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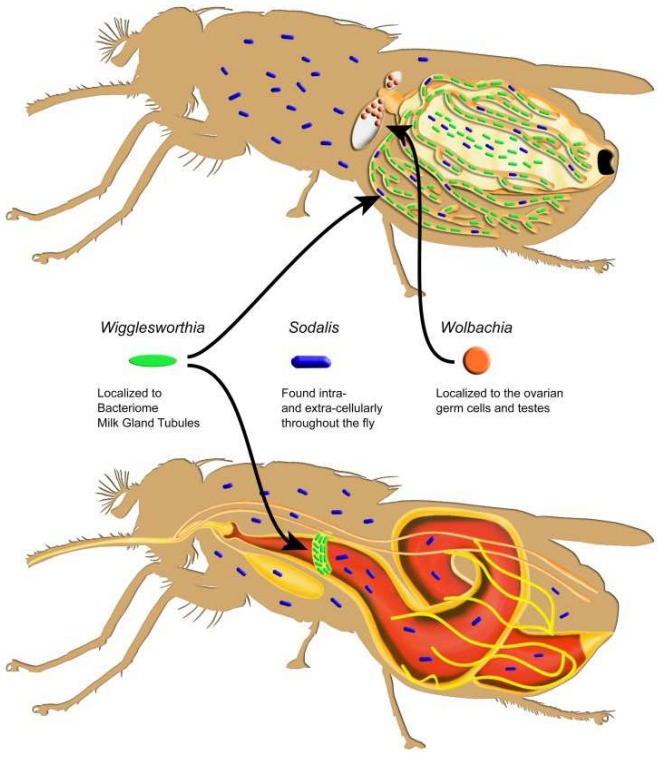
Contents

To our Readers

Microbes have been the dominating forms of life, almost since the birth of our planet about 4.5 billion years ago. Being masters of chemical reactions, they regulate the recycling of all major chemicals relevant to life; manage energy sources and the production of fuels; determine the aerobic conditions of our atmosphere and influence our climate; are the catalytic factors of soil fertility, thus affecting agricultural production; and have also been of paramount importance for the health of ecosystems and of all living organisms including humans. Last, but not least, they have been the driving force of the on-going "biotechnological revolution", which promises to produce more and healthier food, drugs and "green" fuels. Because of all their unique metabolic properties, microbes have been driving the evolution of life on earth, either by being free-living or by establishing symbiotic associations with diverse organisms including insects.

Insects are the most abundant and species-rich animal group on earth, occupying most available ecological niches. Conservative estimates suggest that about 85% of all described animal species are insects; estimates range between 2-30 million insect species and about 10 quintillion (10^{18}) individual insects being alive at any given time (http://www.si.edu/Encyclopedia_SI/nmnh/buginfo/bugnos.htm). During recent years it has become evident that the ecological and evolutionarily success of insects greatly depends on the sophisticated symbiotic associations they have established with diverse microorganisms, which influence all aspects of their biology, physiology, ecology and evolution. The



The tsetse fly Glossina morsitans *and its associated symbiotic bacteria: (a) the primary symbiont* Wigglesworthia glossinidia*, shown in green, is present in the milk gland tubules and the bacteriome, a specialized organ; (b) the secondary symbiont* Sodalis glossinidius*, shown in blue, is found throughout the fly; and (c) the reproductive symbiont* Wolbachia pipientis*, shown in orange, is localized to the ovarian germ cells and testes. All of these symbionts are maternally transmitted to the progeny (image kindly provided by Geoffrey Attardo and Serap Aksoy, Yale University, USA; reproduced with permission).*

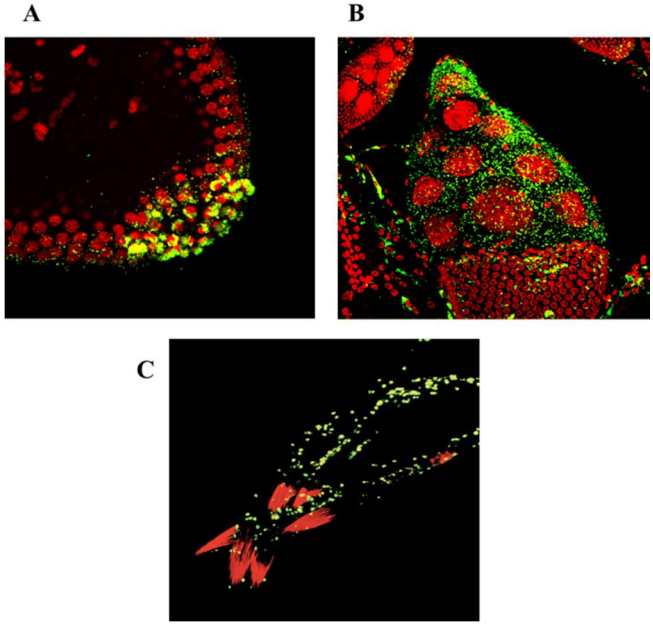
few examples presented below aim to underline the importance of these symbiotic associations and indicate that the characterization, exploitation and management of insect-bacterial symbiotic associations can significantly contribute to the support and enhancement of sterile insect technique (SIT) programmes against agricultural pests and disease vectors.

