Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Insect & Pest Control Newsletter

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

ISSN 1011-274X

No. 83, July 2014

Contents

To our Readers

Aerial release of sterile male tsetse flies Glossina palpalis gambiensis *using a gyrocopter over the Niayes area in Senegal, where very good progress is being made in the eradication of this major pest, which transmits trypanosomosis to livestock. It is estimated that after eradication, farming communities will be able to shift towards more productive livestock systems allowing annual increases of cattle sales of up to ~€ 2,800/km^2. In addition, the removal of this tsetse fly population will make available oxen to plough the land, animals to transport agricultural products to market, and meat and milk to improve human nutrition (see pages 13-15).*

I would like to inform our readers that Aldo Malavasi, our Brazilian colleague who has had a long-standing collaboration with the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, and in particular the Insect Pest Control Subprogramme, has been appointed Deputy Director General of the International Atomic Energy Agency. He will initiate his duties on 1 August, 2014 and will directly manage the IAEA Department of Nuclear Sciences and Applications, which includes the Joint FAO/IAEA Division and other divisions related to human health, nuclear physics and chemistry, and marine and terrestrial ecology. Aldo was Professor of Genetics and Evolution at the Uni-

versity of Sao Paulo, Director of the Carambola Fruit Fly Eradication Programme in Suriname, Director of the Moscamed Facility in Brazil, and General-Secretary of the Brazilian Society for Advancement of Science. He has been member of numerous panels and technical advisory committees in many countries and organizations, and has been on numerous expert missions for FAO and IAEA. We welcome him to the IAEA and wish him much success in all his endeavours.

The Member States of IAEA have called for an initiative to renovate and modernize the Nuclear Sciences and Applications Laboratories in Seibersdorf, called the ReNuAL project. In the 52 years since the IAEA's Nuclear Applications laboratories in Seibersdorf (five of which are in the field of agriculture under the Joint FAO/IAEA Division) were established, there has been no comprehensive renovation or significant upgrading of equipment to ensure the continuing ability of the laboratories to respond to Member States' growing and evolving needs. The ReNuAL project includes in its first phase those elements to be achieved from 2014-2017 within the €31 million target budget established by the Director General. Ground-breaking is planned for 29 September 2014, with completion by December 2017 (see insert on page 27).

We are announcing a new Coordinated Research Project "*Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies*". This CRP will target pest species of agricultural, veterinary and medical importance and compare the performance of strains developed or improved by classical genetic, transgenic and symbiont-based approaches to a level where a decision can be made as to their suitability to produce high-quality sterile males for use in large scale sterile insect technique (SIT) programmes. The five-year CRP will start in 2015 and applications for participation are welcome until the end of 2014 (see page 28).

Until recently the biology and behaviour of male mosquitoes were virtually unknown, mainly because males, which are not blood feeders, do not transmit disease. However, the male mating biology must be well understood to be able to integrate the SIT in area-wide vector management programmes. To address these knowledge gaps, an FAO/IAEA Coordinated Research Project entitled "*Biology of Male Mosquitoes in relation to Genetic Control Programmes*" was implemented between 2008 and 2013. Researchers from 16 countries participated in this coordinated effort and the proceedings have now been published as a Special Issue in the peer reviewed journal "*Acta Tropica"* (see pages 28-29). The issue contains a collection of 23 review and research papers, which covers investigations of pre-mating conditions of male mosquitoes (physiology and natural male behaviour, resource acquisition and allocation, dispersal), mating systems including swarming of a range of mosquito species, the contribution of molecular and chemical approaches to increase the understanding of male mating behaviour, the analysis of competitiveness of males for release, and novel vector control methods.

Special issue in Acta Tropica with proceedings of the Coordinated Research Project (2008-2013) on Biology of Male Mosquitoes.

I would also like to inform our readers that a new version of the FAO/IAEA/USDA manual on "*Product Quality Control for Sterile Mass-reared and Released Tephritid Fruit Flies*" is now available in draft form on the internet at http://www-naweb.iaea.org/nafa/ipc/public/sterile-mass-reared-v6.pdf. Comments and corrections are welcome until the end of 2014 (see pages 29-30).

This international manual is a living document and has been subject to periodic updates. Since 1997, it has provided an objective set of standards for assessing quality of sterile fruit flies used in SIT programmes. The manual continues to evolve and the most recent, Version 6 represents the recommendations of an international group of quality control experts (2010-2014). This significantly revised version expands on the routine and periodic procedures for product quality control intended to be carried out at both the mass-rearing and in particular the fly emergence and release facilities.

Jorge Hendrichs

Head, Insect Pest Control Section

Insect Pest Control Subprogramme

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

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

Staff of the Insect Pest Control Subprogramme

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	21629	Vienna
Rui Cardoso Pereira	Entomologist (Plant Pests)	R.Cardoso-Pereira@iaea.org	26077	Vienna
Jesús Reyes	Entomologist (Plant Pests)	J.Reyes-Flores@iaea.org	26062	Vienna
Nima Mashayekhi-Tabrizi	Programme Assistant	N.Mashayekhi-Tabrizi@iaea.org	21633	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
Andrew Parker	Entomologist (Tsetse)	A.Parker@iaea.org	28408	Seibersdorf
Barbara Massinger	Team Assistant	B.Massinger@iaea.org	28259	Seibersdorf

Forthcoming Events (2014-2015)

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

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

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

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, France.

First RCM on Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies. 22–26 June 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. 12–14 November 2015, Guatemala City, Guatemala.

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. 16–20 November 2015, Antigua, Guatemala.

II. Consultants and Expert Meetings

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

III. Other Meetings/Events

FAO/IAEA Regional Training Course on Fruit Fly Biocontrol in West Africa (under Regional TC Project RAF5061). 4–8 August 2014, Dakar, Senegal.

FAO/IAEA Regional Training Course on Use of GIS for Area-Wide Fruit Fly Programmes in Indian Ocean (under Regional TC Project RAF5062). 18–22 August 2014, Zanzibar, United Republic of Tanzania.

FAO/IAEA Regional Training Course on Fruit Fly Monitoring and Suppression including MAT and SIT for Southeast Asia (under Regional TC Project RAS5067). 15–19 September 2014, Bandung, Indonesia.

FAO/IAEA Regional Training Course on Mass Rearing and SIT-Related Activities for the Control of *Aedes* Mosquitoes, the Major Vectors of Dengue and Chikungunya (under Regional TC Project RAS5066). 22–26 September 2014, Juazeiro, Brazil.

FAO/IAEA Regional Training Course on Taxonomy and Identification of Fruit Fly Pest Species Exotic to the Balkans and the Eastern Mediterranean (under Regional TC Project RER5020). 13–17 October 2014, Tervuren, Belgium.

FAO/IAEA Regional Training Course on Diagnosis of the New World Screwworm (under Regional TC Project RLA5067). 27–31 October 2014. Pecora, Panama

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. 10–11 November 2014, Swaziland.

Expert Consultation on Phytosanitary Treatments for the *Bactocera dorsalis* Complex, International Plant Protection Convention, FAO. 1–5 December 2014, Yokoama, Japan.

FAO/IAEA Coordination Meeting of the West Africa Regional TC Project RAF5061 on Supporting Capacity Building and a Feasibility Study on Control of Fruit Flies of Economic Significance in West Africa. 12–14 December 2014, Dakar, Senegal.

FAO/IAEA Regional Training Course on Fruit fly Monitoring and Suppression including MAT and SIT for Indian Ocean (under Regional TC Project RAF5062). 20–24 April 2015, 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). 1–5 June 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 de Dominguez, Chiapas, Mexico and Antigua / El Pino, Guatemala.

FAO/IAEA Regional Training Course on Taxonomy and Identification of Fruit Fly Pest Species to the Southeast Asia (under Regional TC Project RAS5067). 7–11 September 2015, Kuala Lumpur, Malaysia.

Meeting of the Technical Panel on Pest Free Areas and Systems Approaches for Fruit Flies (TPFF). 12–16 October 2015, Vienna, Austria.

Meeting of the Technical Panel on Phytosanitary Treatments (TPPT), International Plant Protection Convention, FAO. 26–30 October 2015, Japan.

Past Events (mid 2013-mid 2014)

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

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

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

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

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

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

II. Other Meetings/Events

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

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). 29 July–23 August 2013, Metapa de Dominguez, Chiapas, Mexico and Antigua / El Pino, Guatemala.

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

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

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

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

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

12th PATTEC Coordinators Meeting. 25–28 November 2013, Dakar, Senegal.

FAO/IAEA Sub-regional Assessment Meeting of the Regional TC Project RAS5059 on Supporting Area-wide Integrated Pest Control of Native and Exotic Flies in the Middle East Subregion, Incorporating the Sterile Insect Technique (SIT). 25–26 February 2014, Vienna, Austria.

FAO/IAEA Regional Workshop to Present Respective Experiences with Fruit Flies and Synergise Future Activities in the Balkans and the Eastern Mediterranean (under Regional TC Project RER5020). 25–27 March 2014, Vienna, Austria.

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

FAO/IAEA Regional Training Course on Taxonomy and Identification of Fruit Fly Pest Species Exotic to the Middle East (under Regional TC Project RAS5059). 31 March–4 April 2014, Seibersdorf, Austria.

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

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

FAO/IAEA Coordination Meeting of the Indian Ocean Regional TC Project RAF5062 on Preventing the Introduction of Exotic Fruit Fly Species and Implementing the Control of Existing Species with the Sterile Insect Technique and other Suppression Methods. 12–16 May 2014, Bangkok, Thailand.

FAO/IAEA Regional Training Course on Free Open Source Software for GIS and Data Management Applied to Tsetse and Trypanosomosis Control Programmes. 12–23 May 2014, Addis Ababa, Ethiopia.

FAO/IAEA First Coordination Meeting of the Regional TC Project RLA5067 on Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm. 2–6 June 2014, Panama City, Panama.

Meeting of the Technical Panel on Phytosanitary Treatments (TPPT), International Plant Protection Convention, FAO. 23–27 June 2014, Jakarta, Indonesia.

Technical Cooperation Field Projects

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

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

Country	Project Number	Title National Projects	Technical Officer
Angola	ANG5012	Supporting Feasibility Studies for using Sterile Insect Techniques as part of Area-Wide Integrated Pest Management for Control of Tsetse Flies (*G. morsitans centralis*)	Rafael Argiles
Burkina Faso	BKF5012	Collecting Baseline Data and Implementing Fruit Fly Suppression in Mango Fruit	Rui Cardoso Pereira
Chad	CHD5003	Finalising the Feasibility Study to Assess Whether the Sterile Insect Technique (SIT) Can Be Applied for the Creation of Sustainable Tsetse-Free Zones	Rafael Argiles
Costa Rica	COS5030	Supporting Biological Control of Stable Flies (*Stomoxys calcitrans*) through the Use of Parasitoids Reproduced on Fruit Flies	Jesús Reyes
China	CPR5020	Integrating the Sterile Insect Technique (SIT) for Area-Wide Integrated Pest Management of Tephritid Fruit Flies	Rui Cardoso Pereira
Ethiopia	ETH5018	Contributing to the Creation of Sustainable Tsetse Free Areas	Rafael Argiles Andrew Parker
Guatemala	GUA5017	Using the Sterile Insect Technique (SIT) to Establish Fruit Fly Low Prevalence Pilot Areas and to Assess it as an Alternative for the Control of the Sugarcane Borer in Pilot Areas	Jesús Reyes
Honduras	HON5006	Using Sterile Insect Technique (SIT) to Obtain Recognition as a Mediterranean Fruit Fly Free Area in the Aguan River Valley	Jesús Reyes
Israel	ISR5017	Targeting the Olive Fly with SIT in Olive Orchards Located in the North and South of Israel	Jesús Reyes
Israel	ISR5018	Improvement of Artificial Mass-Rearing Systems for the Ethiopian Fruit Fly, *Dacus ciliatus*, and Establishment of Optimal Sterilizing Doses: Towards Small-Scale SIT	Jorge Hendrichs Jesús Reyes
Israel	ISR5019	Supporting a Feasibility Study for the Implementation of Leafminer (*Liriomyza* spp.) Sterile Insect Technique Combined with Biological Control under Greenhouse Conditions	Jesús Reyes
Libya	LIB5011	Enhancing Area-Wide Integrated Management of Fruit Flies	Jesús Reyes

Madagascar	MAG5021	Implementing the Sterile Insect Technique (SIT) in Integrated Fruity Fly Control for High Quality Fruit Production	Rui Cardoso Pereira
Mauritius	MAR5019	Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for the Integrated Control of Mosquitoes	Jeremie Gilles
Mauritius	MAR5022	Reducing Insecticide Use and Losses to Melon Fly (*Bactrocera cucurbitae*) through Environment-Friendly Techniques to Increase Production in Different Areas, Phase II	Jorge Hendrichs Rui Cardoso Pereira
Morocco	MOR5032	Supporting Control of the Medfly Using the Sterile Insect Technique for Citrus Fruits and Early Fruits and Vegetables to Establish Low Medfly Prevalence Zones	Jesús Reyes
Myanmar	MYA5021	Integrating Sterile Insect Technique with other Biocontrol Tactics to Improve Diamondback Month Control	Rui Cardoso Pereira
Oman	OMA5002	Assessing the Suitability of Sterile Insect Technique (SIT) and Related Techniques for Combating Date Palm Insect Pests	Marc Vreysen
Territories Under the Jurisdiction of the Palestinian Authority	PAL5004	Integrated management of fruit flies in Palestinian Territories	Jesús Reyes
Panama	PAN5020	Strengthening Technical Capacity to Control Mediterranean Fruit Fly Using the Sterile Insect Technique (SIT)	Jesús Reyes
Palau	PLW5001	Improving the Quality of the Fruits and Vegetables Through an Area-Wide Integrated Pest Management of *Bactrocera* Fruit Flies in Production Areas of Palau	Rui Cardoso Pereira
South Africa	SAF5013	Assessing the Sterile Insect Technique for Malaria Mosquitoes in a South African Setting	Jeremie Gilles
Senegal	SEN5033	Supporting the Operational Phase of Eliminating *Glossina palpalis gambiensis* from the Niayes Area by Promoting the Development of Integrated Stockbreeding	Marc Vreysen
Seychelles	SEY5005	Enhancing the Melon Fruit Fly Area-Wide Integrated Pest Management Programme Using the Sterile Insect Technique to Improve National Food Security	Rui Cardoso Pereira
Sri Lanka	SRL5044	Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for Integrated Control of Mosquitoes	Jeremie Gilles
Sudan	SUD5034	Supporting a Feasibility Study on the Suitability of the Sterile Insect Technique as a Strategy for the Integrated Control of *Anopheles arabiensis*	Jeremie Gilles
Tunisia	TUN5027	Supporting an Area-Wide Integrated Pest Management Pilot Project for Evaluating the Effectiveness and Economic Feasibility of Using SIT as a Component of Integrated Date Moth control	Marc Vreysen

Thailand	THA5052	Developing Sustainable Management of Fruit Flies Integrating Sterile Insect Technique with other Suppression Methods	Rui Cardoso Pereira
Uganda	UGA5036	Demonstrating the Feasibility of a Sterile Insect Technique Component as Part of an Area-Wide Integrated Pest Management Approach to Increase Livestock Productivity	Rafael Argiles
Vietnam	VIE5017	Supporting Area-Wide Integrated Pest Management to Improve the Quality of Fruit for Export	Rui Cardoso Pereira
Zimbabwe	ZIM5019	Improving Crop and Livestock Production through the Eradication of Bovine and Human Trypanosomosis in Matusadona National Park	Rafael Argiles
		Title **Regional Projects**	
Regional Africa	RAF5061	Supporting Capacity Building and a Feasibility Study on Control of Fruit Flies of Economic Significance in West Africa	Rui Cardoso Pereira
Regional Africa	RAF5062	Preventing the Introduction of Exotic Fruit Fly Species and Implementing the Control of Existing Species with the Sterile Insect Technique and Other Suppression Methods	Rui Cardoso Pereira
Regional Africa	RAF5064	Supporting Area-Wide Tsetse and Trypanosomosis Management to Improve Livestock Productivity and Enable Sustainable Agriculture and Rural Development	Rafael Argiles Andrew Parker
Regional Africa	RAF5065	Promoting the sharing of expertise and physical infrastructure for mass rearing mosquitoes and integration of the sterile insect technique (SIT) with conventional methods for vector control, among countries of the region.	Jeremie Gilles
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
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
Regional Asia	RAS5059	Supporting Area-Wide Integrated Pest Control of Native and Exotic Flies in the Middle East Subregion Incorporating the Sterile Insect Technique (SIT)	Jesús Reyes
Regional 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 Jeremie Gilles

Regional Asia	RAS5067	Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in South-east Asia	Rui Cardoso Pereira
Regional Europe	RER5020	Controlling Fruit Flies in the Balkans and the Eastern Mediterranean	Rui Cardoso Pereira
Regional Latin America	RLA5067	Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm	Jesús Reyes
		Title **Continuing Interregional Project**	
Interregional	INT5151	Sharing Knowledge on the Use of the Sterile Insect and Related Techniques for Integrated Area-Wide Management of Insect Pests	Jorge Hendrichs

Highlights of Technical Cooperation Projects

Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm (RLA5067)

The First Regional Coordination Meeting under Project RLA5067 was held at the US-Panama Commission for the Eradication and Prevention of the Screwworm (COPEG) in Panama, 2 to 6 June 2014, to revise the regional work plan of the project, which will help countries to improve their capacity to manage more efficiently the prevention and treatment of the myiasis caused by the New World Screwworm (NWSW), through the adoption of a strategy for the progressive control of the disease.

