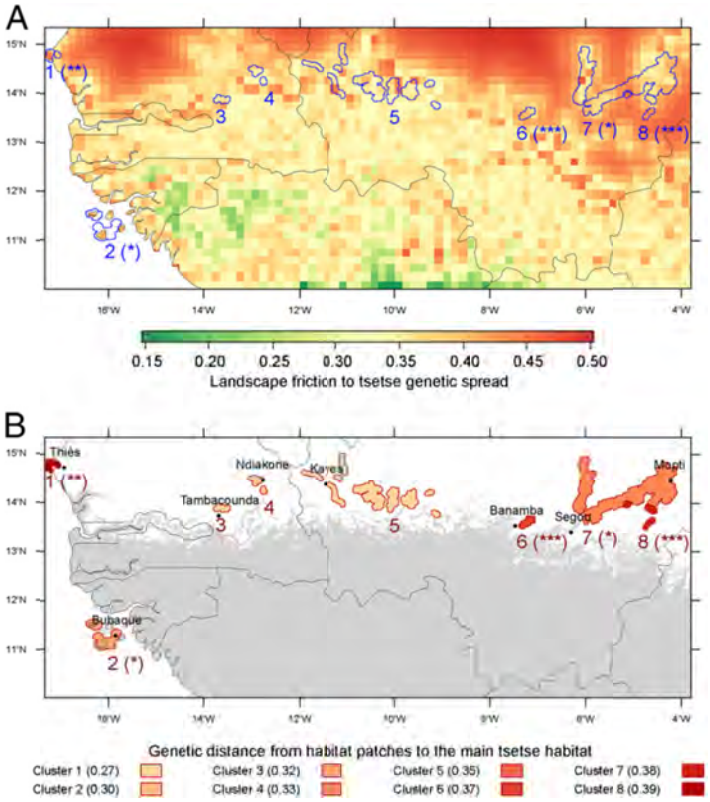
A map to predict isolation: First, the scientists determined the genetic distance separating 37 populations of the species *Glossina palpalis gambiensis*, the main vector of trypanosomoses in West Africa. To do so, they analysed

the genome of 1 158 flies caught in four West African countries (Burkina Faso, Mali, Guinea and Senegal, or 80 to 90% of the distribution area of this fly). Using satellite images of these regions, they also identified the natural barriers likely to limit the dissemination of tsetse flies of this species and determined the most likely dispersal patterns for these flies. They thus established a "friction map" revealing the connections between the different populations of tsetse flies. Eight populations presenting different degrees of isolation were consequently revealed in the "tsetse belt" (the area in which tsetse flies live, which crosses 38 sub-Saharan African countries and covers more than 10 million km²). These are all potential targets for eradication campaigns. One population in Senegal is already the object of an elimination programme selected for the Milano 2015 World Expo because of its exemplary nature for the sustainable development of small communities of livestock farmers.

Eight potentially isolated clusters of *Glossina p. gambiensis* habitat were identified thanks to this methodology.

A wide variety of practical applications: "This original methodology could not have been developed without close cooperation between ecologists, geographers, population geneticists and modellers. In particular, it has the advantage of moving away from expert opinions, which are subjective and may in some cases be a source of error", says Jérémy Bouyer.

This approach is currently being transferred to other vectors, such as the midge *Culicoides imicola*, in the Mediterranean basin. It can also be used to study the genetic structure of virus populations on the scale of a whole continent in order to develop the most appropriate vaccination strategies based on this. Finally, it will facilitate the work of conservation biologists, by helping them for example to identify exchange corridors between certain endangered animal populations living in increasingly fragmented ecosystems.



Isolated patches of suitable habitat for Glossina p. gambiensis. *(A) Landscape friction is the coloured background, and the eight habitat patches are delimited with blue contours. (B) The main tsetse belt predicted by MaxEnt for a sensitivity of 0.90 is in gray and habitat patches are shown as filled, red shapes.*

The originality of this research, published in the prestigious journal Proceedings of the National Academy of Sciences, has attracted the attention of managers at Earth Engine, the remote sensing data analysis platform belonging to Google.

Source: CIRAD press release (http://www.cirad.fr/en/news/all-news-items/press-releases/2015/optimising-tsetse-fly-eradication-using-satellite-imagery-and-genetics, 10 November 2015).