Insects with nutrient-poor diets, like aphids (phloem sap) and tsetse flies (blood), depend on the establishment of nutritional symbiotic associations with bacteria such as *Buchnera* and *Wigglesworthia*. These provide important nutrients such as essential amino acids and vitamins not present in the diet of these insects. Gut-associated bacteria and fungi help termites and other xylophagous insect digest and break down cellulose and lignin in plant cell walls. Interestingly, the development and function of the adult tsetse fly immune system also depends on the presence of symbiotic bacteria like *Wigglesworthia* during the immature stages. Tsetse flies lacking *Wigglesworthia* are more susceptible to trypanosomes, the major pathogens that cause nagana in animals and sleeping sickness in humans in sub-Saharan Africa. So, in tsetse flies the same symbiotic bacteria are responsible for nutrition, proper host immune system development and even host vectorial capacity.

Facultative symbiotic bacteria of the pea aphids, *Acyrthosiphon pisum* determine specific ecological properties of their hosts including their ability to utilize host plants, to change the colour of their body, to survive under heat stress conditions, as well as to get protected against parasitoids. Conventional views that ecological and physiological traits, such as the pest status and insecticide resistance respectively, are determined only by insect genes have been challenged by recent findings in different insect symbiotic systems. For example the ability of the stinkbug, *Megacopta punctatissima*, to perform well on legumes is determined not by their genome but by the obligate symbiont *Candidatus Ishikawaella capsulata*. So the symbiont may determine the pest status of the insect! Also, bacteria of the genus *Burkholderia* establish a mutualistic association in the gut of the bean bug, *Riptortus pedestris,* which confers resistance to the insecticide fenitrothion, i.e. the symbiont, not the insect, genome determines the resistance!

Gut-associated bacteria also affect insect mating behaviour and contribute to mating isolation and speciation events. The *Drosophila* diet can determine the structure of gut microbiota, which in turn can influence mating preferences and induce pre-mating isolation. Gut microbiota can also determine hybrid-lethality and drive mating isolation and speciation in the parasitoid species of the genus *Nasonia*. Gut-associated bacteria can also be used as probiotics to enhance mating performance of irradiated sterile male Mediterranean fruit fly, *Ceratitis capitata*. In other words, gut symbionts can influence mating behaviour, mating isolation and speciation in insects, including species of agricultural and medical importance.

In addition to the gut-associated microbiota, a number of symbiotic bacteria in the reproductive tissues and organs affect the reproduction of their insect hosts, the most famous one being *Wolbachia*. This symbiont induces in its hosts diverse reproductive alterations including cytoplasmic incompatibility (CI), a kind of male sterility with potential to enhance SIT applications to control insect pests. Interestingly, it was recently shown that *Wolbachia* can also prevent the establishment and transmission of major human pathogens such as the *Plasmodium* parasite, the Dengue and Chikungunya virus and others in mosquito species. In addition, it has been suggested that *Wolbachia* can be a driving force for speciation by inducing pre- and post-mating isolation phenomena. Given that this symbiont appears to be present in the majority of insect species, it would not be surprising if *Wolbachia* and other reproductive and gut-associated symbionts, are responsible for insects being the most diverse and speciose animal group. Symbiotic bacteria may actually be the cause of unresolved relationships of members of many insect species complexes, some of which are of major agricultural and medical importance.



Wolbachia *is perhaps the most widespread symbiont on this planet. This symbiont is able to influence many aspects of insect host biology and physiology including its reproductive properties. These images show infected* Drosophila *(A) pole cells, the progenitor cells of testes and ovaries, (B) ovary and (C) spermatids.* Wolbachia *bacteria are shown in yellow-green while* Drosophila *DNA is shown in red (Image courtesy: Zoe Veneti).*

Realizing the importance of symbiotic bacteria, the Insect Pest Control Sub-programme has increasingly become involved in applied research to investigate the many ways insect symbionts could improve the SIT

and related genetic control methods in fruit pests, tsetse, mosquitoes and other insects. The IPC Subprogramme is currently implementing two Coordinated Research Projects "*Use of Symbiotic Bacteria to Reduce Mass-Rearing Costs and Increase Mating Success in Selected Fruit Pests in Support of SIT Application*" and "*Enhancing Vector Refractoriness to Trypanosome Infection*", while symbiosis-related research activities may also have significant relevance to a third CRP "*Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade*".

Moving to another subject, the IAEA Director General, Yukiya Amano, visited in July 2013 FAO headquarters in Rome to make a statement at the 38th FAO Conference and to co-sign the Revised Arrangement for the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture together with FAO Director General Graziano da Silva (see picture). Thus, both Directors General reaffirmed their organizations' commitment to the Joint Division whilst emphasizing the intensification and strengthening of the FAO/IAEA partnership to reduce hunger, improve global food security and achieve sustainable agricultural production. Mr Amano also invited Mr Graziano da Silva to the 50 year anniversary celebration of the Joint FAO/IAEA Division in 2014, which Mr Da Silva has accepted.