Participants of the first coordination meeting of RLA 5067 (Panama City, Panama).

The meeting was attended by participants from Brazil, Ecuador, Panama, Paraguay, Peru and Uruguay. This first coordination meeting was the launching event for bringing together relevant stakeholders. The Minister of Agriculture and Livestock Development of Panama inaugurated the event, together with representatives from the Ministry of Economy and Finance, FAO, PAHO, OIE and COPEG, including staff from the US Department of Agriculture.

The NWSW is an important transboundary animal disease, also of zoonosis significance, which constraints sustainable livestock production, national/international trade and public health conditions. Each participant presented a report about the current situation of the disease in their countries, including activities carried out to control this transboundary myiasis in the past decade. They also prepared national work plans to strengthen the actions programmed under the regional project, which provided more clarity about the roles and responsibilities that each counterpart would play in the implementation of the capacity building project. The group also participated in a site-visit to the COPEG sterile screwworm mass-rearing plant, which produces the sterile flies to maintain a barrier along the Colombian-Panamanian border and which protects screwworm free Central and North America. This visit allowed obtaining a better understanding of the area-wide integrated application of the Sterile Insect Technique against this major insect pest of veterinary and human importance.

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

Regional Coordinators Meeting

A Regional Coordination Meeting under Project RAS5059 was held at the IAEA Headquarters in Vienna, Austria, from 25 to 26 February 2014, to review and assess the progress on the control of native and exotic flies in the Middle East. The meeting was attended by participants from Israel, Jordan, and the T.T.U.T.J. of T. Palestinian Authority, and project officers from the IAEA.

Participants of the regional coordination meeting of RAS5059 (Vienna, Austria).

Each counterpart presented a comprehensive report of the activities carried out during the last two years in their respective country, including goals achieved as well as the benefits brought by the transboundary project. They also informed about the collateral activities each country is carrying out to control native fruit fly pests, such as *Ceratitis capitata* and *Dacus ciliatus*, or prevent the entrance of fruit flies under quarantine regulation such as *Bactrocera zonata* and other invasive species of this genus.

Also, there was much analysis and discussion on project management. Each participant contributed significantly to the way the project has been executed so far and the most suitable approach to reach full project implementation by the end of 2014. There were also brainstorming sessions on ideas for a future regional project for the 2016-2017 Technical Cooperation biennium.

Regional Training Course on Taxonomy and Identification of Fruit Fly Pest Species Exotic to the Middle East

A Regional Training Course on "Taxonomy and Identification of Fruit Fly Pest Species Exotic to the Middle East" was conducted in the FAO/IAEA Agriculture and Biotechnology Laboratories in Seibersdorf, Austria, from 31 March to 4 April, 2014. The training course was attended by one participant from the Ministry of Agriculture and Rural Development in Israel, three participants from the Ministry of Agriculture in Jordan, and two participants from the Ministry of Agriculture of the T.T.U.T.J of T. Palestinian Authority. The course consisted of lectures and discussions led by Marc De Meyer from the Biology Department of the Royal Museum for Central Africa, Belgium and included such topics as general morphology of adult fruit flies, taxonomic classification and recognition of major fruit fly pest genera, major exotic pest species of interest to the Middle East region, morphological identification of major pest species and their congeners, and molecular identification tools.

Participants of the regional training course on Taxonomy and Identification of Fruit Fly Pest Species Exotic to the Middle East at the FAO/IAEA Agriculture and Biotechnology Laboratories (Seibersdorf, Austria).

Supporting Area-Wide Tsetse and Trypanosomosis Management to Improve Livestock Productivity and Enable Sustainable Agriculture and Rural Development (Phase II) (RAF5064)

Regional Training Course on Free Open Source Software for GIS and Data Management Applied to Tsetse and Trypanosomiasis Control Programmes

The training course, held in Addis Ababa, Ethiopia from 6 to 16 May 2014, was organized jointly by AU-PATTEC, FAO and IAEA and was attended by a total of 22 participants from 11 Member States (Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, South Sudan, Sudan, Uganda, United Republic of Tanzania, Zimbabwe).

Participants of the regional training course on Free Open Source Software for GIS and Data Management applied to tsetse and trypanosomiasis control programmes (Addis Ababa, Ethiopia).

The following topics were addressed:

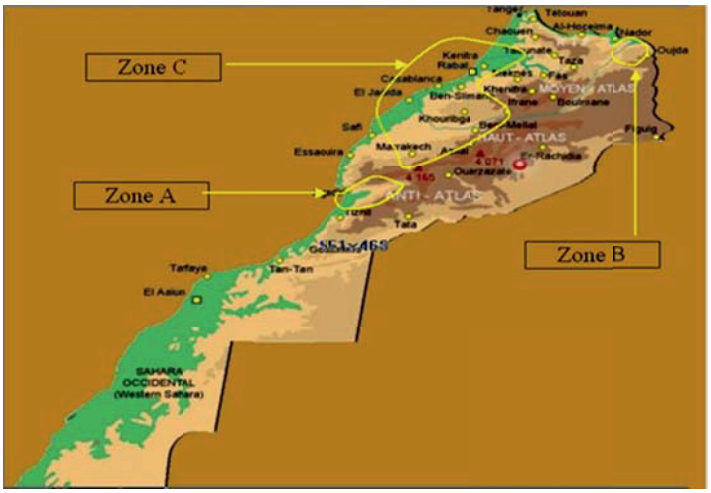
- Free open source basics (Quantum GIS), software installation
- GIS basics
- Managing spatial data
- Advanced spatial operations
- FOSS database basics (Spatialite)
- GPS
- Map Composer
- Harmonization: data management in PATTEC programmes
- ATLAS on tsetse and Animal African Trypanosomosis distribution at the country level.

Throughout the training, theoretical lessons and practical hands-on sessions were combined, following the FAO/IAEA DVD tutorial "Using Open Source GIS Techniques in Insect Pest Control Programmes" that was distributed as supporting material. A visit to the tsetse mass rearing facility in Kality was conducted during the weekend.

A second edition of this training course to be conducted in French is foreseen for November 2014 for francophone trainees.

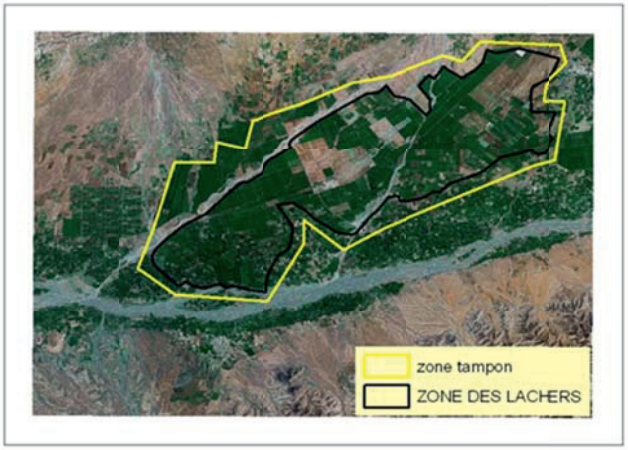
Supporting Control of the Medfly Using the Sterile Insect Technique for Citrus Fruits and Early Fruits and Vegetables to Establish Low Medfly Prevalence Areas (MOR5032)

The National Plant Protection Organization of Morocco (ONSSA) in collaboration with the Citrus Producers Association have been conducting a demonstration SIT trial to suppress the Mediterranean fruit flies (*Ceratitis capitata)* in a selected citrus area in the Souss-Maza Valley, close to Agadir, Morocco. Every week, 8 million sterile male Mediterranean fruit flies (Medfly) have been released over 4,500 Ha of citrus. During 2008-2011 the sterile male flies were imported from the Madeira-Med facility, Portugal. Thereafter, the project was on standby because the Madeira facility stopped operations. In early 2014 the trial was re-initiated with sterile male flies imported from Valencia, Spain.



Citrus and other commercial fruit production zones in Morocco (Photo courtesy of Mrs Zhor DEHBI)

The integration of the SIT in Morocco to suppress the Medfly in citrus production areas is almost mandatory since some of the current citrus importers such as Russia have banned the import of citrus from infested plantations or reject importation due the presence of pesticide residues (Europe and Canada). Alone in the Souss valley, there are more than 45,000 Ha of citrus and Morocco is exporting around 400,000 tons of oranges. Morocco has the potential to double or triple its exports.



SIT pilot project area in a citrus production area of the Souss-Maza Valley, Zone A. (Photo courtesy of Mrs Zhor DEHBI).

The Government together with the citrus industry of Morocco are considering the construction of a Medfly mass-rearing facility in Agadir that will have a capacity to produce sufficient sterile males to effectively suppress this pest from all citrus areas in the Souss valley. Support is being provided from the Insect Pest Control Subprogramme to design such a facility, and to strengthen the detection network and early response capacity to prevent the entrance and establishment of *Bactrocera invadens* and *B. zonata*.

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

Designation of Origin of the Neretva Mandarins

The Croatian Ministry of Agriculture is processing the registration of designation of origin of the characteristic Neretva mandarins fruit with the European Commission. Authenticity of mandarins from Neretva valley ensures the end customer that they are buying a quality product from controlled cultivation and the application of agro-technical measures.

The association of fruit growers "Mandarina" from the Neretva valley, in collaboration with the Ministry of Agriculture and the Croatian Centre for Agriculture, Food and Rural Affairs is successfully implementing the project to combat the Mediterranean fruit fly by Sterile Insect Technique (SIT) in the area of the Neeta valley, which is one of the largest protected wetlands in this part of Europe. Insecticede use has been reduced by ca. 20 000 liters/year in the valley, thus protecting the environment, while ensuring the production of fruit without pesticide residues.

Designation of origin logo of the Neretva mandarins.

Croatian mandarins with protected designation ensure their quality to consumer while the producer income increases. Furthermore, it is also a significant contribution to rural development in terms of visibility of the product itself, as well as from the areas in which it is produced.

The harvest in 2014 is expected to amount to around 80 000 tons of mandarins with a value of up to 20 million Euros. The goal is to get customers in European countries and region to decide for mandarins from the Neretva valley. It is this certificate of authenticity confirming that mandarins produced in the Neretva have low residues and a characteristic sweetness, color and shape.

Regional Workshop to Present Respective Experiences with Fruit Flies and Synergize Future Activities, 25–27 March 2014, Vienna, Austria

The regional workshop was designed to improve regional capabilities to apply the SIT as part of an area-wide integrated management approach. It is setting the basis for the creation of a regional network of specialists and stakeholders involved in fruit fly control activities.

The workshop was attended by a total of 13 participants from 11 Member States (i.e., Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Greece, The Former Yugoslav Republic of Macedonia, Montenegro, Romania, Slovenia, and Turkey).

Participants of the Regional Workshop to Present Respective Experiences with Fruit Flies and Synergize Future Activities, March 2014, Vienna, Austria.

The workshop addressed the following aspects:

- Presentations and group discussions covering the topics related to the fruit fly activities in participating Member States
- Harmonization through the use of the new detection protocol developed within IAEA TC project RER5018 (2012-2013)
- Discuss future activities under RER5020
- Report and Recommendations

The documents shared among all participants contain an overview of fruit fly activities in participating Member States, including key stakeholders and potential target areas for monitoring, as well as the consolidated 2014-2015 work plan of RER5020. The knowledge of participants was also enhanced in relation to the application of SIT as part of an area-wide integrated management approach, with emphasis on the pilot area in the Neretva valley in Croatia.

In terms of detection of exotic fruit flies, all participating Member State (including Cyprus, even though absent, reported on the collected data) reported zero captures in the traps installed at the respective ports of entry.

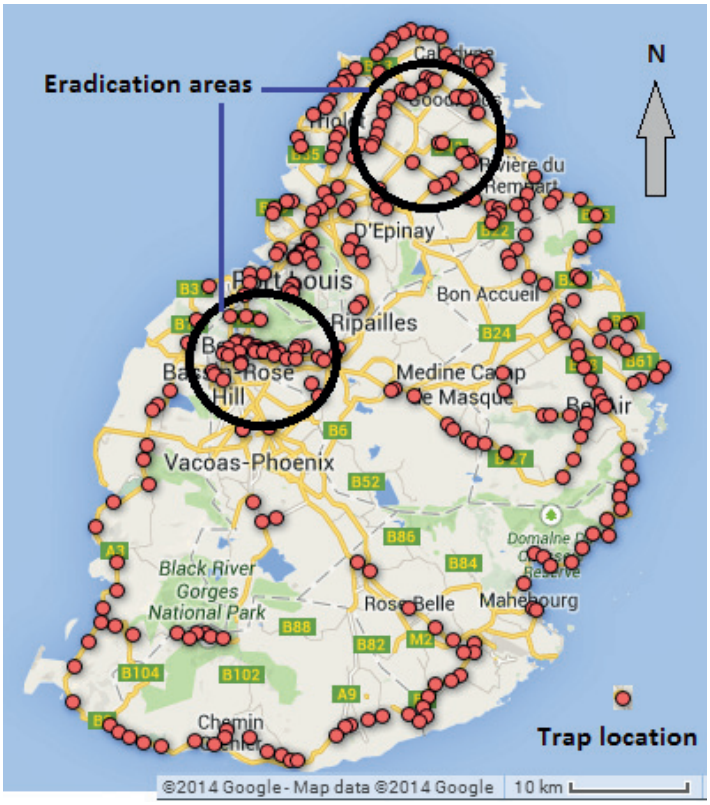
Additionally the counterparts discussed and agreed on:

- Member States continuing to work towards harmonizing the monitoring of established fruit flies and the detection of exotic fruit flies, with special emphasis on the genus *Bactrocera*
- To collect and share data on fruit fly monitoring and detection using a common database
- Dissemination of information and knowledge received during the capacity building
- Dissemination of the results obtained (including a joint publication).

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

Detection of *Bactrocera dorsalis* (Hendel) in Mauritius and rapid response

The first detection of *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) in Mauritius was in 1996 and it was successfully eradicated. The second detection was on 08 March 2013 in an orchard in the north of the island where one male *B. dorsalis* was caught in a methyl eugenol baited trap. Early detection has been possible owing to the ongoing fruit fly surveillance programme since 1994. The day following the detection, the protocol for eradication of *B. dorsalis* was implemented: declaration of a quarantine area of 5 km radius around the detection site, placement of dry and wet traps, application of protein bait sprays, placement of MAT blocks, fruit stripping and sanitation, disposal of infested fruit, and collection and incubation of fruits and vegetables in a room in the north. Four additional male flies were detected in the north during the months of March and April 2013.



Mauritius trapping network and eradication area.

The eradication measures were maintained for a period of two months following the last detection. Since there was no further detection since July 2013 in this eradication area, the control operations were stopped while fruit fly surveillance was maintained for a further period of 12 weeks. *B. dorsalis* has now been declared eradicated in the north. However, in April 2013 *B. dorsalis* was detected in a methyl eugenol baited trap in the western part of the island. The protocol for eradication was implemented also for this eradication area. The last detection in the west dates back to 22 November 2013, even though the mango harvesting season started in November 2013. The eradication measures in the west have been pursued till end of March 2014. As from April 2014 fruit fly surveillance is being carried out in this area. If no *B. dorsalis* flies are detected over a further period of 12 weeks, the insect will be declared eradicated from Mauritius.