Relevant Published Articles

Mapping Landscape Friction to Locate Isolated Tsetse Populations that are Candidates for Elimination

Jérémy Bouyer[1,2,3,4], Ahmadou H. Dicko[5], Giuliano Cecchi[6], Sophie Ravel[7], Laure Guerrini[8,9], Philippe Solano[7], Marc J. B. Vreysen[10], Thierry De Meeûs[7,11] and Renaud Lancelot[1,2]

[1] *Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Unité Mixte de Recherche Contrôle des Maladies Animales Exotiques et Emergentes, Montpellier, France.*

[2] *Institut National de la Recherche Agronomique, Unité Mixte de Recherche 1309 Contrôle des Maladies Animales Exotiques et Emergentes, Montpellier, France.*

[3] *Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Unité Mixte de Recherche Interactions Hôtes-Vecteurs-Parasites-Environnement dans les Maladies Tropicales Négligées Dues aux Trypanosomatides, Montpellier, France.*

[4] *Institut Sénégalais de Recherches Agricoles, Laboratoire National d'Elevage et de Recherches Vétérinaires, Service de Parasitologie, Dakar, Senegal.*

[5] *West African Science Service in Climate Change and Adapted Land Use, Climate Change Economics Research Program, Cheikh Anta Diop University, Dakar, Senegal.*

[6] *Food and Agriculture Organization of the United Nations, Sub-Regional Office for Eastern Africa, Addis Ababa, Ethiopia.*

[7] *Institut de Recherche pour le Développement, Unité Mixte de Recherche Interactions Hôtes-Vecteurs-Parasites-Environnement dans les Maladies Tropicales Négligées Dues aux Trypanosomatides, Montpellier, France.*

[8] *Unité de Recherche Animal et Gestion Intégrée de Risques, Centre de Coopération Internationale en Recherche Agronomique pour le Développement, Montpellier, France.*

[9] *Department Environment and Societies, University of Zimbabwe, Harare, Zimbabwe.*

[10] *Insect Pest Control Laboratory, Joint Food and Agriculture Organization of the United Nations/International Atomic Energy Agency, Vienna, Austria.*

[11] *Centre International de Recherche-Développement sur l'Elevage en Zone Sub-humide, Bobo-Dioulasso, Burkina Faso.*

Abstract

Tsetse flies are the cyclical vectors of deadly human and animal trypanosomes in sub-Saharan Africa. Tsetse control is a key component for the integrated management of both plagues, but local eradication successes have been limited to less than 2% of the infested area. This is attributed to either resurgence of residual populations that were omitted from the eradication campaign or reinvasion from neighboring infested areas. Here we focused on *Glossina palpalis gambiensis*, a riverine tsetse species representing the main vector of trypanosomoses in West Africa. We mapped landscape resistance to tsetse genetic flow, hereafter referred to as friction, to identify natural barriers that isolate tsetse populations. For this purpose, we fitted a statistical model of the genetic distance between 37 tsetse populations sampled in the region, using a set of remotely sensed environmental data as predictors. The least-cost path between these populations was then estimated using the predicted friction map. The method enabled us to avoid the subjectivity inherent in the expert-based weighting of environmental parameters. Finally, we identified potentially isolated clusters of G. p. gambiensis habitat based on a species distribution model and ranked them according to their predicted genetic distance to the main tsetse population. The methodology presented here will inform the choice on the most appropriate intervention strategies to be implemented against tsetse flies in different parts of Africa. It can also be used to control other pests and to support conservation of endangered species.

The full paper was published in: PNAS: 112 (47) 14575-14580 (2015).

Symbiotic Bacteria Enable Olive Fly Larvae to Overcome Host Defenses

Michael Ben-Yosef[1], Zohar Pasternak[2], Edouard Jurkevitch[2] and Boaz Yuval[1]

[1] *Department of Entomology, The Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot, Israel.*

[2] *Department of Plant Pathology and Microbiology, The Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot, Israel.*