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

Concerning staff news, I would like to inform our readers that Udo Feldmann retired in October 2013 after a long and distinguished career over more than 30 years. From 1980–1983 and again from 1988–1993 Udo was involved in research at the FAO/IAEA Agriculture and Biotechnology Laboratories in Seibersdorf, achieving important advances in mass-rearing technology for tsetse different species. As a result of this effort, the cost per sterile male was reduced nearly ten-fold, opening the possibility of large-scale area-wide application of the SIT against tsetse species. During 1984-1987 he was involved in a successful SIT pilot project in West Africa, which eradicated a riverine tsetse species from a 1,500 km^2 in central Nigeria. Since 1993, when he moved to Vienna headquarters, he directed the FAO/IAEA tsetse programme, managing with great motivation, devotion and tenacity many field projects, coordinated research projects and training courses not only related to tsetse flies, but also to other livestock pests, including screwworms. A special highlight in his career is the eradication of tsetse from Zanzibar, which succeeded in 1997, demonstrating the essential role of the SIT achieving the elimination of the last individuals where previous only insecticide-based eradication attempts had failed. It resulted in major economic benefits confirmed by several independent groups of tsetse experts and economists. This and other successes were achieved with a great sense of team spirit collaborating closely with colleagues at FAO and IAEA and counterparts and experts in the field. Udo's technical competence, dedication and hard work over all these years, implementing activities under particularly difficult conditions in rural areas of least develop countries, are very much appreciated. We and counterparts will miss him much also as a friend and colleague. We wish him the best in his well-deserved retirement, but hope to be able to continue profiting from his extensive experience for the benefit of our Member States.

We also would like to warmly welcome Rafael Argilés from Spain, who replaced Udo in November 2013. Rafael has excellent technical credentials and is fluent in English and French, important to support field projects in Sub-Saharan Africa. For over ten years he was director of the area-wide integrated pest management programme against the Mediterranean fruit fly in Valencia, which remains the biggest SIT operation in Europe to date. It is applying the SIT to protect the largest fresh citrus export region in the world, drastically reducing insecticide use and facilitating trade. Rafael has been responsible for this programme from its inception, including the field operations and the design, construction and management of the mass-rearing factory with a capacity of 500 million sterile males a week. In view of his leadership, practical skills and extensive experience, as well as his numerous productive interactions over the years with the FAO/IAEA collaborating in various projects, including a sabbatical supporting the tsetse SIT field project in Ethiopia, he is well-suited to advance the FAO/IAEA tsetse SIT programme. We wish him much success in his new position.

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
Ludmila Pacalova	Team Assistant	L.Pacalova@iaea.org	21632	Vienna
Marc Vreysen	Laboratory Head	M.Vreysen@iaea.org	28404	Seibersdorf
Adly Abd Alla	Virologist	A.Abdalla@iaea.org	28425	Seibersdorf
Kostas Bourtzis	Molecular Biologist	K.Bourtzis@iaea.org	28423	Seibersdorf
Carlos Cáceres	Entomologist (Plant Pests)	C.E.Caceres-Barrios@iaea.org	28413	Seibersdorf
Jeremie Gilles	Entomologist (Mosquitoes)	J.Gilles@iaea.org	28407	Seibersdorf
Andrew Parker	Entomologist (Tsetse)	A.Parker@iaea.org	28408	Seibersdorf
Barbara Massinger	Team Assistant	B.Massinger@iaea.org	28259	Seibersdorf

Forthcoming Events (2014)

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

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

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

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

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

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

II. Consultants and Expert Meetings

FAO/IAEA Consultants Meeting on New Methods for the Detection and Quantification of Irradiation in Intercepted Insects. 10–14 March 2014, Vienna, Austria.

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

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

III. Other Meetings/Events

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 First Coordination Meeting of the Regional TC Project RLA 5067 on Supporting Capacity Building for Evaluation of Feasibility of a Progressive Control Programme for New World Screwworm. 3–7 March 2014, Panama City, Panama.

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 Southeast Asia Regional TC Project RAS5067 on Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-wide Fruit Fly Pest Management Programmes in Southeast Asia. 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 Regional Training Course on Fruit Fly Biocontrol in West Africa (under Regional TC Project RAF5061). 2–6 June 2014, Dakar, Senegal.

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. 4-6 June 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). 16-20 June 2014. Zanzibar, United Republic of Tanzania.

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

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). 22–26 September 2014, Tervuren, Belgium.

Expert Consultation on *Bactocera invadens* Treatments, International Plant Protection Convention, FAO. 1–5 December 2014, Yokoama, Japan.

Past Events (2013)

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

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

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

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

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

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

II. Other Meetings/Events

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

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

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

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

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

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

Sixth International Workshop on Insect Transgenesis Shanghai, China 21–25 May 2013

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

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 Invertebrate. 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.