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

The Eradication of *Glossina palpalis gambiensis* from the Niayes in Senegal: a short review and current progress

Tsetse transmitted trypanosomosis or nagana is one of the most devastating livestock diseases in Sub-saharan Africa. The disease prevents the integration of livestock keeping with crop production and is therefore considered one of the root causes of hunger and poverty in Africa. The disease is often lethal and leads in addition to a debilitating chronic condition that reduces fertility, weight gain, meat and milk production and work efficiency of oxen used to cultivate the land. Every year, at least 3 million animals succumb to the disease in sub-Saharan Africa.

The Niayes area is located north-east of Dakar, Senegal and has a coastal microclimate favourable to holding exotic cattle breeds for milk and meat production, but its ecological conditions are also favoured by the tsetse fly *Glossina palpalis gambiensis*. The *G. p. gambiensis* population of the Niayes constitutes the most extreme north-western limit of the tsetse distribution in Africa. In 2006, the Government of Senegal embarked on a project with the ultimate aim to create a sustainable *G. p. gambiensis* free area in the Niayes. The Directorate of Veterinary Services (DSV) of the Ministry of Livestock of the Government of Senegal is implementing the project in collaboration with the Senegal Institute for Agricultural Research (ISRA) and technical and financial support have been provided by the International Atomic Energy Agency (IAEA) through its Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture and its Department of Technical Cooperation (SEN5033), the USA (through its Peaceful Uses Initiative (PUI)), and France (through the deployment of a Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) staff member on site in Senegal).

From 2006 to 2010, a comprehensive feasibility study was undertaken to assess whether a sustainable tsetse free zone

could be created in the Niayes and subsequently, to develop and implement the most appropriate control strategy. The study consisted of an entomological base line data collection effort using a stratified sampling strategy (indicating that suitable tsetse habitat was extremely fragmented, that flies were present in very small pockets but at high densities, and that the total infested area was limited to 525 km^2), a parasitological and serological survey of the trypanosomosis disease in cattle residing inside and outside the tsetse-infested areas (on average 28.7% of the cattle population was infected), and a population genetics study that indicated the absence of gene flow between the *G. p. gambiensis* populations of the Niayes and the nearest known population of the main tsetse belt of Senegal and which confirmed the apparent isolated nature of the Niayes population. These data confirmed that the creation of a zone free of *G. p. gambiensis* in the Niayes will be sustainable without any risk of re-invasion with flies coming from the main tsetse belt in Senegal. An environmental study has been designed to assess any potential impact of the eradication on biodiversity and the ecosystem. Data are being collected as long as the programme is being implemented and until now, no significant impact has been measured.

A benefit cost analysis of the socio economic data was completed. Three main cattle farming systems were identified, i.e. a traditional system based on trypanotolerant cattle and two "improved" systems based on more productive cattle breeds targeting milk and meat production. Tsetse distribution significantly impacted the frequency of occurrence of these farming systems with 34% and 6% of farmers owning improved breeds in the tsetse-free and tsetse-infested areas, respectively. Potential increases of cattle sales as a result of tsetse eradication were calculated considering two scenarios, i.e. a conservative scenario with a 2% annual replacement rate from traditional to improved systems after tsetse eradication and a more realistic scenario with an increased replacement rate of 10% five years after eradication of the tsetse population. The final annual increase of cattle sales was estimated at ~€2,800/km^2 for a total cost of the eradication campaign reaching ~€6,400/km^2 (which includes costs of the feasibility and preparatory phases). Despite its relatively high cost, the benefit-cost analysis indicated that the project was highly cost-effective, with Internal Rates of Return (IRR) of 9.8% and 19.1% for the two scenarios, respectively. In addition to an increase in farmers' income the benefits of the eradication of the *G. p. gambiensis* population include a reduction of grazing pressure on the various ecosystems.

The gyrocopter equipped with the newly developed chilled adult release system that is now routinely being used to release sterile male Glossina palpalis gambiensis *over the Niayes.*

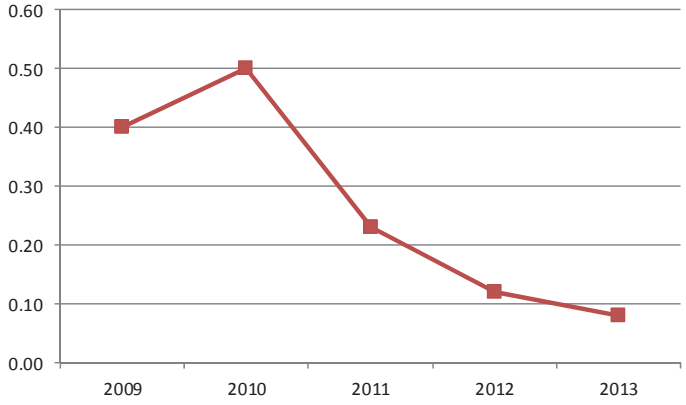
As a result of this study, the Government of Senegal opted for an area-wide integrated pest management (AW-IPM) approach to create a sustainable *G. p. gambiensis*-free zone in the Niayes. Application of insecticide as pour-on on livestock, impregnated in traps, and in netted fences around pig pens were selected as the most appropriate tactics to reduce the high fly population densities, whereas the release of sterile male flies would be used as the final eradication component.

During the period 2008-2011, a number of preparatory activities were carried out that enabled the project to proceed towards the final operational phase: (1) a dispersal center was established in Dakar where pupae (from a facility in Burkina Faso) are received and adult flies can emerge, (2) a colony originating from the Niayes was established at the FAO/IAEA Insect Pest Control Laboratory (IPCL) in Austria as a back-up should the strain from Burkina Faso not perform adequately in Senegal, (3) mating compatibility was confirmed between the Senegal strain and the Burkina Faso strain in field cage studies at the IPCL, (4) handling and transport protocols were developed at the IPCL and validated during weekly pupal shipments from Burkina Faso to Senegal, (5) ground trial releases were carried out in four different ecosystems to assess the performance of the sterile flies in the target area including competitiveness, survival and dispersal (weekly releases for two years), (6) data on temporal and spatial dynamics of the native fly population were collected over three years including natural abortion rate, (7) a new aerial release machine was developed by the Mexican company Mubarqui to allow chilled adult fly releases, and (8) trial releases were carried with boxed flies from a gyrocopter that proved to be very suited for releasing flies over the target area.

Operational activities (2011 – present) – The entire project area was divided into 3 operational blocks. In 2011, suppression activities using insecticide impregnated targets and as pour-on cattle were implemented in Block 1. This

was followed in 2012 by operational ground releases of sterile males in selected release sites and in 2013 by aerial releases using biodegradable boxes. Initial problems of too high temperatures in the carton boxes were resolved using ice packs in cooling boxes for transport of the flies to the airport and in the gyrocopter. Flies were released using 200 release boxes at 40 flies per box obtaining a release density of approx. 160 sterile flies/km^2. A total of 237,922 and 125,091 sterile males were released over Block 1 in 2013 and 2014, respectively. No wild flies have been trapped in Block 1 since April 2012. Releases will continue for 12 more months (until Dec. 2014) to ensure complete eradication of the fly population in Block 1.

In Block 2, over 1200 insecticide impregnated traps were deployed at the end of 2012, which were complemented with a treatment of more than 2900 cattle with pour-on insecticides as an additional method to suppress the fly population. As a result, the apparent fly density dropped from 1.24 (s.d. 1.23) flies/trap/day before to 0.005 (s.d. 0.017) flies/trap/day after the suppression. Operational aerial releases of sterile males over Block 2 were initiated in early 2014. During the April 2014 monitoring, no wild flies were trapped in the 72 monitoring traps indicating excellent progress.

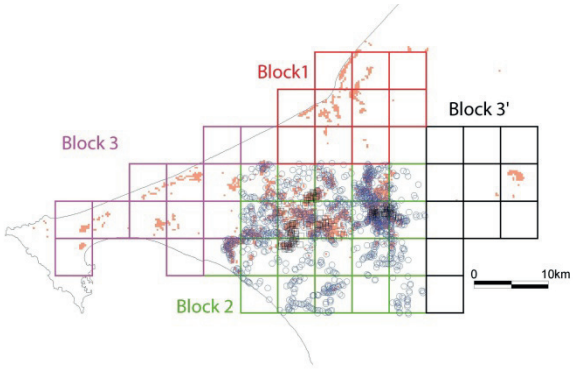


A significant decrease in the serological prevalence of trypanosomosis in the Niayes area since 2009 as a result of the tsetse control activities.

The drastic reduction in the fly populations in Block 1 and 2 was also reflected in the prevalence of the disease: the trypanosomosis prevalence using the serological Ab-ELISA test in cattle decreased from 40-50% in 2009-2010 to less than 10% in 2013. Data for 2014 are currently being collected.

A tsetse population distribution model was developed (based on a Maxent model) using presence-absence dataset, an expert-based classification of landscapes and various environmental parameters. The Maxent predictions have since then been used throughout the eradication campaign to make control operations more efficient in terms of the selection and deployment of insecticide impregnated traps, the release density of the sterile males, and the location of monitoring traps used to assess programme progress.

A new gyrocopter was equipped with a larger capacity alternator. Trial runs were carried out on the ground with the newly developed chilled adult release machine, and sufficient power can now be produced to operate the machine without any problems. Initial trial flights were implemented in early 2014 after installation of the necessary software. The machine is now routinely used to release the flies over Block 1 and Block 2. Suppression activities in Block 3 (Dakar and Thies) are scheduled to be initiated in mid-2014, whereas releases in Block 2 are scheduled to continue until late 2015. For more info, please visit: http://projet-tsetse-niayes.cirad.fr/



The 3 blocks of the eradication programme in the Niayes with the sites in Block 2 where the insecticide impregnated traps (circles) were deployed.

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

Project Number	Ongoing CRPs	Scientific Secretary
D4.10.22	Increasing the Efficiency of Lepidoptera SIT Through Enhanced Quality Control (2009-2014)	Marc Vreysen
D6.20.08	Development of Generic Irradiation Doses for Quarantine Treatments (2009-2014, managed with Food and Environmental Protection Subprogramme)	Andrew Parker (co-secretary)
D4.20.14	Development and Evaluation of Improved Strains of Insect Pests for SIT (2009-2014)	Kostas Bourtzis
D4.10.23	Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade (2010-2015)	Jorge Hendrichs
D4.10.24	Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application (2012-2017)	Carlos Cáceres
D4.20.15	Enhancing Vector Refractoriness to Trypanosome Infection (2013-2018)	Andrew Parker
D4.40.01	Exploring Genetic, Molecular, Mechanical and Behavioural Methods of Sex Separation in Mosquitoes (2013-2018)	Jeremie Gilles
Project Number	**New CRPs**	**Scientific Secretary**
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

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

The fourth and final Research Coordination Meeting under this CRP was held from 7 to 11 April 2014 in Capri, Italy. The meeting was hosted by Giuseppe Saccone, Università degli Studi di Napoli Federico II, Dipartimento di Biologia, Napoli, Italy and it was attended by 16 scientists from the following Member States: Argentina, Australia, Czech Republic, Germany, Greece, Guatemala, India, Italy, Mexico, Spain, Thailand and USA. Also, eleven observers from Italy and Switzerland attended the meeting.

Sixteen progress report papers on insect transformation, sex determination, construction of novel sexing strains and improvement of existing strains for the development and application of the SIT against fruit fly, mosquitoes and lepidopteran pests were presented and reviewed. During the discussion it was concluded that the CRP had been very productive, with a much better understanding and exploitation of available classical genetic and molecular tools that can accelerate and enhance the application of modern biotechnologies to the radiation-based SIT against insect pests and vector species. In addition, all attendees underlined the valuable genetic information becoming available through the sequencing and annotation of the genomes of several insect pests and disease vectors. This knowledge can be exploited for the development and or improvement of genetic strategies for the control of pests and diseases. It is worth noting that the CRP also provided the ground for the establishment of international collaborations between some

member scientists resulting in the sequencing the genome of the Mediterranean fruit fly *Ceratitis capitata*.

Participants of the final RCM on Development and Evaluation of Improved Strains of Insect Pests for SIT (Capri, Italy).

A special session was devoted in memoriam of our colleague and CRP member Javaregowda Nagaraju (1954-2012) from India, who passed away on the 31 December 2012. CRP members and observers talked about the inspired scientist and his major contributions to silkworm biology as well as on his endless work to connect science and society.

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

Meeting participants reviewed the rapid progress being made in the exploitation of classical genetic and modern biotechnological approaches for the control of major agricultural pests and disease vectors. These approaches have resulted in the construction of a large number of strains and a comparative analysis of their rearing efficiency and competitiveness is required prior to their use in large scale field applications. The consultants recommended that these issues should be addressed in a new CRP on the "*Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies*".

The application of the SIT in area-wide integrated pest management (AW-IPM) programmes continues to increase in response to requests from Member States. However, programme efficiency can still be considerably enhanced when certain components of the technology are improved, such as the strains used to mass-produce sterile males, which are the key component of SIT programmes. They can be produced by classical and modern biotechnology approaches and strains producing such males are now available for key insect pests. The pests targeted for SIT applications include species of agricultural, veterinary and medical importance such as the Mexican fruit fly, the oriental fruit fly, the codling moth, the pink bollworm, the screwworm as well as various disease transmitting mosquitoes. This CRP will focus on comparing the performance of strains developed or improved by classical genetic, transgenic and symbiont-based approaches to a level where a decision can be made as to their suitability to produce high-quality sterile males for use in large scale SIT programmes. Major beneficiaries will be operational AW-IPM programmes in MS that apply the SIT against these major insect pests. By the end of the CRP several strains, including strains for new target species, producing high quality sterile males should be available with the following tangible benefits for pest control programmes in MS using SIT:

1) As only the males are needed for the SIT, the production, handling and release costs can be reduced significantly if sexing strains are used.
2) The efficacy, sustainability and the cost of SIT programmes depends on the performance of released sterile males. The availability of strains producing high quality sterile males will increase the efficiency and will decrease the cost of SIT programmes.
3) A considerable proportion of the cost of SIT programmes is used for monitoring sterile insects in the field and therefore a stable, fail proof genetic marking system for the released flies will reduce costs considerably.
4) Male-only releases are several-fold more efficient than releases of both sexes and are mandatory for disease transmitting insect species such as mosquitoes. Consequently, when the genetic sexing technology is available, SIT programmes are significantly more efficient, safe and cost effective.
5) As horizontal transfer phenomena are of major ecological concern, strains producing males by transgenic or symbiont-based approaches for SIT applications will be assessed in this respect.

The announcement of the new CRP with detailed information can be seen in this newsletter under Announcements or under http://www-naweb.iaea.org/nafa/ipc/crp/new-crps-ipc.html.

Second 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*, 6–10 May 2014, Bangkok, Thailand

The second RCM was hosted by the Pest Management Division, Bureau of Agriculture and Product Quality Development, Department of Agricultural Extension of Thailand.

Twenty five participants, including six observers, from sixteen countries attended this RCM. The participants reported on the progress made since the last RCM in 2012. Specifically the following three areas were considered:

1) Larval diet and radiation effects,
2) Probiotics in adults and

3) Symbionts and novel control tools.

Significant progress has been made in the characterization of the gut microflora of larvae or 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 probiotics to enhance sterile insect competitiveness in several pest species. Results presented also suggest that radiation of mass-reared 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*, and *A. obliqua*, *Bactrocera dorsalis*, while the absence of *Wolbachia* infection in *Ceratitis capita* was confirmed from several populations in Brazil and Turkey. Preliminary information was presented on the potential use of lines of *C. capitata* inoculated with the reproductive symbiont *Wolbachia* that induces male-killing and cytoplasmic incompatibility.

Participants of the Workshop on The Characterization of Symbionts of Fruit Flies of Economic Importance via Bioinformatic Approaches" and Second 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 (Bangkok, Thailand).

Workshop on *The Characterization of Symbionts of Fruit Flies of Economic Importance via Bioinformatic Approaches*, 4–5 May 2014, Bangkok, Thailand

The workshop was organized in Bangkok, Thailand on 4-5 May 2014 with the participation of 15 members of the Coordinated Research Project *Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application*.