Abstract

Ripe fruit offer readily available nutrients for many animals, including fruit fly larvae (Diptera: Tephritidae) and their associated rot-inducing bacteria. Yet, during most of their ontogeny, fruit remain chemically defended and effectively suppress herbivores and pathogens by high levels of secondary metabolites. Olive flies (*Bactrocera oleae*) are uniquely able to develop in unripe olives. Unlike other frugivorous tephritids, the larvae maintain bacteria confined within their midgut caeca. We examined the interaction between larvae, their associated bacteria, and fruit chemical defence, hypothesizing that bacterial contribution to larval development is contingent on the phenology of fruit defensive chemistry. We demonstrate that larvae require their natural complement of bacteria (*Candidatus Erwinia dacicola*: Enterobacteriaceae) in order to develop in unripe olives. Conversely, when feeding on ripe fruit, larval development proceeds independently of these bacteria. Our experiments suggest that bacteria counteract the inhibitory effect of oleuropein—the principal phenolic glycoside in unripe olives. In light of these results, we suggest that the unique symbiosis in olive flies, compared with other frugivorous tephritids, is understood by considering the relationship between the fly, bacteria and fruit chemistry. When applied in an evolutionary context, this approach may also point out the forces which shaped symbioses across the Tephritidae.

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Effects of Radiation on the Fertility of the Ethiopian Fruit Fly, *Dacus ciliatus*

Polychronis Rempoulakis, Rossana Castro, Esther Nemny-Lavy and David Nestel

Department of Entomology, Institute of Plant Protection, The Volcani Center, Beit Dagan Israel.

Abstract

The Ethiopian fruit fly, *Dacus ciliatus* (Loew) (Diptera: Tephritidae), is a significant pest of cucurbit crops in Asia and Africa and is currently controlled with insecticides. The sterilizing effect of gamma radiation on *D. ciliatus* adults was investigated to assess the suitability of sterile insect technique (SIT) for use as an alternative, non-chemical strategy for the control of this pest. Late pupae (48 h before emergence) were irradiated with 60, 80, 100, 120, and 140 Gy of gamma rays emitted by a ^{60}Co source. Following emergence, the biological characteristics of the experimental cohorts (including all possible male-female combinations of irradiated and untreated flies) were recorded. No significant negative effects of irradiation on pupal eclosion or the ability of newly emerged flies to fly were observed. Samples of eggs at reproductive fly-ages (12-, 15-, and 17-day-old pairs) were collected and their hatch rates were assessed. At 60 Gy, females were completely sterilized, whereas complete sterilization of the males was observed only at 140 Gy (a small amount of fertility persisted even at 120 Gy). In addition to the above experiments, three fruit infestation trials were conducted with zucchini [*Cucurbita pepo* L. (Cucurbitaceae)] as the plant host and the pupae produced in those trials were collected and recorded. We observed significant (ca. 10%) infestation following treatment with up to 120 Gy and zero progeny only at 140 Gy, mirroring the egg-hatch results. Our findings support the feasibility of SIT for the control of *D. ciliatus*.

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Radiobiology of Small Hive Beetle (Coleoptera: Nitidulidae) and Prospects for Management Using Sterile Insect

Danielle Downey[1], Stacey Chun[1] and Peter Follett[2]

[1] Hawaii Department of Agriculture, Hilo, HI, USA.
[2]USDA-ARS, U.S. Pacific Basin Agricultural Research Center, Hilo, HI, USA.

Abstract

Small hive beetle, *Aethina tumida* Murray (Coleoptera: Nitidulidae), is considered a serious threat to beekeeping in the Western Hemisphere, Australia, and Europe mainly due to larval feeding on honey, pollen, and brood of the European honeybee, *Apis mellifera* L. Control methods are limited for this pest. Studies were conducted to provide information on the radiobiology of small hive beetle and determine the potential for sterile insect releases as a control strategy. Adult males and females were equally sensitive to a radiation dose of 80 Gy and died within 5–7 d after treatment. In reciprocal crossing studies, irradiation of females only lowered reproduction to a greater extent than irradiation of males only. For matings between unirradiated males and irradiated females, mean reproduction was reduced by >99% at 45 and 60 Gy compared with controls, and no larvae were produced at 75 Gy. Irradiation of prereproductive adults of both sexes at 45 Gy under low oxygen (1–4%) caused a high level of sterility (>99%) while maintaining moderate survivorship for several weeks, and should suffice for sterile insect releases. Sterile insect technique holds potential for suppressing small hive beetle populations in newly invaded areas and limiting its spread.

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