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 Continuing National Projects	Technical Officer
Chad	CHD5003	Finalising the Feasibility Study to Assess Whether the Sterile Insect Technique (SIT) Can Be Applied for the Creation of Sustainable Tsetse-Free Zones	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	ETH5016	Creating Sustainable Tsetse and Trypanosomosis Free Areas for Enhancing Livestock and Agricultural Development	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
Madagascar	MAG5021	Implementing the Sterile Insect Technique (SIT) in Integrated Fruity Fly Control for High Quality Fruit Production	Rui Cardoso Pereira
Mauritius	MAR5019	Supporting a Feasibility Study Using the Sterile Insect Technique (SIT) for the Integrated Control of Mosquitoes	Jeremie Gilles
Mauritius	MAR5022	Reducing Insecticide Use and Losses to Melon Fly (*Bactrocera cucurbitae*) through Environment-Friendly Techniques to Increase Production in Different Areas, Phase II	Jorge Hendrichs

Morocco	MOR5032	Supporting Control of the Medfly Using the Sterile Insect Technique for Citrus Fruits and Early Fruits and Vegetables to Establish Low Medfly Prevalence Zones	Jesús Reyes
Myanmar	MYA5021	Integrating Sterile Insect Technique with other Biocontrol Tactics to Improve Diamondback Month Control	Rui Cardoso Pereira
Oman	OMA5002	Assessing the Suitability of Sterile Insect Technique (SIT) and Related Techniques for Combating Date Palm Insect Pests	Marc Vreysen
Panama	PAN5020	Strengthening Technical Capacity to Control Mediterranean Fruit Fly Using the Sterile Insect Technique (SIT)	Jesús Reyes
Pakistan	PAK5049	Support for Capacity Building in Baseline Data Collection for Mosquito Dengue Vector Management in Pakistan	Jeremie Gilles
Palau	PLW5001	Improving the Quality of the Fruits and Vegetables Through an Area-Wide Integrated Pest Management of *Bactrocera* Fruit Flies in Production Areas of Palau	Rui Cardoso Pereira
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
Territories Under the Jurisdiction of the Palestinian Authority	PAL5004	Integrated management of fruit flies in Palestinian Territories	Jesús Reyes
Uganda	UGA5033	Demonstrating the Feasibility of a Sterile Insect Technique (SIT) Component as Part of an AW-IPM Approach against *Glossina f. fuscipes* to Increase Livestock Productivity	Rafael Argiles Andrew Parker
Vietnam	VIE5017	Supporting Area-Wide Integrated Pest Management to Improve the Quality of Fruit for Export	Rui Cardoso Pereira

Zimbabwe	ZIM5017	Improving Crop and Livestock Production through the Eradication of Bovine and Human Trypanosomiasis in Matusadona National Park	Rafael Argiles
		Continuing Regional Projects	
Regional Africa	RAF5059	Supporting the Creation of a Tsetse-Free Zone in Southern Mozambique and North-East South Africa	Marc Vreysen Rui Cardoso Pereira
Regional Africa	RAF5061	Supporting Capacity Building and a Feasibility Study on Control of Fruit Flies of Economic Significance in West Africa	Rui Cardoso Pereira
Regional Africa	RAF5062	Preventing the Introduction of Exotic Fruit Fly Species and Implementing the Control of Existing Species with the Sterile Insect Technique and Other Suppression Methods	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 Asia	RAS5059	Supporting Area-Wide Integrated Pest Control of Native and Exotic Flies in the Middle East Subregion Incorporating the Sterile Insect Technique (SIT)	Jesús Reyes
Regional Europe	RER5018	Supporting Fruit Fly Pest Prevention and Management in the Balkans and the Eastern Mediterranean	Rui Cardoso Pereira
Regional Latin America	RLA5058	Building Capacity for Suppression of Fruit Flies using an Area-Wide Pest Management Approach	Jesús Reyes
		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
Country	**Project Number**	**Title** **New National Projects to Start in 2014**	**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
Ethiopia	ETH5018	Contributing to the Creation of Sustainable Tsetse Free Areas	Rafael Argiles Andrew Parker

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
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
Zimbabwe	ZIM5019	Improving Crop and Livestock Production through the Eradication of Bovine and Human Trypanosomosis in Matusadona National Park	Rafael Argiles
		Title **New Regional Projects to Start in 2014**	
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	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	Jeremie Gilles
Regional Asia	RAS5067	Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area-Wide Fruit Fly Pest Management Programmes in Southeast Asia	Rui Cardoso Pereira
Regional 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

Highlights of Technical Cooperation Projects

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

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

Participants of the interregional training course on Use of the Sterile Insect and Related Techniques for the Area-wide Integrated Manage-ment of Insect Pests (Antigua, Guatemala).