The objective of the workshop was to update the participants with the latest knowledge on molecular analysis of microbial communities of fruit flies of economic importance, and to introduce the use of bioinformatics and phylogenetic analysis of microorganisms. The workshop was held in conjunction with the second RCM of this CRP, held from 6 to 10 May 2014 in Bangkok, Thailand.

Final RCM of the CRP on *Development of Generic Irradiation Doses for Quarantine Treatments*, 2–6 June 2014, Vienna, Austria

This fourth and final research coordination meeting was held in the IAEA headquarters from 2 – 6 June 2014. This CRP has been run jointly by the Food and Environmental Protection (FEP) and the Insect Pest Control (IPC) Sections. The 4th RCM was attended by 16 participants, 3 observers from 17 countries and 3 staff members.

The principal aim of the CRP was to generate data in support of generic quarantine irradiation treatments for insects other than tephritid fruit flies, particularly for certain 'data-deficient' groups of major quarantine pest importance, such as thrips, mealybugs, scale insects and spider mites. The CRP has been very successful, with all of the principal objectives addressed. The 19 participants from 15 countries have produced treatment data on 37 arthropod species, covering 5 orders of insects and 3 families of mites to support specific and generic irradiation doses for phytosanitary treatments and several treatment proposals have already been or will be presented to the IPPC for formal consideration. In addition, the new data will support future efforts to establish new generic doses, similar to the 150 Gy generic dose already accepted for all tephritid fruit fly pests.

Participants of the final RCM on Development and Evaluation of Improved Strains of Insect Pests for SIT (Capri, Italy).

Considerable emphasis has been placed on dosimetry throughout the CRP. It was recognized at the beginning of the CRP that previous work on phytosanitary irradiation treatments was often compromised by the poor information provided on the dosimetry used. A research protocol, emphasizing the importance of dosimetry, was developed at the first RCM and assistance was provided to the participants throughout the CRP with the application and interpretation of dosimetry. It was clear in this final RCM that as a result the quality of reporting has greatly improved, with

the important move away from reporting target doses to the reporting of actual measured doses with suitably calculated confidence limits.

The development of a substantial network of researchers, the improvement in the understanding and application of dosimetry and the involvement of both the FEPS and the IPCS will contribute significantly to enhancing the development of phytosanitary irradiation treatments in the future.

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

The 4th RCM was hosted by the Okanagan Kootenay Sterile Insect Release (OKSIR) Program in Kelowna, British Columbia, Canada and held at the Coast Capri Hotel in Kelowna (2–6 June 2014). Sixteen contract and agreement holders from 13 countries attended the meeting. In addition, invited speakers from France (Bernard Blum), Canada (Luc Brodeur (Quebec), Cary Gates, Haley Catton, and Hugh Philip (British Columbia) gave presentations on the Regio Biocontrole (a new European initiative on area-wide approaches for codling moth control, see page 33), the sterile onion maggot programme in Quebec, sterile leaf miner project, biological control of invasive weeds and reduction in pesticide sales in the Okanagan valley, respectively. The last RCM of the CRP was very well organized and the great efforts of the local host Cara Nelson, General Manager of OKSIR are very much appreciated.

The first two days of the RCM were devoted to presentations of the participants on the progress made with their research since the last RCM in Phoenix, USA as well as an overview of all research accomplished during the CRP.

Significant progress was made in identifying and describing factors and variables that affect quality and field performance of sterile moths to be used in SIT programs. The effect of irradiation on moth physiology, moth survival, sperm production, sperm quality, sperm transfer success, sperm competition, moth longevity, moth dispersal, moth flight ability, and moth mating success was characterized. Radiation dose response studies identified the most appropriate dose for each insect species under investigation that would induce the required level of sterility while maintaining the highest level of quality. Laboratory, semi-field, and field bioassays were conducted on several moth pests to identify bioassays that successfully detected quality and performance differences that were relevant to moth performance in the field. Major advances were made by several laboratories in developing and implementing operational use of quality measures that reliably predict field performance to improve mass-rearing procedures, enhance quality, and SIT outcomes.

Participants of the RCM in front of the codling moth rearing facility (Osoyoos, BC, Canada).

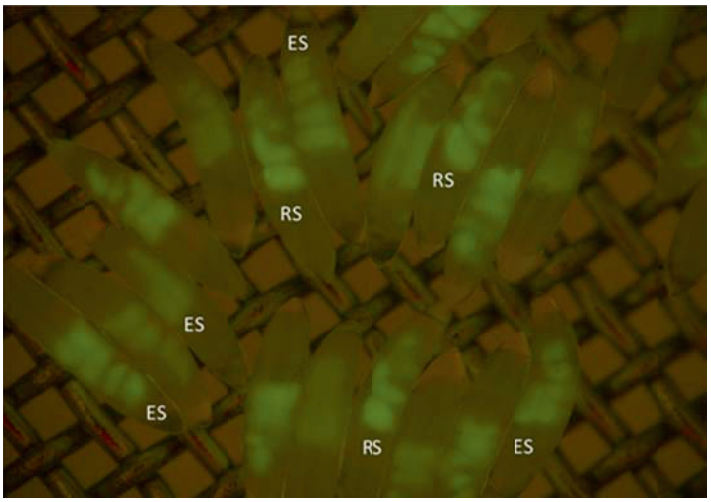
Tools and methods were developed to assess, predict and enhance the field performance of released moths based on insect quality. New methods and technologies, such as stable isotope labelling, wind tunnel or semi-field scale assessment, are helping to deliver a better understanding of the requirements for success that will enable the expansion of current programmes, target new insect pests, and increase the efficiency and effectiveness of pest control programmes.

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

FRUIT FLIES

Cryopreservation of fruit fly strains

The IPCL continues to maintain more than 200 strains of tephritid fruit fly species, making it an essential reference centre for strains of *Ceratitis capitata*, as well as of 4 other fruit fly species (*Anastrepha ludens*, *A. fraterculus*, *Bactrocera cucurbitae* and *B. dorsalis*). The collection includes genetic sexing strains (GSS), morphological and chromosomal mutations, transgenic lines, *Wolbachia*-infected strains and wild type populations from different geographic areas. The maintenance of these strains is laborious, expensive and requires significant space. Based on the recommendations of an external review, a project was initiated to determine the technical and economic feasibility of cryopreservation of tephritid fruit fly strains. During cryopreservation biological material can be preserved by cooling at very low temperatures, ideally at −196 °C, the boiling point of liquid nitrogen.



Determining the appropriate embryonic developmental stage for the initiation of the cryopreservation process of the Mediterranean fruit fly VIENNA-8 GSS (ES: early development stage; RS: appropriate development stage).

During a two-week visit of an expert in this field, Arun Rajamohan (Biosciences Research Laboratory of USDA, Fargo, ND, USA), experimental efforts were begun to cryopreserve the Mediterranean fruit fly VIENNA-8 GSS. This strain was chosen because it carries a number of morphological and chromosomal mutations and is a valuable strain which is currently being used in many mass-rearing facilities and SIT programmes on all continents. The preliminary results suggest that briefly cryopreserved eggs can hatch and develop to adults. The cryopreserved Mediterranean fruit fly VIENNA-8 GSS has been reared for over five generations now in the laboratory and genetic, molecular and quality control analysis is in process to confirm that it has maintained all its unique characteristics including its phenotypic markers (white pupae (*wp*) and temperature sensitive lethal (*tsl*)), mitochondrial DNA haplotype, the chromosomal rearrangements (the Y-autosome translocation and the D53 inversion, both involving chromosome 5) as well as its fitness and mating competitiveness.

Anastrepha fraterculus complex

In further support of the Co-ordinated Research Project on the resolution of cryptic species and the *Anastrepha fraterculus* complex, the IPCL hosted consultants from Argentina and the Czech Republic who carried out bioassays and sampled pheromones from the different morphotypes. Particular emphasis was put on assessing whether the males of different morphotypes were equally attractive to females of their own morphotype in comparison to females of other morphotypes. Preliminary data on female responses to artificial leks (males in containers) have been obtained with morphotypes from Tucumán (Argentina), and Parnamirim, Piracicaba, and Vacaria (Brazil). The study was carried out in standard field cages in the insect greenhouse of the IPCL at Seibersdorf. Although data analysis is still in progress preliminary results show that females visited containers that have males more frequently than containers with no males and females from Tucumán can discriminate between males from their own origin and from Vacaria. This was not evident for Vacaria or Piracicaba females. In a next step, bioassays are being carried out to assess the responses of the females to the extracts of male pheromone.

Aromatheraphy for *Bactrocera* spp.

During the second semester of the year 2013, the IPCL hosted Ihsan ul Haq, a consultant from Pakistan who focused on developing practical methods to administer methyl eugenol (ME) to enhance the mating behaviour of males of some *Bactrocera* species. ME is a natural chemical occurring in a variety of plant species and is a powerful attractant for males of many tropical tephritid fruit fly species of the genera *Bactrocera* and *Dacus*. This behavioural attractiveness has been exploited for fruit fly population monitoring and as part of an environment-friendly lure-and-kill approach to eliminate outbreaks called male annihilation technique (MAT).

ME-feeding is known to enhance the mating competitiveness of male *Bactrocera carambolae* 3 days after feeding. Enhanced male mating competitiveness due to ME-feeding can increase the effectiveness of the SIT. However, the equipment and the protocols currently used for emergence and holding fruit flies prior to field releases are not suitable for ME feeding. ME application by aromatherapy, however, could be a practical method that could be applied in

emergence and holding facilities.

A study was implemented to assess the effects of ME-aromatherapy and ME-feeding on the mating competitiveness of male B. *carambolae*. ME-aromatherapy and ME-feeding increased the mating success of males 3 days after exposure in comparison to untreated males. Mating success of ME-aromatherapy-treated males was similar to that of ME-fed males. Application of ME by aromatherapy could be a practical approach for improving male B. *carambolae* mating competitiveness thereby improving SIT effectiveness.

Drosophila suzukii

Drosophila suzukii is the only *Drosophila* species known as a crop pest. Females display a different oviposition behaviour and are able to penetrate the skin of fruits to deposit their eggs inside the host. D. *suzukii* is a new invasive pest which has been recently introduced into Europe, USA, Mexico and other countries, where especially berry and stone-fruit crops are affected.

Drosophila suzukii *colony maintained at the Insect Pest Control Laboratory, Seibersdorf, Austria.*

In November 2013 a small sample of *D. suzukii* was obtained from the "Sustainable Agro-Ecosystems and Bioresources Department, Research and Innovation Centre - Fondazione Edmund Mach, Italy", and rearing studies are ongoing to assess production parameters.

Postharvest treatment using hot water immersion

As part of the USDA/IAEA collaborative agreement on "The development of phytosanitary and regulatory treatments for exotic tephritid fruit flies", studies were conducted to assess the relative tolerance to hot water immersion among different tropical fruit fly species available at the IPCL. Plastic bags filled with 450g standard *Bactrocera* carrot-based rearing diet were used as "artificial fruits" to standardize the testing procedure. Testing was conducted comparing these bioassay containers to the heating of mango. Experiments for testing for relative heat tolerances of late stage larvae were replicated nine times. The experiments were developed as a factorial design, with species and time (35-65 min) as factors. The standard hot water treatment procedures according to the UDSA treatment manual, including a minimum temperature of 46°C and constant water circulation, was used as reference. Two experiments were conducted to assess similar treatment for eggs for the same species, one experiment with eggs imbedded in the "artificial fruits" and one experiment with the eggs exposed directly to the water in micro-centrifuge tubes. Species used were: *Anastrepha fraterculus, Bactrocera carambolae, B. correcta, B. cucurbitae, B. dorsalis, B. invadens, B. papayae, B. philippinensis, B. tryoni, B. zonata, and Ceratitis capitata.*

TSETSE FLIES

Tsetse salivary gland hypertrophy virus and symbionts

Tsetse flies harbour three symbiont bacteria and a pathogenic virus (salivary gland hypertrophy virus (SGHV)). The interaction between tsetse symbionts, virus infection and the performance of tsetse colonies remains unclear. Research was initiated to identify symbiotic bacteria that may interfere with the establishment and transmission of trypanosomes and/or SGHV, with the aim to develop refractory tsetse fly lines that could be used for mass-rearing. Recent research proved that elimination of tsetse microbiota with ampicillin treatment impedes SGHV transmission between tsetse generations, which indicates a possible role of tsetse microbiota in SGHV transmission. To identify this impeding mechanism a visiting scientist from Turkey, Güler Demirbas, is investigating which bacteria play a role in SGHV transmission by testing the impact of selective antibiotics treatment.

Guler Demirbas dissecting flies to study the SGHV host range.

In addition she will continue the study the SGHV host range by injecting the larvae of several tsetse species with virus extracted from *G. pallidipes* to investigate the possibility of SGH development in emerged adults, as well as

determining the impact of virus injection on symbiont titres.

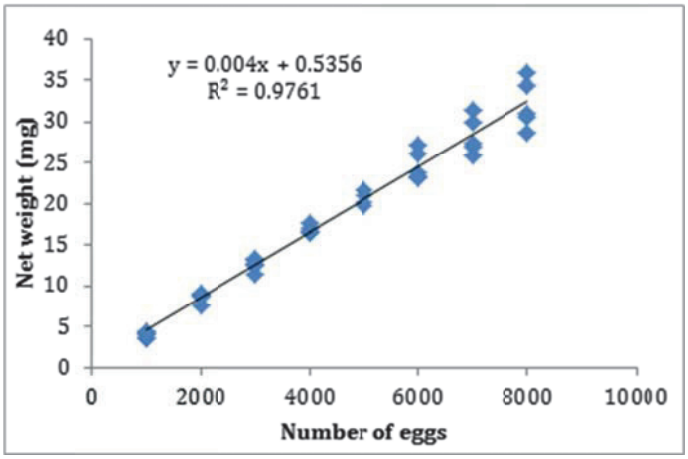
A study on the impact of *Wolbachia* infection on the sterility of inter-subspecies hybrids was initiated. Initial results indicate that the suppression of *Wolbachia* infection by tetracycline treatment of *G. m. centralis* males before mating with *G. m. morsitans* females leads to a significant increase in the productivity of the hybrids in comparison with non-treated males. Erica Ras from the Netherlands has started an internship at the IPCL to study the impact of antibiotic treatment and *Wolbachia* removal on inter-subspecies hybrid fertility.

In the past months, the study on the use of oligopeptides as an alternative strategy to control SGHV has been hindered by some technical problems related to the solubility of the oligopeptides and the development of *per os* infection methods. To solve these problems a second intern, Ms Irene Meki from Kenya, is working on virus stability under different storage conditions and the impact of virus infection on the expression of some tsetse genes.

MOSQUITOES

Improving *Anopheles arabiensis* mass-rearing technique

One bottleneck remains the availability of a practical method to dispense eggs in rearing trays to get an equal and standardized number of larvae/pupae per tray. We developed a method that correlates the weight with the number of *Anopheles arabiensis* dried eggs.



Linear relation between number of eggs and their weights.

The efficiency of the method and the effect of drying, brushing and weighing the eggs on their hatch rate were also investigated. Egg weight was correlated linearly with egg numbers. Drying, brushing and weighing had no effect on the eggs hatch rate. It is concluded that the described methodology makes it possible to estimate accurately large numbers of *An. arabiensis* eggs; additional experiments to determine the effects of this method on a number of life history parameters are ongoing for further validation.

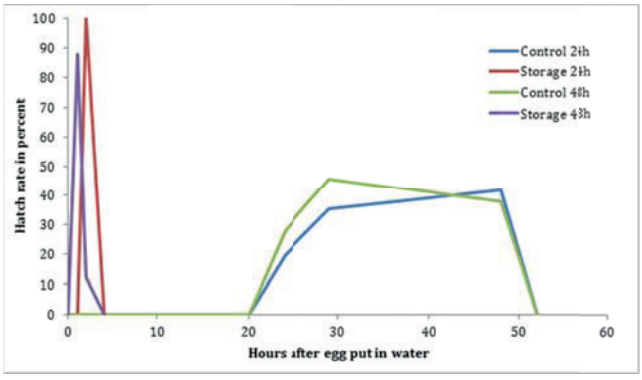
Effect of genetic manipulation, dieldrin treatment, and irradiation on the mating competitiveness of *Anopheles arabiensis* males

Before the release, *An. arabiensis* males are subjected to several treatments. From the original wild type strain, a genetic sexing strain (ANO IPCL1) based on a dieldrin resistant mutation was created with a translocation. Treatment of the eggs with dieldrin allows a complete elimination of female mosquitoes from the production line. The absence of female larvae and pupae reduce rearing costs, space and labour requirements. Finally, the male pupae are sterilized with a dose of 75 Gy of ionizing radiation. The impact of these three treatments (genetic manipulation, dieldrin treatment and irradiation) on the competitiveness of the males was assessed in field cages.