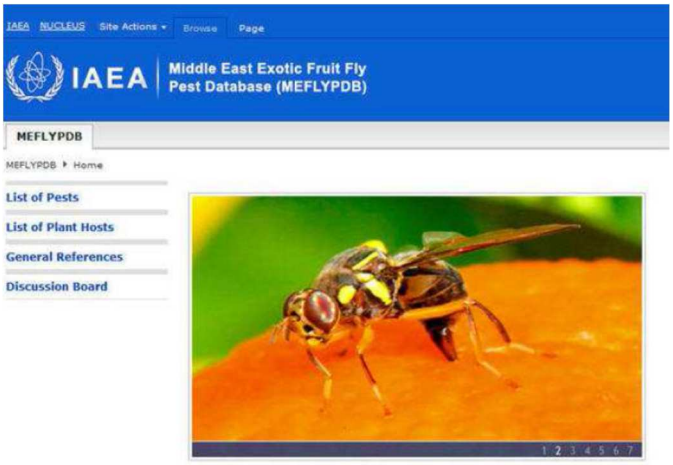
The four week course was successfully held in Mexico and Guatemala, from 29 July to 23 August 2013, with 24 participants from 21 countries in Africa, Asia, Europe and Latin America, selected for the course among close to one hundred applicants. The excellent organization and hospitality both in Mexico and Guatemala is much appreciated.

Participants of the interregional training course on Use of the Sterile Insect and Related Techniques for the Area-wide Integrated Management of Insect Pests, during a laboratory exercise in Guatemala.

The course was held at the Moscamed/Moscafrut complex in Metapa and Tapachula, Chiapas, Mexico, and in Antigua, El Pino facility and Retalhuleu, Guatemala. It provided a thorough overview and training on the application of nuclear-related techniques within the context of area-wide integrated insect pest management programmes to managers of insect control programmes, animal/human health and plant protection officials and applied research entomologists. The course included visits to three mass-rearing and sterilization facilities, mass-production of parasitoids, release centers, monitoring and other field operations, as well as various hands-on laboratory exercises.

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

Development of a Middle East Fruit Fly Exotic Pest Database (MEFLYPDB). This database is designed to meet the needs of the subregion in preparing and enabling quick and intelligent actions on the discovery of an exotic pest to the subregion.



Welcome page of the database showing an exotic fruit fly as part of the slide-show.

Originally proposed by Israel, Jordan and the Palestinian Authority under this regional cooperative exotic fruit fly project, this database is intended to describe and explain phytosanitary procedures common to all exotic fruit fly species of quarantine significance in the Middle East countries. This database includes information on the biology, hosts, pathways, surveillance and control of these pests; it includes information on expertise available within the region and incorporates both field techniques and regulatory documents that have been worldwide released in connection with fruit fly control and quarantine, so that its contents reflect the current situation regarding these phytosanitary measures.

As new pests threaten agriculture in Middle East countries and as new exotic pest control or quarantine techniques are adopted, and/or regulatory priorities change, this database will be revised, so that it can provide a "work-in-progress" forum, enabling it to remain current and applicable.

Improvement of Artificial Mass-Rearing Systems for the Ethiopian Fruit Fly, *Dacus ciliatus*, and Establishment of Optimal Sterilizing Doses: Towards a Small-Scale SIT (ISR5018)

The Ethiopian Fruit Fly (EFF) *Dacus ciliatus* is an important pest of Cucurbits (zucchinis, melons, watermelons, cucumbers, etc.) throughout Asia and Africa. Several years ago the fly invaded the south of Israel, where it has been contained to date.

At the request of Israel a project was approved aimed at developing the SIT against this pest. Main goals are: to develop an artificial mass rearing system, and to determine an effective irradiation dose to sterilize the fly; an additional aim is to isolate and characterize chemical volatiles emitted by the fly (pheromones) with the objective to develop an attractant for this fly.

GC-EAD system with the image of Dacus ciliatus *head connected to electrodes (left screen) and measuring antennal activity (right screen) in the pheromone laboratory of the Agricultural Research Organization, Israel.*

After almost two years, a completely artificial diet with good signs of stability was developed, and an artificial system to collect eggs was also established. The optimal irradiation dose for the species has been determined; the sexual compatibility and competitiveness of the laboratory strain with wild flies has been also tested. Sub-sterilizing doses for male EFF were achieved with 120 Gy, and total sterility irradiation doses was obtained with 40 Gy. Females are significantly more sensitive than males, and doses of 60 Gy can induce full sterility to them.

Considerable advances have also been achieved in the isolation and characterization of pheromone volatiles emitted during courtship of EFF. The Electroantennograph System (EAG) provided has significantly improved the abilities to discern between emitted-chemicals eliciting antennal activity and those lacking stimulating activity. The coupling of the system to a Gas Chromatograph (GC-EAD), has allowed characterizing chemicals that may be involved in mating communication. More advances are expected on the characterization of volatiles involved in the mating behaviour of the EFF in the following months.

Preventing the Introduction of Exotic Fruit Fly Species and Implementing the Control of Existing Species with the Sterile Insect Technique and Other Suppression Methods (RAF5062)

Regional Training Course on Quarantine and International Standards for Phytosanitary Measures for the Indian Ocean

The FAO/IAEA Regional Training Course was held at the Faculty of Agronomy and Forest Engineering, Eduardo Mondlane University, Maputo, Mozambique from 1-5 July 2013. It was attended by a total of 21 participants from 6 Member States (France (La Reunion), Madagascar, Mauritius, Mozambique, Seychelles, United Republic of Tanzania).

Participants of the regional training course on Quarantine and International Standards for Phytosanitary Measures for the Indian Ocean (Maputo, Mozambique).

The course addressed the following aspects:

- Basics of pest risk analysis and pest risk assessment
- Assessing pest establishment, spread and impact
- Fruit fly pest risk management
- Visit to the quarantine facilities
- International Standards for Phytosanitary Measures (ISPM) for fruit flies
- Risk management options and risk communication
- Host status determination.

The course was successfully conducted, contributing to the capacity building on fruit fly control of the partici-

pants from the Indian Ocean region. The organization and hospitality of the local organizer is greatly appreciated.

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

Regional Training Course on Area-wide Integrated Fruit Fly Suppression, including MAT and SIT for the Balkans and Eastern Mediterranean

The FAO/IAEA Regional Training Course was held in Metković, Croatia from 7-11 October 2013. It was attended by a total of 29 participants, from 12 Member States (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Greece, Montenegro, Romania, Slovenia, The Frmr. Yug. Rep. of Macedonia, Turkey). Two of the 5 days were dedicated to visit and participate in all ongoing activities of the Mediterranean fruit fry control programme in Neretva valley, including at the fly emergence and release facility.

Participants of the regional training course on Area-wide Integrated Fruit Fly Suppression, including MAT and SIT for the Balkans and Eastern Mediterranean (Metković, Croatia).

The course addressed the following aspects:

- Fruit fly biology and ecology
- Adult and larval surveillance
- Suppression techniques (sanitation, bait sprays, mass trapping, bait stations, biological control, SIT, and male annihilation technique (MAT))
- Area-wide insect pest management (AW-IPM) concept
- Phased conditional approach to AW-IPM of fruit flies
- Visit to the Neretva valley fly emergence and release facility where 11 million pupae are weekly received from Spain to be released 6-7 days later
- Field visit to observe the ground release machine; releases in paper bags; and trapping and fruit sampling
- Conduct field cage tests, to assess the competitiveness of sterile flies, including sexing and painting the flies for the tests
- Visit to a mandarin packing house
- Practical exercise in relation to area-wide approach and the SIT (Curaçao model).

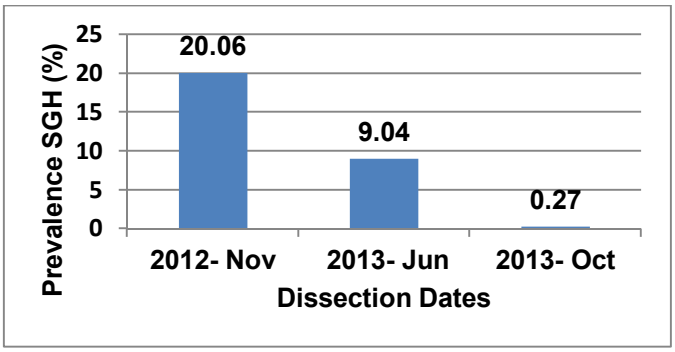
Creating Sustainable Tsetse and Trypanosomosis Free Areas for Enhancing Livestock and Agricultural Development (ETH5016)

Glossina pallidipes colony in Kality facility Ethiopia finally without salivary gland hypertrophy

Since the first attempt to establish a mass-rearing colony of *G. pallidipes* tsetse flies collected from Arba Minch, Ethiopia in 1999 at the Insect Pest Control Laboratory (IPCL), Seibersdorf, Austria to support the STEP project in Ethiopia, salivary gland hypertrophy (SGH) has been a major challenge for colony establishment and sustainability. One colony was lost at the IPCL and several colonies failed in the Kality facility in Ethiopia.

Over the last eight years the Joint FAO/IAEA Division conducted pioneering research to develop an effective SGH management strategy based on the use of antiviral drug (valacyclovir) combined with modifications to the feeding system ("clean feeding" system reducing the number of times flies are exposed to the same batch of blood).

The virus management package was transferred to the Kality facility and has been implemented since 2012. This has resulted in a significant decrease in the SGH prevalence in the *G. pallidipes* colony (see Figure) such that SGH no longer poses a problem to colony maintenance.



Impact of valacyclovir treatment combined with 'clean feeding' on the prevalence of salivary gland hypertrophy in the G. pallidipes colony mass-reared at the Kality facility in Ethiopia.

Nevertheless, research is continuing to develop alternative strategies to be used in case the virus should develop resistance to the antiviral drug.

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

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

One critical area where important advances need to be made before any mosquito SIT or related application is possible, concerns the development of genetic sexing strains (GSS). Unlike agriculture pests where the releases of both sexes is primarily of economic concern, in mosquitoes it is an essential prerequisite to release only males since females are blood feeders and can transmit diseases. Without male-only releases, SIT applications against mosquitoes are not possible.

The first RCM of this new CRP was attended by 23 participants from Africa, Asia, South/Central America, Europe, and the USA. The first two days of the meeting were devoted to presentations on the ongoing and future research of the participants.