In three field cage experiments, the competitiveness of (1) ANO IPCL1 males, (2) irradiated ANO IPCL1 males, and (3) dieldrin treated, irradiated ANO IPCL1 males was compared with that of the wild type *An. arabiensis* Dongola strain. Genetic manipulation had no effect on male competitiveness with ANO IPCL1 males showing a Fried competitiveness index of 1.02 (equally competitive with the Dongola strain). Irradiated ANO IPCL1 males had a competitiveness index of 0.5, meaning that they were approximately half as competitive as wild-type males when evaluated in this given scenario. The irradiated ANO IPCL1 males that had been additionally treated with dieldrin at the egg stage appeared to be more competitive than those that had only been irradiated. An unexpected radio protectant effect of dieldrin on the *An. arabiensis* germinal cells is a possible explanation. The study likewise indicated that a minimum irradiated: fertile male ratio of 10:1 is needed to reduce the cage population's fertility by 81%. These results now need to be validated in field tests.

Anopheles arabiensis egg synchronisation

A rearing rack that contains 50 plastic larval trays, each containing 4 000 larvae, allows a maximal production of 200 000 pupae. In previous experiments, differences in developmental duration were observed with some pupae having a longer pupation period. Factors such as water quantity, surface in the tray, larval density or feeding schedule could be responsible for these variations.



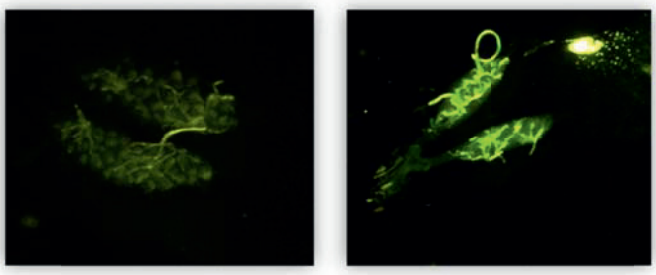
Dynamics of Anopheles arabiensis *egg hatch after 24 and 48 hours of storage.*

We examined egg storage as a potential factor that could affect insect quality. Eggs were placed in water immediately after counting or stored for 24 or 48 hours. Hatch rate of stored eggs was significantly higher than that of untreated eggs. The timing of hatch was also different between the treatment and the control group. All eggs of the treatment group hatched 2h after their deposition in water while without treatment the hatching began 20 hours after the eggs were deposited in water.

The effects of irradiation on adult female *Aedes albopictus*

Wolbachia pipentis is an intracellular maternally inherited bacterium that is capable of inducing cytoplasmic incompatibility (CI) in mosquitoes, which results in early embryo death when *Wolbachia* infected males mate with uninfected females or females that harbour a different *Wolbachia* strain. Incompatible Insect Technique (IIT) is a *Wolbachia*-based vector control strategy using sequential releases of incompatible males. Since *Wolbachia* is not paternally transmitted, the infection in the release strain is not transferred to the wild population. The application of IIT relies on the availability of perfect sexing systems as accidental releases of females may result in replacement of the targeted population with a population harbouring the new *Wolbachia* infection type.

Sex separation methods that are 100% accurate are not available for *Ae. albopictus*. A solution to this problem may be provided by combining irradiation with IIT. Previous studies have shown that irradiation with a low dose will sterilize *Aedes polynesiensis* females without any negative impact on the incompatible males. The combination of irradiation and IIT may guarantee that any accidental release of females will not result in fertile crosses and viable offspring.



Effects of irradiation on the ovary of female Aedes albopictus*. On the left the ovaries of the control females of the GT strain (30 ×); on the right the ovaries of irradiated females (40 Gy) of the GT strain (30 ×).*

We tested this strategy with irradiated pupae of *Ae. albopictus* triple *Wolbachia*-infected HC (wAlbA, wAlbB, wPip), double *Wolbachia*-infected GUA (wAlbA and wAlbB) and Wolbachia-free GT strains. Female pupae were irradiated at 0, 11, 23, 26, 28, 32, 34, 38 and 40 Gy and then caged with non-irradiated male pupae of the same strain at the ratio of 1:1. The results showed that fecundity and fertility decreased with increasing radiation dose and *Ae. albopictus* females were fully sterile with a dose of 28 Gy. Our results show that irradiation can be used to reduce the risk of unintentional population replacement caused by the inadvertent release of incompatible *Ae. albopictus* females in the field.

Hatch medium in *Aedes aegypti* and *Ae. albopictus* mass rearing

Hatch rate of eggs is one of the critical steps in the mass-rearing process of mosquitoes. An efficient hatch medium (0.25 g bacterial broth and 0.05 g yeast/100 ml) has traditionally been used at the IPCL and that solution showed good egg hatch of *Ae. aegypti* and *Ae. albopictus*. An experiment was conducted to assess the need for bacterial broth as part of the hatch medium. Eggs stored for 15 days after collection were added to the following hatch media: (1) deionized water and no hatch medium, (2) boiled deionized water and no hatch medium, and (3) deionized water and bacterial broth + yeast hatch medium. Eggs in the bacterial broth hatch medium always had the highest hatch rate (85-95%) for both species.

Aedes albopictus mark-release-recapture in Pointe des Lascars in Mauritius

Staff of the IPCL provided assistance to an *Ae. albopictus* release trial in Mauritius. The centre of the village Pointe des Lascars was chosen as the release point and the aim was to assess dispersal of the released mosquitoes. A total of 3 000 un-irradiated males and 3 000 irradiated males were released on 15 December 2013 at dusk. Traps were deployed at 30, 60, 90, 120 and 150 meters from the release point in the 4 directions. For 5 days, mosquitoes were collected twice a day, between 7:30 - 9:00 and 16:00-17:30 h. In addition to the 20 trapping points around the release point, swarming sites were visited and mosquitoes trapped by sweeping a racket (sticky plastic sheets) fixed to a badminton racket) for 15 minutes.

Of the 6 000 male *Ae. albopictus* released, 359 marked males (6%) were recaptured during the 6 days of collection. A similar number of unirradiated and irradiated males were collected: 183 and 176 respectively. Marked male mosquitoes were recaptured in all collection events following the release. The highest percentage of recaptures occurred on day 2 and 3 with around 30% and the lowest catch of 0 % occurred after 6 days but some males were trapped 8 days after the release. Eighty percent of the marked males were found close to the release point (30 m) with the number drastically decreasing beyond that: around 4-9% at 60 m and 90 m and 2% at 120 m. Six percent of unirradiated mosquitoes were found at 150 m compared to 3% for irradiated males. These data show that dispersal of *Ae. albopictus* (sterilized or not) is limited. Trials in different landscapes have to be done to confirm those data.

Reports

Participants of the 9th International Symposium on Fruit flies of Economic Importance (Bangkok, Thailand).

9th International Symposium on Fruit flies of Economic Importance, 12–16 May 2014

The 9th International Symposium on Fruit Flies of Economic Importance was attended by 396 researchers, plant protection officials, fruit industry representatives, exhibitors and institutions from 61 countries. There were 40 oral and more than 157 posters presented during the week covering the nine sessions: (1) Area-wide and action programs, (2) Biology, ecology, physiology and behaviour, (3) Morphology and taxonomy, (4) Genetics and evolution, (5) Chemical ecology and attractants, (6) Control methods and supporting technology, (7) Natural enemies and biological control, (8) SIT principles and applications, and (9) Risk assessment, quarantine and post-harvest.

Field trips took place during mid-week, including to fruit packing houses and different mango growing areas with participation of hundreds of small-scale farmers under area-wide integrated fruit management.

Many oral and poster presentations referred to the SIT, confirming that the area-wide integrated application of the SIT against fruit fly pests is gaining momentum.

The field of fruit fly research and control is highly specialized, with a number of areas rapidly evolving with the aim to increase cost-effectiveness, environmental sustainability and farmer acceptability. Integrated area-wide programmes are achieving significant socio-economic impact in a number of countries, helping farmers to drastically reduce losses and insecticide use, and to overcome barriers to international trade of fresh fruit and vegetables. However, to be successful they need long-term commitment with both financial and political stability, as well as strong outreach activities with the public and growers, to fully benefit from this approach.

Consultants' Group Meeting on New Methods for the Detection and Quantification of Irradiation in Intercepted Insects, 10–14 March 2014, Vienna, Austria

A Consultants' Group Meeting was held to advise the FAO/IAEA on the current status of research and technology for the detection of irradiated insects, in view of the objections sometimes raised by countries to the possibility of live, mobile insects being present in agricultural commodities that have undergone phytosanitary irradiation. There is also the possibility of using such techniques to confirm the irradiation status of an unmarked insect caught in a monitoring trap in a pest free area in conjunction with an SIT programme.

Current techniques used in the detection of irradiated food were discussed and their applicability to confirming the irradiation status of insects. The techniques can be divided into three groups: chemical detection of radiolytic products; free-radical detection; and biochemical/ microbiological techniques.

Current technology lacks the necessary sensitivity to be used on individual insects but can be used to confirm irradiation of the commodity when the insect is still associated with the commodity. Recent advances in analytical and biochemical techniques could provide substantial gains in sensitivity, potentially getting to the levels needed to analyze individual insects, but research is needed to validate these new techniques and to develop practical tests that can be used in the field. Issues of specificity also need to be addressed, if a systems approach is not ultimately acceptable.

Ninth Session of the Commission on *Phytosanitary Measures (CPM), International Plant Protection Convention*, 31 March–4 April, Rome, Italy

The FAO Assistant Director General and head of the Agriculture and Consumer Protection Department of FAO Ren Wang, welcomed the CPM members to FAO. He strongly linked the IPPC's work with the new Strategic Objectives of the FAO.

The CPM adopted the Annex 2 of ISPM 26 on "Control measures for an outbreak within a fruit fly-pest free area" and an Annex of ISPM 28 on "Vapour heat treatment for *Bactrocera cucurbitae* on *Cucumis melo* var. *reticulatus*".

During the CPM, an additional draft ISPM on "Determination of host status of fruit to fruit fly (Tephritidae)" was subject of formal objection by Argentina, Chile, Paraguay and Peru prior to the CPM. As a result, the document will be presented to the Standard Committee (SC) in May 2014 with the agreed changes made to overcome the formal objection.

Consultants Meeting on *Process Control for Fruit Fly Rearing Facilities that Mass-Produce Insects for Sterilization and Release*, 13–15 May 2014, Bangkok, Thailand

The consultants meeting was held with the participation of six fruit flies mass-rearing experts from Argentina, Australia, Guatemala, Mexico, Spain and the US. The objective of the meeting was to review and improve a *Dashboard for Managers* based on a spreadsheet developed at the Moscamed Programme in Guatemala. The *Dashboard* is designed as a working tool primarily for managers and staff of mass-production facilities to monitor insect rearing operations. It can also be used to monitor performance of small scale colonies and to compare strain performance.

Managers can easily be overwhelmed by the volume of information generated by various production processes. Presenting production trends in an organized, dashboard-style presentation brings a lot of value to the facility and programme managers. Dashboards are commonly used in industrial production and are ideally suited to monitor insect production. Key Performance Indicators ("KPIs") display production trends in simple, easy to interpret graphs and charts. The dashboard can also be used to predict different production scenarios compared with actual operations. A stable production process with known performance measurements provides better control over production output leading to reduced operational costs.

Monitoring operation activities helps to quickly identify production problems, take corrective actions, and measure their impact to improve processes. Monitoring also strengthens process planning and implementation, use of resources, supervision in general, and invites participation by staff at all levels of rearing. The final version of the *Dashboard* with Excel spreadsheet and manual will be made available on line.

International Conference "*Insects to Feed the World*", 14–17 May 2014, Ede, The Netherlands

The International Conference "Insect to Feed the World", organized jointly by FAO and the University of Wageningen, was held with the participation of 450 researches, private company representatives, international organizations and governmental bodies from 45 countries. The meeting was extremely well organized by Paul Vantomme (Non-Wood Forest Products, FAO) and Arnold Van Huis (Wageningen University). The programme covered different aspects of arthropod rearing as they relate to production of insect for feed and food, nutrition quality, public acceptance and the legislations available and required. FAO/IAEA activities in terms of developing systems to mass produce insects and managing and operating insect factories received good visibility; a presentation on "Industrial fruit fly mass rearing for the application of the Sterile Insect Technique: The FAO/IAEA Spreadsheet for Designing and Operating Insect Mass-rearing Facilities" was made. During discussions with conference participants, many mentioned diseases control as their main problem and they showed therefore special interest in the viral management strategies developed by the Joint FAO/IAEA Division.

Mealworm production cage shown during the International Conference "Insect to Feed the World" 14-17 May 2014 (Ede, The Netherlands).

Announcements

Interregional Training Course on *The Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests* 3–28 August 2015, Metapa de Dominguez, Chiapas, Mexico and Antigua / El Pino, Guatemala

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

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

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

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

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

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

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

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

Application Procedure: Nominations should be submitted on the standard IAEA application form for training courses/workshops (downloadable from: http://www-tc.iaea.org/tcweb/participion/astrainee/default.asp). Completed forms should be endorsed by and submitted through the official channels established (either the Ministry of Foreign Affairs, the National Atomic Energy Authority, the Office of the United Nations Development Programme, the Office of the FAO Resident Representative or the Ministry of Agriculture). (**Deadline for nominations: 30 April 2015).**

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

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

Joint FAO/IAEA Division
of Nuclear Techniques in Food and Agriculture
50 years, 1964–2014

50TH ANNIVERSARY: 1964-2014 & Beyond

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

Established on 1 October 1964, the FAO and IAEA created the Joint FAO/IAEA Division as a strategic partnership in order to mobilize the talents and resources of both organizations and hence to broaden cooperation between their Member States in the peaceful application of nuclear science and technology in a safe and effective manner to provide their communities with more, better and safer food and agricultural produce while sustaining natural resources.

Fifty years later, this FAO/IAEA partnership still remains unique, with its key strengths based on interagency cooperation within the United Nations family. It is a tangible joint organizational entity with a fusion of complementary mandates, common targets, a joint programme, co-funding and coordinated management. It entails close cooperation, greater efficiency and shared approaches, and geared to demand-driven and results-based services to its Members and to the international community at large.

Nuclear applications provide added value to conventional approaches in addressing a range of agricultural problems and issues, including food safety, animal production and health, crop improvement, insect pest control and sustainable use of finite natural resources. Over the past 50 years, this partnership has brought countless successes with distinct socio-economic impact at country, regional and global levels in Member States.

During the past 50 years the mission of the Joint Division has proactively evolved to embrace the adaptation to and mitigation of climate change and the adverse effects of globalisation, to increase biodiversity and to further contribute to agricultural development and global food security. Today, both FAO and IAEA strive to mobilize commitment and concerted action towards meeting the Millennium Development Goals and the Sustainable Development Goals through appropriate use of nuclear and related technologies for sustainable agriculture and food security.

Ren Wang
Assistant Director-General
FAO

Daud Mohamad
Deputy Director General
IAEA

50th Anniversary of the Joint FAO/IAEA Division: 1964-2014 & beyond

Call for Submission of Research Proposals for a new FAO/IAEA Coordinated Research Project on *Comparing Rearing Efficiency and Competitiveness of Sterile Male Strains Produced by Genetic, Transgenic or Symbiont-based Technologies*

The application of the Sterile Insect Technique (SIT) in area-wide integrated pest management (AW-IPM) programmes continues to increase in response to requests from Member States. However, programme efficiency can still be considerably enhanced when certain components of the technology are improved, such as the strains used to mass-produce sterile males, which are the key component of SIT programmes. They can be produced by classical and modern biotechnology approaches and strains producing such males are now available for key insect pests. The pests targeted for SIT applications include species of agricultural, veterinary and medical importance such as the Mexican fruit fly, the oriental fruit fly, the codling moth, the pink bollworm, the screwworm as well as disease transmitting mosquitoes. This CRP will focus on comparing the performance of strains developed or improved by classical genetic, transgenic and symbiont-based approaches to a level where a decision can be made as to their suitability to produce high-quality sterile males for use in large scale SIT programmes. Major beneficiaries will be operational AW-IPM programmes in Member States that apply the SIT against these major insect pests. By the end of the CRP several strains, including strains for new target species, producing high quality sterile males will be available with the following tangible benefits for pest control programmes in Member States using SIT:

1. As only the males are needed for the SIT, the production, handling and release costs can be reduced significantly if sexing strains are used.
2. The efficacy, sustainability and the cost of SIT programmes depends on the performance of released sterile males. The availability of strains producing high quality sterile males will increase the efficiency and will decrease the cost of SIT programmes.
3. A considerable proportion of the cost of SIT programmes is used for monitoring sterile insects in the field and therefore a stable, fail proof genetic marking system for the released flies will reduce costs considerably.
4. Male-only releases are several-fold more efficient than releases of both sexes and are mandatory for disease transmitting insect species such as mosquitoes. Consequently, when the genetic sexing technology is available, SIT programmes are significantly more efficient, safe and cost effective.
5. As horizontal transfer phenomena are of major ecological concern, strains producing males by transgenic or symbiont-based approaches for SIT applications will be assessed.

The expected duration of the CRP is 5 years (2015-2020) and the first Research Coordination Meeting is planned for June 2015 in Vienna, Austria. Scientists and researchers who are interested in collaborating in this new CRP should contact Kostas Bourtzis (K.Bourtzis@iaea.org). Information on the IAEA Coordinated Research Programme and how to apply for research contracts and research agreements can be found at http://www-crp.iaea.org/. Applications should be submitted by **30 November 2014** to Official.Mail@iaea.org.

Special issue on "Biology of Male Mosquitoes in Relation to New Approaches to Control Disease Transmitting Mosquitoes

Mosquito-borne diseases are a threat in many parts of the world. Malaria continues to be a major disease, infecting 300 million Africans annually despite the progress that has been achieved using indoor residual spraying and insecticide treated bednets. It is increasingly difficult to control due to the spread of insecticide resistance in the mosquito vectors and also resistance of the parasite to the available drugs. In terms of dengue, 2.5 billion people live at risk of infection with one or more of the four serotypes of the virus, which cause an estimated 390 million infections a year, and the affected area has increased rapidly in the past 30 years. Chikungunya outbreaks in Europe have drawn the attention of the Western world to this disease, spread by the Asian tiger mosquito, *Aedes albopictus*. With no specific treatment or vaccination available for these latter diseases, the focus in controlling outbreaks must be on suppressing the mosquito vectors.

Male mosquitoes utilize a variety of volatile and contact chemicals cues to orient towards sources of sugar (photo by R. Jason Pitts).

The continued importance of arboviral disease has led to increased demand from the Member States of the FAO/IAEA for development and feasibility testing of the

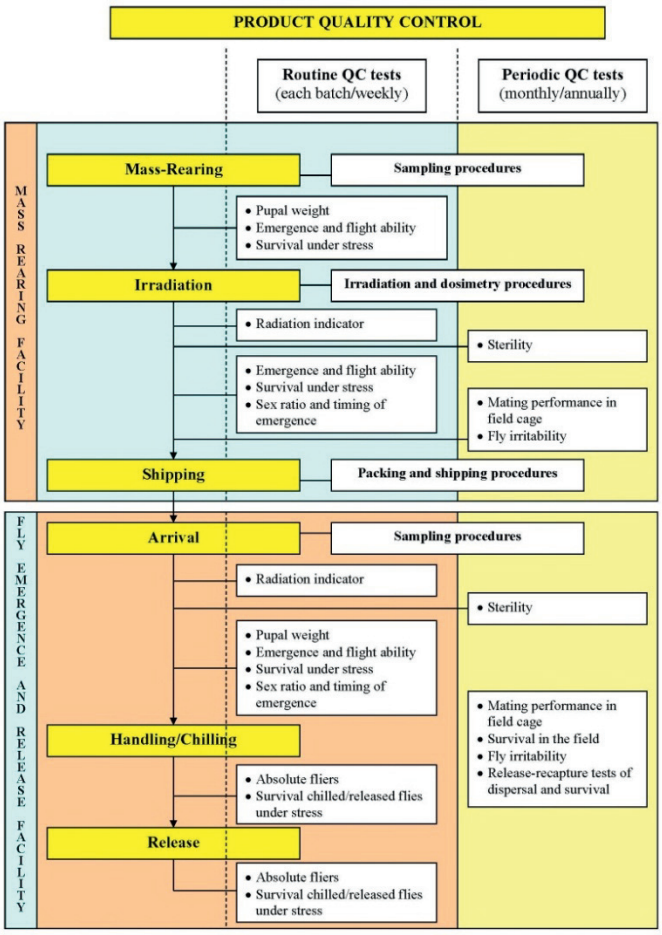
sterile insect technique (SIT) against some mosquito vectors. As a result, five national feasibility projects are ongoing in Sudan, South Africa, Mauritius, Pakistan and Sri Lanka, along with one regional project in the Indian Ocean (including Madagascar, La Réunion, Mauritius and Seychelles). These projects focus on capacity building, training and the development of suitable diets, irradiation protocols and standardized mass rearing systems, supported by a six year Coordinated Research Project (CRP), which involved researchers from 11 countries and ended in 2011. In order to effectively apply the SIT against a vector species, the mating biology must also be well understood, with particular focus on the males, against which released sterile males must compete and whose behaviour and biology will affect the scale and design of an effective release programme. Compared to the female, which transmits disease, relatively little is known about the male mosquito.

To increase the knowledge available in this crucial area another CRP entitled "*Biology of male mosquitoes in relation to genetic control programmes*" was initiated in 2007 and completed with a final meeting in March 2013. Researchers from 16 countries undertook studies on the pre-mating conditions and mating systems of a range of mosquito species, and investigated the contribution of molecular and chemical approaches to increase the understanding of male mating behaviour including swarming. A special issue in *Acta Tropica* has now been published that represents a collection of 23 reviews and research papers which have resulted from this coordinated effort. It expands the knowledge base of male mosquito biology and behaviour available to those wishing to apply sterile male releases and related methods of mosquito population control. This information will help to inform genetic control programmes, and inspire those in the field to continue to answer the remaining questions in this important area.

One additional effort in this direction is a further FAO/IAEA CRP initiated in 2013 and planned to continue until 2018, aiming to "*Explore mechanical, molecular, behavioural or genetic methods of sex separation in mosquitoes*". The need for an effective means to separate female from male mosquitoes prior to the release of sterilised males represents the next great challenge and technological or biological requirement of genetic control programmes.

FAO/IAEA/USDA. 2014. Product Quality Control for Sterile Mass-Reared and Released Tephritid Fruit Flies, Version 6.0.

This document represents the recommendations, reached by consensus of an international group of quality control experts, on the standard procedures for product quality control (QC) for sterile mass-reared and released tephritid flies that are to be used in Sterile Insect Technique (SIT) programmes, both at the mass-rearing facilities and fly emergence and release facilities. This international manual describes recommended procedures for sampling, irradiation, dosimetry, packaging and shipping. A new addition in this version is a flowchart showing the sequence of routine and periodic QC test to be carried out at the mass-rearing and fly emergence and release facilities.



Flowchart of the product quality control for sterile mass-reared and released tephritid flies at the mass rearing facility and at the fly emergence and release facility.

If followed, tests and procedures described in this manual will help ensure that the quality of mass-produced flies is measured accurately in a standardized fashion, allowing comparisons of quality over time and across rearing facilities and field programmes. Problems in rearing, irradiation, packing, shipping, handling and releasing procedures, and strain quality can often be identified by closely monitoring QC results thus allowing for corrections to be made before field programmes are adversely affected. Although routine and periodic QC testing can reveal measurable changes (both positive and negative), it is less definitive in pinpointing the cause or causes of reduced performance or quality.

The product QC evaluations included in this manual are intended to be carried out at both the mass-rearing and the fly emergence and release facilities. Both parties benefit in comparing and assessing results of routine and periodic QC tests to see: (1) what positive effects to sterile fly performance may result in making production changes or improvements (new strain assessments; nutritional, microbiological, semiochemical and hormonal supplements; etc)

and (2) what quality loss may have occurred during handling and shipping.

The manual continues to evolve and is subject to periodic updates. Future additions will include new tests, other fruit fly species and/or stages at which tests should be run as the need is identified and data become available. Previous versions of the manual contained minimum and mean acceptability specifications of conventional and genetic sexing strains for the main SIT target species of Tephritidae (e.g. *C. capitata* and some *Bactrocera* and *Anastrepha* species). This revision adds standards for new species and updates previous threshold values as a result of the increasing use of the SIT. This expansion is being driven by the need for more environmentally compatible pest control methods, lower costs in the production of sterile insects, and increased availability of sterile insects stemming from a number of newly constructed facilities with greater production capacity. It also important to mention that there is a greater need today to increase production of healthier, nutritious foodstuffs free of pesticide residues to meet an ever increasing global demand. Apart from demonstrated effectiveness of SIT to control pests, there also are important environmental benefits derived from reducing dependence on use of chemical controls.

The manual is available at: http://www-naweb.iaea.org/nafa/ipc/public/sterile-mass-reared-v6.pdf and additional suggestions to improve the manual are very welcome (please send any comment to R. Cardoso-Pereira @iaea.org).

Announcement of FAO/IAEA Interregional and Regional Training Courses

- Regional Training Course on *Fruit Fly Biocontrol in West Africa* (under Regional TC Project RAF5061). 4-8 August 2014, Dakar, Senegal. (**Deadline for nominations: 31 May 2014).**
- Regional Training Course on *Use of GIS for Area-Wide Fruit Fly Programmes in Indian Ocean* (under Regional TC Project RAF5062). 18–22 August 2014, Zanzibar, United Republic of Tanzania. (**Deadline for nominations: 15 June 2014).**
- Regional Training Course on *Fruit fly monitoring and suppression including MAT and SIT for Southeast Asia* (under Regional TC Project RAS5067). 15-19 September 2014, Bandung, Indonesia. (**Deadline for nominations: 15 July 2014).**
- Regional Training Course on *Mass Rearing and SIT-Related Activities for the Control of Aedes Mosquitoes, the Major Vectors of Dengue and Chikungunya* (under Regional TC Project RAS5066). 22-26 September 2014, Juazeiro, Brazil. (**Deadline for nominations: 15 July 2014).**
- Regional Training Course on *Taxonomy and Identification of Fruit Fly Pest Species Exotic to the Balkans and the Eastern Mediterranean* (under Regional TC Project RER5020). 13-17 October 2014, Tervuren, Belgium. (**Deadline for nominations: 31 July 2014).**
- Regional Training Course on *Free Open Source Software for GIS and Data Management Applied to Tsetse and Trypanosomosis Control Programmes*, (under Regional TC Project RAF5070). 10–21 November 2014, Bobo Dioulasso, Burkina Fasso. (**Deadline for nominations: 31 August 2014).**
- Regional Training Course on *Fruit fly monitoring and suppression including MAT and SIT for Indian Ocean* (under Regional TC Project RAF5062). 20-24 April 2015, Mauritius. (**Deadline for nominations: 31 January 2015).**
- 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). 1-5 June 2015, Vienna, Austria. (**Deadline for nominations: 31 March 2015).**
- 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 de Dominguez, Chiapas, Mexico and Antigua / El Pino, Guatemala. (**Deadline for nominations: 30 April 2015).**
- Regional Training Course on *Taxonomy and Identification of Fruit Fly Pest Species to the Southeast Asia* (under Regional TC Project RAS5067). 7-11 September 2015, Kuala Lumpur, Malaysia. (**Deadline for nominations: 30 June 2015).**

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.

Other News

Tsetse Fly Genome Breakthrough Brings Hope for African Farmers

Scientists have cracked the genetic code of the bloodsucking tsetse fly, prompting hope that the breakthrough will help future efforts to control one of the most devastating livestock diseases in sub-Saharan Africa spread by the insect.

The tsetse genome was sequenced and annotated during a 10-year international collaborative effort that involved the Insect Pest Control Laboratory run jointly by FAO/IAEA in Vienna. The achievement allows scientists to better study the fly's genes and their functions, knowledge that should open the door for researching ways to control the insect.

Found only in Africa, tsetse flies are vectors for the single-cell parasites that cause trypanosomosis, or nagana, an often-lethal disease that affects some 3 million animals in the region each year at massive costs to farmers' livelihoods and food security.

The disease leads to a debilitating chronic condition that reduces fertility, weight gain, meat and milk production, and makes livestock too weak to be used for ploughing or transport, which in turn affects crop production.

Humans bitten by carrier flies can develop African sleeping sickness, which can be fatal without treatment. No vaccine against the disease exists for livestock or humans because the parasite is able to evade mammalian immune systems, so control methods primarily involve targeting tsetse flies through trapping, pesticide treatments and sterile male release strategies.

"Decoding the tsetse fly's DNA is a major scientific breakthrough that opens the way for more effective control of trypanosomosis, which is good news for millions of herders and farmers in sub-Saharan Africa", said Kostas Bourtzis of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

"Detection and treatment of trypanosomiasis is currently expensive, difficult and dangerous for the livestock as it often involves toxic drugs, but this new knowledge will accelerate research on tsetse control methods and help scientists develop new and complementary strategies to reduce the use of costly drugs and insecticides," he said.

Unique Biology: In their contribution to decoding the genome, scientists from the FAO/IAEA Insect Pest Control Laboratory focused on the tsetse fly's relationship with a symbiotic bacterium, *Wolbachia*, which in many insect species affects its host's biology and physiology, including reproduction, mating behaviour and capacity as a vector.

"Our group was involved in the discovery of the horizontal transfer of large stretches of genomic sequence from the *Wolbachia* bacteria into the tsetse genome," Bourtzis said. "How these gene insertions affect the biology of the tsetse is currently being investigated."

The tsetse fly's complex relationship with *Wolbachia* and two other symbiotic bacteria are part of its unique biology, which also involves feeding exclusively on vertebrate blood, giving birth to live young, and feeding young by lactation.

A first set of findings on the tsetse fly genome has been published in the journal Science in a paper entitled 'Genome Sequence of the Tsetse Fly *(Glossina morsitans):* Vector of African Trypanosomiasis'.

Sterile Insect Technique: The Joint FAO/IAEA Division is currently supporting 14 African nations in their efforts to tackle the trypanosomosis problem by controlling tsetse fly populations by integrating the Sterile Insect Technique (SIT) with other control methods.

Tsetse flies were successfully eradicated from the island of Zanzibar using the Sterile Insect Technique and are currently being suppressed in parts of southern Ethiopia. In January, Senegal reported that it was making significant progress in infested areas in the Niayes with the same method in a project with FAO and IAEA.

Source: FAO and IAEA Press Release (24 April 2014).

Tephritid Workers of Asia, Australia and Oceania (TAAO)

The TAAO (Tephritid Workers of Asia, Australia and Oceania) network was recently revitalized during the 9th International Symposium on Fruit Flies of Economic Im-

portance (ISFFEI) in Bangkok. Against the backdrop of two other active regional tephritid networks i.e. Tephritid Workers of Western Hemisphere (TWWH) and Tephritid Workers of Europe, Africa and Middle East (TEAM), there has been increasing interest in fostering similar closer networking amongst tephritid researchers and pest control officers in Asia and the Pacific, particularly when this region contains a considerable proportion of the global tephritid workers community and is host to a significant number of the world's most invasive fruit fly species.

Thus, a meeting of the participants from Asia, Australia and Oceania took place on the sidelines of the 9th ISFFEI on the evening of 13 May 2014. A total of 35 participants from Australia, China, Fiji, India, Indonesia, Japan Malaysia, Thailand, and Vietnam, including Jorge Hendrichs, Head of the Insect Pest Control, FAO/IAEA, Vienna, were present. Although Mark Schutze (Australia), who was instrumental in preparing the presentation for reviving the TAAO initiative could not attend the meeting, his presentation was delivered by Tony Clarke (Australia). In that meeting, chaired by fellow colleague Alvin Hee (Malaysia), there was strong support from the participants on the reinvigoration of the TAAO networking. A positive outcome of the brief meeting also resulted in the support of the participants for the inaugural TAAO meeting scheduled for 2016 in Kuala Lumpur, Malaysia with Alvin Hee as the host. A mailing list of the participants including those from the region who attended the 8th and 9th ISFFEI will be created. The new TAAO steering committee will also be formed before details of the 2016 TAAO meeting are finalized. Further details will follow, and please spread this message to your national colleagues.