Participants of the first RCM on Exploring Mechanical, Molecular, Behavioural or Genetic Methods of Sex Separation in Mosquitoes (Vienna, Austria).

Participants were divided into three groups according to their approaches for the development of a new GSS: (1) development of GSS based on classical genetics; (2) development of GSS based on molecular genetics and (3) development of GSS based on mechanical, behavioural and developmental approaches.

The future work plan for each participant was discussed and agreed and collaborations were established. Finally,

the timing and location for the second RCM were discussed and tentatively set for the Moscamed mosquito facility in Juazeiro, Brazil from 2–6 March 2015.

Third RCM of the CRP on *Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade*, 26–31 August 2013, Tucumán, Argentina

This RCM was held with the participation of over fifty researchers and plant protection officers. The great hospitality and organization by Teresa Vera and her team is greatly appreciated.

A follow-up *Workshop on Reviewing Evidence to Resolve Species Complexes of Tephritid Pests* held on 31 August 2013 with invited external experts and chaired by Dave Haymer from the University of Hawaii, reviewed extensively technical gaps and pending activities in order to focus research work plans for the last 18 months of the CRP for each of the three major complexes studied: *Anastrepha fraterculus*, *Bactrocera dorsalis* and *Ceratitis* FAR species.

Some participants of the third RCM on Resolution of Cryptic Species Complexes of Tephritid Pests to Overcome Constraints to SIT Application and International Trade (Tucumán, Argentina).

The *Bactrocera dorsalis* complex includes some of the worst of tephritid pest species known collectively as the Oriental fruit fly complex: *B. dorsalis* s.s., *B. papayae*, *B. philippinensis*, *B. carambolae* and *B. invadens*. Very signficant research has been undertaken, within an integrative taxonomic framework, to biologically delimit the target taxa. The tools used have included: i) morphological examination, including traditional morphology, morphometrics of genitalic characters, and fine-scale wing shape analysis using geometric morphometrics; ii) molecular-based approaches using both phylogenetic and population genetic analyses of nuclear DNA sequence and microsatellite data coupled with mitochondrial DNA sequence analysis and comparative transcriptome analysis; iii) studies of mating in field cages and post-zygotic sexual compatibility; iv) analysis of pheromones and cuticular hydrocarbons; and v) cytogenetics based on comparative polytene chromosone analysis. CRP participants have so far failed to find evidence of any species level biological differentiation between *B. dorsalis*, *B. invadens, B. papayae* and *B. philippinensis*. Any genetic and morphological differences (such as thoracic colour patterns, which play no role in courtship behaviour) are best explained as intra-specific variation in one wide-ranging biological species. All evidence collected so far suggests that *B. dorsalis*, *B. invadens, B. papaya* and *B. philippinensis* are one biological species, while *B. carambolae* is a closely related but biologically unique species. The strength of the case for considering the synonymisation of *B. invadens, B. papayae* and *B. philippinensis* with *B. dorsalis* rests not on the strength of any one approach (i.e. mating, pheromone, genetics), but the highly consistent results for all of these dependent on approaches.

In terms of the South American fruit fly, *Anastrepha fraterculus* ongoing studies and the different methodologies so far applied (DNA, morphology, cytology, sexual behaviour and chemical profile of male-emitted volatiles and cuticle extracts) confirm the existence of at least seven different biological entities. Their existence is supported by a recent comprehensive morphological study that incorporates increasing number of collections from the whole region. All evidence up to now points towards the fact that the population differences are correlated with behavioural reproductive isolation. Therefore, if the biological concept of species is followed, *A. fraterculus* is composed of several species. Research is continuing to define species limits and their distribution. Formal naming of these putative species will be critical for international trade and any SIT application.

The *Ceratitis* FAR complex comprises three described entities: *C. rosa*, *C. fasciventris* and *C. anonae*. All evidence so far points towards the fact that these three entities are indeed separate species. Pheromone, morphometrics and cuticular hydrocarbon analyses also showed that the three entities are clearly separable. Further evidence using microsatellite markers indicate that *C. rosa* and *C. fasciventris* might each comprise two different entities, while *C. anonae* remains a single entity. For the two *C. fasciventris* types, there is only the indication of some adult morphological differences and different biogeographic patterns. Further investigation of the two entities will require the establishment of live colonies. Most research has been focusing on the two *C. rosa* types, also because of their economic importance. There is some evidence that these are indeed two separate species. One type, R2, appears to occur at lower latitudes on the African continent as well as at higher altitudes. It might be more cold resistant than the R1 type that is absent from the colder locations within the geographic range of *C. rosa*.

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

FRUIT FLIES

Symbiotic bacteria and SIT-targeted fruit fly species

Research has been initiated at the IPCL towards the detection, isolation and characterization of the role of gut- and gonad-associated symbionts on the biology, physiology, ecology and evolution of SIT-targeted fruit fly species, including their impact on nutrition, digestion, reproduction, mating behaviour and pest status. Both culture-dependent and culture-independent approaches are being considered in order to characterize the structure of the symbiotic communities for each targeted species. Wherever this is possible, several strains, populations or "morphotypes" of the fruit fly host species are being considered.