Source: Alvin Hee, Anthony Clarke and Mark Schutze (6 June, 2014).

The Asia-Pacific Dacine database

The Asia-Pacific Dacine database website now contains an interactive distribution map for more than 80 species that are either major/minor pests or that have been bred from commercial/edible fruit. On the maps page (http://www.herbarium.hawaii.edu/ fruitfly/maps.php), you can select a species from a drop-down window, and a map is generated, showing localities where the species is known to occur. The records used on this map were taken from credible literature, label data on specimens in the large collection developed by Elmo Hardy at the Bishop Museum, and data from fruit fly trapping and host fruit surveys carried out while I was working for the Regional Fruit Fly Project in the Pacific. You can click on each marker to view the source of the record. This is an ongoing project. Coverage of some of the countries, such as Australia, are in a preliminary phase and will be improved as more detailed records are becoming available.

Source: Luc Leblanc (23 May, 2014).

Irradiation may be future option for exports

The phase out of the fumigant methyl bromide may position irradiation as an emerging phytosanitary option for U.S. fresh produce exporters. That is the view of Cory Lunde, policy analyst and project manager for Western Growers, Irvine, Calif., after participating in a workshop on irradiation in late March.

The March 25-26 workshop in Orange, Calif., called "Opportunities in Phytosanitary Irradiation for Fresh Produce Workshop," was sponsored by Chapman University and the USDA. The workshop, the fourth annual workshop on that topic at Chapman University and co-sponsored by the USDA, included presentations of research that compared the shelf life of product treated by methyl bromide and irradiation.

Methyl bromide was largely phased out by the U.S. in 2005, but the U.S. government provides limited critical use exemptions to eliminate quarantine pests and for agricultural users with no feasible alternatives. Lunde gave a presentation on the importance of exports for Western agriculture and a presentation by Chapman University's Anuradha Prakash looked at irradiation's effect on the shelf life and quality of cherries and blueberries. California's farm exports totaled more than $18 billion in 2012, supporting about 125,000 jobs, Lunde said in his presentation. But a survey of Western Growers reveals sanitary and phytosanitary issues - along with competition, payment risks, perishability of product, tariff rates, pricing and logistics - limit export potential of the state.

For example, Lunde said the European grapevine moth and the light brown apple moth prevent exports of grapes into South Africa, while fire blight prevents apples from being shipped to China, Australia and Australia. The spotted wing *Drosophila* prevents exports of stone fruit to Australia, Brown rot on cherries requires that fruit exported to Australia is fumigated with methyl bromide, and the European Union imposes restrictions and inspections cherries can be shipped there. Peaches, nectarines and apricots sent to Mexico must undergo close inspection to prevent the spread of the Oriental fruit fly. So far, Lunde said produce industry exporters have not pursued irradiation as long as they have access to more traditional treatment options, including methyl bromide. As that fumigant is phased out, more produce exporters may weigh the benefits of the process. Consumer and industry acceptance are issues that must be faced, he said. "I think it can be accomplished, but it will be a long-term project.

Source: The Packer (http://www.thepacker.com, 8 April, 2014).

Regio Biocontrol – A New Regional European Integrated Programme for the Control of Insect Pests Centred on Biological Tactics, including the Release of Sterile Insects

The Regio Bicontrole is a new initiative that is being driven by the Academie du Biocontrole et de la Protection Biologique Integree in France. It is a response to European (Safe Use Directive) and national regulations (National Action Plan – Ecophyte 2018 in France) that demand a reduced use of insecticides, replacing them with efficient but environmentally friendly control tactics. The French Comite National d'Orientation et de Suivi Ecophyte adopted in 2011 a "road map" that included an important action point on support for biocontrol programmes.

The Regio Bicontrol intends to develop a consortium of organizations, including the private sector, to join forces to control important endemic and possibly to eradicate some outbreaks of invasive pests in France and later maybe other regions in Europe. It is anticipated that control methods such as mating disruption, attractants, the sterile insect technique and other biological control tactics will be integrated to reach the goals of the project.

The organizations that are targeted to become part of the consortium are: (1) production co-operatives, (2) regional technical organizations, (3) research organizations, (4) industry, and (5) private biocontrol groups.

Although the ultimate aim of the project is to present an answer to manage pests such as *Drosophila suzukii* and *Ragholetis completa*, the project will start with a trial period against codling moth, *Cydia pomonella*, in the region of Montauban, France. The project will therefore be able to benefit from the extensive experience of the OKSIR programme in Canada that has been operating a very successful SIT programme against codling moth for the last 20 years. A planning meeting for the trial is scheduled to be held in Toulouse, France in July 2014.

For more info, please contact Bernard Blum (agrometrix.blum@balcab.ch). Also visit the OECD IPM Hub at http://www.oecd.org/ chemicalsafety/integrated-pest-management/bio-physical-crop-sector.htm

State Government to build A$3 million fruit fly research centre at Port Augusta, Australia

Work on the A$3 million world-class centre will start next year, where researchers will develop a fruit fly management technique called sterile insect technology to combat the Queensland variety of the pest, or Q-fly.

Agriculture, Food and Fisheries Minister Gail Gago said Port Augusta was the ideal spot for this project because of its location at the crossroads of Australia. "The city has excellent transport links and as a crossroads is well placed to host a facility that will be able to produce and deliver millions of sterile Q-fly (*Bactrocera tryoni*) pupae each week to parts of Australia wherever fruit fly is a problem," she said. "Sterile insect technology has been used with great success here and worldwide to combat Mediterranean fruit fly, but this is a first for the development of male-only sterile Q-flies. "This is a game changer for our $677 million horticulture industry and marks a transformation in the way we manage Q-fly in Australia." Ms Gago described fruit fly as the most damaging fruit and vegetable pest worldwide, one which imposes significant costs on producers or consumers.

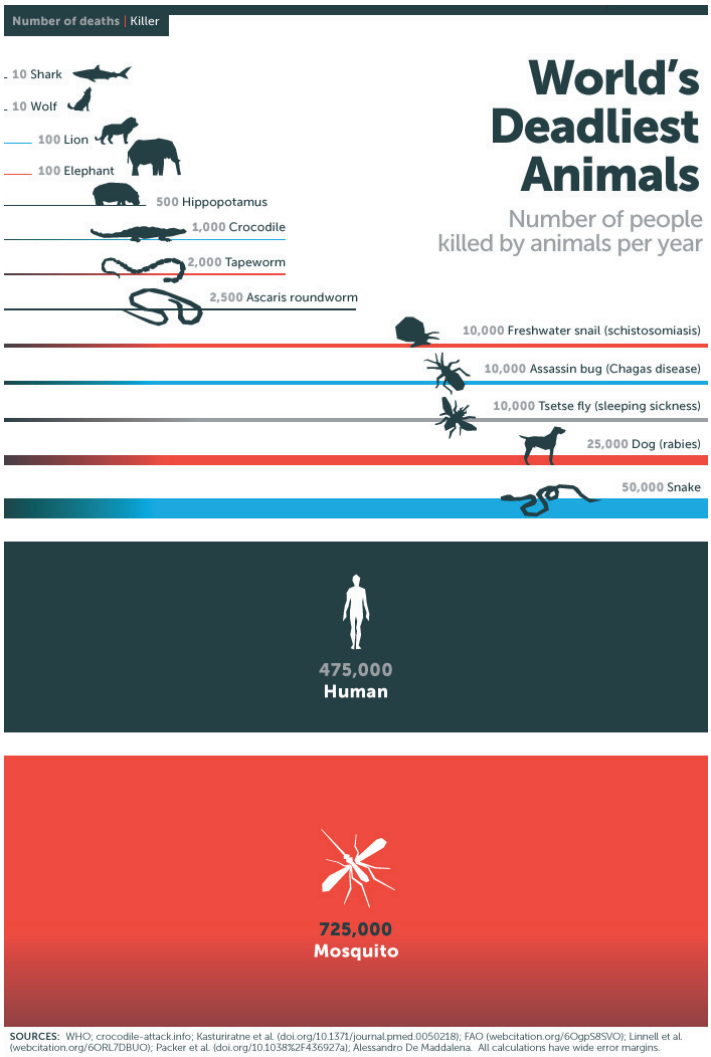
The State Government will own the centre while partners, Horticulture Australia, the CSIRO and Plant and Food Research Australia, will conduct the research.

Source: http://www.news.com.au (10 December 2013).

The Deadliest Animal in the World

What would you say is the most dangerous animal on Earth? Sharks? Snakes? Humans?

Of course the answer depends on how you define dangerous. Personally I've had a thing about sharks since the first time I saw Jaws. But if you're judging by how many people are killed by an animal every year, then the answer isn't any of the above. **It's mosquitoes**.



Source: Bill Gates Blog (http://www.gatesnotes.com, 25 April 2014).

Relevant Published Articles

Early life hormetic treatments decrease irradiation-induced oxidative damage, increase longevity, and enhance sexual performance during old age in the Caribbean fruit fly

Giancarlo López-Martínez[1,2] and Daniel A. Hahn[1]

[1] *Department of Entomology and Nematology, University of Florida, Gainesville, Florida, USA*

[2] *Department of Biology, New Mexico State University, Las Cruces, New Mexico, USA*

Abstract

Early life events can have dramatic consequences on performance later in life. Exposure to stressors at a young age affects development, the rate of aging, risk of disease, and overall lifespan. In spite of this, mild stress exposure early in life can have beneficial effects on performance later in life. These positive effects of mild stress are referred to as physiological conditioning hormesis. In our current study we used anoxia conditioning hormesis as a pretreatment to reduce oxidative stress and improve organismal performance, lifespan, and healthspan of Caribbean fruit flies. We used gamma irradiation to induce mild oxidative damage in a low-dose experiment, and massive oxidative damage in a separate high-dose experiment, in pharate adult fruit flies just prior to adult emergence. Irradiation-induced oxidative stress leads to reduced adult emergence, flight ability, mating performance, and lifespan. We used a hormetic approach, one hour of exposure to anoxia plus irradiation in anoxia, to lower post-irradiation oxidative damage. We have previously shown that this anoxic-conditioning treatment elevates total antioxidant capacity and lowers post-irradiation oxidative damage to lipids and proteins. In this study, conditioned flies had lower mortality rates and longer lifespan compared to those irradiated without hormetic conditioning. As a metric of healthspan, we tracked mating both at a young age (10 d) and old age (30 d). We found that anoxia-conditioned male flies were more competitive at young ages when compared to unconditioned irradiation stressed male flies, and that the positive effects of anoxic conditioning hormesis on mating success were even more pronounced in older males. Our data shows that physiological conditioning hormesis at a young age, not only improves immediate metrics of organismal performance (emergence, flight, mating), but the beneficial effects also carry into old age by reducing late life oxidative damage and improving lifespan and healthspan.

The full paper was published in: PLoS ONE (2014) 9(1): e88128.

Improving the sterile sperm identification method for its implementation in the area-wide sterile insect technique program against *Ceratitis capitata* (Diptera: Tephritidae) in Spain

M. Juan-Blasco[1] A. Urbaneja[1] V. San Andrés[1] P. Castañera[2] and B. Sabater-Muñoz[1,3]

[1] *Instituto Valenciano de Investigaciones Agrarias (IVIA), Centro de Proteccion Vegetal y Biotecnologia, Moncada, Spain*

[2] *Centro de Investigaciones Biológicas (CIB) del Consejo Superior de Investigaciones Científicas (CSIC), Departamento de Biología Medioambiental, Madrid, Spain*

Abstract

The success of sterile males in area-wide sterile insect technique (aw-SIT) programs against *Ceratitis capitata* (Wiedemann) is currently measured by using indirect methods as the wild: sterile male ratio captured in monitoring traps. In the past decade, molecular techniques have been used to improve these methods. The development of a polymerase chain reaction-restriction fragment-length polymorphism-based method to identify the transfer of sterile sperm to wild females, the target of SIT, was considered a significant step in this direction. This method relies on identification of sperm by detecting the presence of Y chromosomes in spermathecae DNA extract complemented by the identification of the genetic origin of this sperm: Vienna-8 males or wild haplotype. However, the application of this protocol to aw-SIT programs is limited by handling time and personnel cost. The objective of this work was to obtain a high-throughput protocol to facilitate the routine measurement in a pest population of sterile sperm presence in wild females. The polymerase chain reaction-restriction fragment-length polymorphism markers previously developed were validated in Mediterranean fruit by samples collected from various locations worldwide. A laboratory protocol previously published was modified to allow for the analysis of more samples at the same time. Preservation methods and preservation times commonly used for Mediterranean fruit by female samples were assessed for their influence on the correct molecular detection of sterile sperm. This high-throughput methodology, as well as the results of sample management presented here, provide a robust, efficient, fast, and economical sterile sperm identification method ready to be used in all Mediterranean fruit by SIT programs.

The full paper was published in: Journal of Economic Entomology (2013) 106(6): 2541-2547.

Papers in Peer Reviewed Journals

In Press

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

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

CÁCERES, C., J. HENDRICHS and M.J.B. VREYSEN. Development and improvement of rearing techniques for fruit flies (Diptera: Tephritidae) of economic importance. International Journal of Tropical Insect Science (in press).

DICKO, A.H., R. LANCELOT, M.S. SECK, L. GUERRINI, M., M.J.B. VREYSEN at al. Using species distribution models to optimize vector control in the framework of the tsetse eradication campaign in Senegal. Proceedings of the National Academy of Sciences (in press).

DONG, Y.C., L. WAN, R. PEREIRA, N. DESNEUX and C.Y. NIU. Feeding and mating behavior of Chinese citrus fly *Bactrocera minax* (Doiptera; Tephritidae) in the field. Journal of Pest Science (in press).

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

HAQ, I., M.J.B. VREYSEN, C. CACÉRES, T.E. Shelly, and J. Hendrichs. Methyl eugenol aromatherapy enhances competitiveness of male *Bactrocera carambolae* Drew & Hancock (Diptera: Tephritidae) mating competitiveness. Journal of Insect Physiology (in press).

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

MUBARQUI, R., PEREZ, R.C., KLADT, R.A., ZAVALA LOPEZ, J.L., PARKER, A., SECK, M.T., SALL, B., BOUYER, J. The smart aerial release machine, a universal system for applying the sterile insect technique. PLoS One (in press)

SOTERO, R. and R. PEREIRA. Age and temperature related pupal eye colour changes in various tephritid fruit fly species with a view to optimizing irradiation timing. International Journal of Tropical Insect Science (in press).

YAMADA, H., A.G. PARKER, C.F. OLIVA, F. BALESTRINO and J.R.L. GILLES. (in press) X- Ray induced sterility in Aedes albopictus. Journal of Medical Entomology.

2014

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

AKSOY, S. G. ATTARDO, M. BERRIMAN, K. BOURTZIS et al. International Glossina Genome Initiative (2014). Genome Sequence of the Tsetse Fly (*Glossina morsitans*): Vector of African Trypanosomiasis. *Science* 344(6182):380-386.

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

AUGUSTINOS, A.A., A.K. ASIMAKOPOULOU, C.A. MORAITI, P. MAVRAGANI-TSIPIDOU, K. BOURTZIS, et al. Microsatellite and *Wolbachia* analysis in *Rhagoletis cerasi* natural populations: extended structuring and multiple infections. Ecology and Evolution ece3.553.

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

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

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

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

of the Entomological Society of America 107(1): 97-112.

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

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

BRELSFOARD, C., G. TSIAMIS, M. FALCHETTO, L. GOMULSKI, K. BOURTZIS, et al. (2014). *Wolbachia* symbiont genome sequence and extensive chromosomal insertions described from the tsetse fly *Glossina morsitans*. PLoS Neglected Tropical Diseases 8(4):e2728.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2013

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

ABD-ALLA, A., M. BERGOIN, A. PARKER, K. BOURTZIS, S. AKSOY, et al. (2013). Improving sterile insect technique (SIT) for tsetse flies through research on their symbionts and pathogens. Journal of Invertebrate Pathology 112 (Supplement 1): S2-S10.

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

AHMADI, M., A.M. ABD-ALLA and S. MOHARRAMIPOUR (2013). Combination of gamma radiation and essential oils from medicinal plants in managing *Tribolium castaneum* contamination of stored products. Applied Radiation and Isotopes 78:16-20.

ARIITHI, H.M., A.G. PARKER, G. FRANZ, M.J.B. VREYSEN, A.M.M. ABD-ALLA et al. (2013). Prevalence and genetic variation of salivary gland hypertrophy virus in wild populations of the tsetse fly *Glossina pallidipes* from southern and eastern Africa. Journal of Invertebrate Pathology 112 (Supplement 1): S123-S132.

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

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

BOUCIAS, D.G., H.M. KARIITHI, K. BOURTZIS, A. PARKER, A.M.M. ABD-ALLA, et al. (2013). Transgenerational transmission of the *Glossina pallidipes* Hytrosavirus depends on the presence of a functional symbiome. PLoS ONE 8(4): e61150.

DAMIENS, D., M.J.B. VREYSEN and J.R.L. GILLES (2013). *Anopheles arabiensis* sperm production after genetic manipulation, dieldrin treatment, and irradiation. Journal of Medical Entomology 50: 314-316.

DAMIENS, D., S.M. SOLIBAN, F. BALESTRINO, M.J.B. VREYSEN, J.R.L. GILLES, et al. (2013). Different blood and sugar feeding regimes affect the productivity of *Anopheles arabiensis* colonies (Diptera: Culicidae). Journal of Medical Entomology 50: 336-343.

DONG, Y.C., Z.J. WANG, A.R. CLARKE, R. PEREIRA, N. DESNEUX et al. Pupal diapause development and termination is driven by low temperature chilling in *Bactrocera minax*. Journal of Pest Science 86:429-436.

DOUDOUMIS, V., R. ALATALO, E. AKSOY, A. ABD-ALLA, G. TSIAMIS, K. BOURTZIS et al. (2013). Tsetse-*Wolbachia* symbiosis: comes of age and has great potential for pest and disease control. Journal of Invertebrate Pathology 112 (Supplement 1): S94-S103.

ELLEGAARD, K.M., L. KLASSON, K. NÄSLUND, K. BOURTZIS and S.G.E. ANDERSSON (2013). Comparative genomics of *Wolbachia* and the bacterial species concept. PLoS Genetics 9(4): e1003381.

FELDMANN, U., F. MRAMBA, A.G. PARKER, V.A. DYCK, M.J.B. VREYSEN, et al. (2013). Application of the sterile insect technique in Zanzibar to eradicate tsetse flies, the vectors of trypanosomosis. pp 125-132. *In* Ruane, J., J.D. Dargie, C. Mba, P. Boettcher, H.P.S. Makkar, D.M. Bartley and A. Sonnino (eds.). Biotechnologies at Work for Smallholders: Case Studies from Developing Countries in Crops, Livestock and Fish. FAO, Rome, Italy.

GÓMEZ, Y., P.E.A. TEAL and R. PEREIRA (2013). Enhancing efficacy of Mexican fruit fly SIT programmes by large-scale incorporation of methoprene into pre-release diet. Journal of Applied Entomology 137 (Supplement 1): S252-S259.

HALLMAN, G.J., V. ARTHUR, C.M BLACKBURN, and A.G. PARKER (2013). The case for a generic phytosanitary irradiation dose of 250 Gy for Lepidoptera eggs and larvae. Journal of Economic Entomology 106: 525-532.

HALLMAN, G.J, S.W. MEYERS, M.E. EL-WAKKAD, M.D. TRADOUS and A. JESSUP (2013). Development of phytosanitary cold treatments for oranges infested with *Bactrocera invadens* and *Bactrocera zonata* (Diptera:Tephritidae) by comparison with existing cold treatment schedules for *Ceratitis capitata*. Journal of Economic Entomology 106: 1608-1612.

HALLMAN, G.J, S.W. MEYERS, G. TARET, E.A. FONTENOT and M.J.B. VREYSEN (2013). Phytosanitary cold treatment for oranges infested with *Bactrocera zonata* (Diptera: Tephritidae). Journal of Economic Entomology 106: 2336-2340.

HALLMAN, G.J., A.G. PARKER and C.M. BLACKBURN (2013). The case for a generic phytosanitary irradiation dose of 400 Gy for Lepidoptera that infest shipped commodities as pupae. Radiation Physics and Chemistry 89: 70-75.

HAQ, I. and J. HENDRICHS (2013). Pre-release feeding on hydrolysed yeast and methoprene treatment enhances male *Bactrocera cucurbitae* Coquillett (Diptera: Tephritidae) longevity. Journal of Applied Entomology 137 (Supplement 1): S99-S102.

HAQ, I., M.J.B. VREYSEN, A. ABD-ALLA and J. HENDRICHS (2013). Ability of genetic sexing strain male melon fly (Diptera: Tephritidae) to suppress wild female remating: implications for SIT. Florida Entomologist 96:839-849.

HAQ, I., C. CÁCERES, A. JESSUP, J. HENDRICHS, A.S. ROBINSON et al. (2013). Effect of methoprene application, adult food and feeding duration on male melon fly starvation survival. Journal of Applied Entomology 137 (Supplement 1): S61-S68.

JEHLE, J.A., A.M.M. ABD-ALLA and Y. WANG (2013). Phylogeny and evolution of *Hytrosaviridae*. Journal of Invertebrate Pathology 112 (Supplement 1): S62-S67.

JUAN-BLASCO, M., B. SABATER, R. ARGILÉS, J.A. JACAS, F. ORTECO et al. (2013). Effects of pesticides used in citrus grown in Spain on the mortality of *Ceratitis capitata* (Diptera: Tephritidae) Vienna-8 strain sterile males. Journal of Economic Entomology 106: 1226-1233.

KARIITHI, H.M., J. VAN LENT, M.M. VAN OERS, A.M.M. ABD-ALLA and J.M. VLAK (2013). Proteomic footprints of a *Glossina* virus (Hytrosaviridae): An expeditious approach to virus control strategies in tsetse factories. Journal of Invertebrate Pathology 112 (Supplement 1): S26-S31.

KARIITHI, H.M., M.M. VAN OERS, M.J.B. VREYSEN, A. PARKER and A.M.M. ABD-ALLA et al. (2013). Virology, epidemiology and pathology of *Glossina* hytrosavirus, and its control prospects in laboratory colonies of the tsetse fly G*lossina pallidipes* (Diptera: Glossinidae). Insects, 4: 287-319.

KHAN, I., D. DAMIENS, S.M. SOLIBAN and J.R GILLES (2013). Effects of drying eggs and egg storage on hatchability and development of *Anopheles arabiensis* . Malaria Journal 12:318.

LIENDO, M.C., F. DEVESCOVI, G.E. BACHMANN, M.E. UTGES, J. HENDRICHS, et al. (2013). Precocious sexual signalling and mating in *Anastrepha fraterculus* (Diptera: Tephritidae) sterile males achieved through juvenile hormone treatment and protein supplements. Bulletin of Entomological Research 103: 1-13.

MALELE, I.I., O. MANANQWA, H.H. NYINGILILI, W.A. KIWIKA, A.M.M. ABD-ALLA, et al. (2013). Prevalence of SGHV among tsetse species of economic importance in Tanzania and their implication for SIT application. Journal of Invertebrate Pathology 112 (Supplement 1): S133-S137.

MAVOUNGOU, J.F., N. PICARD, L.T. KOHAGNE, B. M'BATCHI, J. GILLES, et al. (2013). Spatio-temporal variation of biting flies, *Stomoxys* spp. (Diptera: Muscidae), along a man-made disturbance gradient, from primary forest to the city of Makokou (North-East, Gabon). Medical and Veterinary Entomology 27(3): 339-345.

MUTIKA, G.N., I. KABORE, M.T. SECK, A.G. PARKER, M.J.B. VREYSEN, et al. (2013). Mating performance of *Glossina palpalis gambiensis* strains from Burkina Faso, Mali, and Senegal. Entomologia Experimentalis et Applicata 146: 177-185.

OLIVA, C.F., M.J. MAIER, J. GILLES, M. JACQUET, M.J.B. VREYSEN, et al. (2013). Effects of irradiation, presence of females, and sugar supply on the longevity of sterile male *Aedes albopictus* (Skuse) under semi-field conditions in Reunion Island. Acta Tropica 125: 287-293.

OLIVA, C., D. DAMIENS, M.J.B. VREYSEN, G. LEMPERIÈRE and J.R.L. GILLES (2013). Reproductive strategies of *Aedes albopictus* (Diptera: Culicidae) and implications for the sterile insect technique. PLoS ONE 8(11): e78884.

PEREIRA, R., B. YUVAL, P. LIEDO, P.E.A. TEAL, T.E SHELLY, J. HENDRICHS, et al. (2013). Improving sterile male performance in support of programmes integrating the sterile insect technique against fruit flies. Journal of Applied Entomology 137 (Supplement 1): S178-S190.

PEREIRA, R., P.E.A. TEAL, H. CONWAY, J. WORLEY, and J. SIVINSKI (2013). Influence of methoprene and dietary protein on maturation and sexual performance of sterile *Anastrepha ludens* (Diptera: Tephritidae). Journal of Applied Entomology 137 (Supplement 1): S191-S199.

PUGGIOLI, A., F. BALESTRINO, D. DAMIENS, R.S. LEES, S.M. SOLIBAN, O.M. MADAKACHERRY, et al. (2013). Efficiency of three diets for larval development in Mass rearing *Aedes albopictus* (Diptera: Culicidae). Journal of Medical Entomology 50(4): 819-825.

RADONJIĆ, S., M. ČIZMOVIĆ and R. PEREIRA (2013). Population dynamics of the Mediterranean fruit fly in Montenegro. International Journal of Insect Science 2013:5.

SAWADOGO, S.P., A. DIABATÉ, H.Y. TOÉ, A. SANON, J. GILLES, et al. (2013). Effects of age and size on *Anopheles gambiae* s.s. male mosquito mating success. Journal of Medical Entomology 50: 285-293.

SCHNEIDER, D.I., K.I. GARSCHALL, A.G. PARKER, A.M.M. ABD-ALLA and W.J. MILLER (2013). Global *Wolbachia* prevalence, titer fluctuations and their potential of causing cytoplasmic incompatibilities in tsetse flies and hybrids of *Glossina morsitans* subgroup species. Journal of Invertebrate Pathology 112 (Supplement 1): S104-S115.

SCHUTZE, M.K., A. JESSUP, I.U. HAQ, M.J.B. VREYSEN, V. WORNOAYPORN, et al. (2013). Mating compatibility among four pest members of the *Bactrocera dorsalis* fruit fly species complex (Diptera: Tephritidae). Journal of Economic Entomology 106: 695-707.

SILVA, N., L. DANTAS, R. CALISTO, M.J. FARIA and R. PEREIRA (2013). Improving an adult holding system for Mediterranean fruit fly, *Ceratitis capitata*, to enhance sterile male performance. Journal of Applied Entomology 137 (Supplement 1): S230-S237.

SOOKAR, P., I. HAQ, A. JESSUP, G. FRANZ, V. WORNOAYPORN, et al. (2013). Mating compatibility among *Bactrocera cucurbitae* (Diptera: Tephritidae) populations from three different origins. Journal of Applied Entomology 137 (Supplement 1): S69-S74.

SOUMANA, I.H., G. SIMO, F. NJIOKOU, B. TCHICARA, A.M.M. ABD-ALLA, et al. The bacterial flora of tsetse fly midgut and its effect on trypanosome transmission. Journal of Invertebrate Pathology 112 (Supplement 1): S89-S93.

SIOZIOS, S., P. IOANNIDIS, L. KLASSON, S.G. ANDERSSON, K. BOURTZIS, et al. (2013). The diversity and evolution of *Wolbachia* ankyrin repeat domain genes. PLoS ONE. 8(2): e55390.

TEAL P.E.A., R. PEREIRA, I. HAQ, A.S. ROBINSON, J. HENDRICHS, et al. (2013). Methoprene and protein supplements accelerate reproductive development and improve mating success of male tephritid flies. Journal of Applied Entomology 137 (Supplement 1): S91-S98.

VAN DEN ABBEELE, J., K. BOURTZIS, B. WEISS, A. ABD-ALLA and A.G. PARKER (2013). Enhancing tsetse fly refractoriness to trypanosome infection - A new IAEA Coordinated Research Project. Journal of Invertebrate Pathology 112 (Supplement 1): S142-S147.

VREYSEN, M.J.B., M.T. SECK, B. SALL and J. BOUYER (2013). Tsetse flies: their biology and control using area-wide integrated pest management approaches. Journal of Invertebrate Pathology 112 (Supplement 1): S15-S25.

VREYSEN, M.J.B., T. BALENGHIEN, K. SALEH, S. MAIGA, Z. KOUDOUGOU, et al. (2013). Release-recapture studies confirm dispersal of *Glossina palpalis gambiensis* between river basins in Mali. PLoS Neglected Tropical Diseases 7(4): e2022.

WANG, Y., A.M.M. ABD-ALLA, H. BOSSIN, Y. LI and M. BERGOIN (2013). Analysis of the transcription strategy of the *Junonia coenia* densovirus (JcDNV) genome. Virus Research 174(1-2):101-107.

WHITE, S., R. MARTINEZ, A.G. PARKER, J. AGARD and D.D. CHADEE (2013). Investigations on *Philornis downsi* Dodge and Aitken (Diptera: Muscidae) in Trinidad: a parasite of the Darwin finches. Living World, Journal of the Trinidad and Tobago Field Naturalists' Club 2013: 38-41.

YAMADA, H., S.M. SOLIBAN, M.J.B. VREYSEN, D.D. CHADEE and J.R.L. GILLES (2013). Eliminating female *Anopheles arabiensis* by spiking blood meals with toxicants as a sex separation method in the context of the sterile insect technique. Parasites & Vectors 6:197.

YAMADA, H., Z. JANDRIC, S. CHHEM-KIETH, M.J.B VREYSEN, J.R.L. GILLES, et al. (2013). *Anopheles arabiensis* egg treatment with dieldrin for sex separation leaves residues in male adult mosquitoes that can bioaccumulate in goldfish (*Carassius auratus auratus*). Environmental Toxicology and Chemistry 32(12):2786-2791.

ZACHAROPOULOU, A. and G. FRANZ (2013). Genetic and cytogenetic characterization of genetic sexing strains of *Bactrocera dorsalis* and *Bactrocera cucurbitae* (Diptera: Tephritidae). Journal of Economic Entomology 106: 995-1003.

Other Publications

2014

FAO/IAEA/USDA (2014). Product Quality Control for Sterile Mass-Reared and Released Tephritid Fruit Flies, Version 6.0. *International Atomic Energy Agency*, Vienna, Austria. 164 pp. (http://www-naweb.iaea.org/nafa/ipc/public/sterile-mass-reared-v6.pdf).

LEES, R.S., D.D. CHADEE and J.R.L. GILLES (eds.) (2014). Biology and behavior of male mosquitoes in relation to new approaches to control diseases transmitting mosquitoes. Acta Tropica 132 (Supplement):S1-S187. (http://www.sciencedirect.com/ science/journal/0001706X/132/supp/S)

2013

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

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

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

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

2012

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

2011

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

2010

DYCK, V.A., HENDRICHS J., ROBINSON A.S. (eds.). (2010). Sterile Insect Technique. Principles and Practice in Area-Wide Integrated Pest Management [in Chinese]. China Agricultural Science and Technology Press, Beijing, China. 955 pp. (unpriced)

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

VREYSEN M.J.B. and ROBINSON A.S (eds.) (2010). Proceedings of an FAO/IAEA Coordinated Research Project on Improvement of Codling Moth SIT to Facilitate Expansion of Field Application. Journal of Applied Entomology. 134 (3): 163-273. (http://onlinelibrary.wiley.com/doi/10.1111/jen.2010.134. issue-3/issuetoc))

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

Impressum

Insect Pest Control Newsletter No. 83

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

International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Printed by the IAEA in Austria, July 2014

14-24981