In the culture-dependent approaches, different microbiological media are being employed to isolate in culture bacteria from larval and adult guts. Males and females of different age, teneral or fed, are being used for these isolations. The Mediterranean fruit fly *Ceratitis capitata*, and particularly the VIENNA-8 genetic sexing strain (GSS), is being used in initial experiments. Several gut-associated bacterial species have already been isolated in culture. Selected bacterial isolates are being delivered as part of the diet in different developmental stages of *C. capitata* and their impact on life history traits and mating behaviour is being recorded. Preliminary experiments have provided quite interesting and encouraging data about the potential use of gut-associated bacteria as probiotics, while future work will examine whether such bacterial isolates could be considered even as an integral component of the fly diet.

Culture-independent approaches, which are based on next generation sequencing techniques (16S rRNA gene pyrosequencing) are being employed to determine the structure of the gut-associated microbiota in diverse tephritid species, including *C. capitata* (VIENNA 8 GSS), *Bactrocera oleae*, *Anastrepha ludens*, *A. grandis* and different morphotypes of *A. fraterculus*.

As for the culture-dependent approaches, males and females of different age, teneral or fed, are being used for this experimental work. The up-to-now results suggest that tephritid fruit flies are characterized by gut-associated microbiota of low complexity. Knowledge acquired by 16S rRNA gene pyrosequencing will be of valuable help for designing appropriate classical microbiological approaches to isolate some of these bacterial species in culture and exploit them as probiotics.

Studies have been also initiated to study the effects of *Wolbachia*, which is a widespread reproductive endosymbiont among arthropod species. In insects, *Wolbachia* commonly induces cytoplasmic incompatibility, which is a kind of male sterility. This symbiont has been proposed as a tool to enhance sterile insect technique applications towards the population control of agricultural pests and disease vectors. Comparative analysis of *Wolbachia*-infected and *Wolbachia*-free *C. capitata* strains has been undertaken to unravel the effect this symbiont may have on the life history traits and mating behaviour of its host. Notably, differences in egg-to-adult survival and male mating competitiveness have been observed in preliminary experiments and statistical analysis is in progress to determine their origin: symbiont, host or both?

Bactrocera dorsalis species complex

In support of the Co-ordinated Research Project on the resolution of cryptic species, field cage studies were performed in relation to the *Bactrocea dorsalis* complex to assess the mating compatibility between *B. invadens* and *B. dorsalis* followed by an assessment of F_1 and F_2 hybrid viability. *B. invadens* originated from Kenya and *B. dorsalis* originated from Pakistan and China. All strains were cultured at the IPCL, Seibersdorf. *B. invadens* mated randomly with *B. dorsalis* from both localities and there were generally high levels of viability of the F_1 hybrids. These results provide additional evidence for the hypothesis that these populations belong to the same species.

Furthermore, studies on the effects of methyl eugenol (ME) on mating competitiveness of various members of the *B. dorsalis* complex and their response to different doses of ME is in progress. Mating competitiveness tests are being conducted under semi-natural conditions and sensitivity of males to ME is being evaluated in field cages placed in the open field. ME feeding enhanced mating competitiveness of *B. dorsalis* and *B. carambolae* males, but its application by feeding is difficult to implement in large scale fly emergence, holding and release facilities. Therefore, ME application using alternative methods such as inhalation or aromatherapy is being investigated.

Anastrepha fraterculus complex

In further support of the Co-ordinated Research Project on the resolution of cryptic species and the *Anastrepha fraterculus* complex, consultants from Argentina and Czech Republic recently visited the IPCL to carry out bioassays and to collect samples of pheromones and

cuticle hydrocarbons of different *A. fraterculus* populations for further characterization. Results of both studies will support the identification of different morphotypes within the *A. fraterculus* complex.

TSETSE FLIES

Salivary gland hypertrophy virus

Some colonies of the tsetse fly *Glossina pallidipes* are infected with the salivary gland hypertrophy virus (SGHV), which hampers the development of these colonies by reducing productivity. After the development of an efficient strategy to manage the virus, based on the combination of "clean feeding" and adding the antiviral drug valacyclovir to blood meals, attempts are continuing to develop alternative strategies to be used in case the virus should develop resistance to valacyclovir.

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. This initiative is carried out within the framework of a new Co-ordinated Research Project on "Enhancing Vector Refractoriness to Trypanosome Infection". Identification of the tsetse gut microbiota has been initiated.

The effect of the *G. pallidipes* SGHV in other tsetse species was assessed by Güler Demirbas, a visiting scientist from Turkey. She has been testing the impact of injecting several species with the virus extracted from *G. pallidipes*. The results indicated that the virus can replicate in *G. p. gambiensis*, *G. morsitans morsitans,* and *G. m. centralis*, but not in *G. brevipalpis*. Although virus replication was observed in several species, development of SGH in the F_1 generation was restricted to *G. pallidipes*.

Table: Prevalence of SGHV, Trypanosomes *and* Wolbachia *infection in tsetse flies from West African populations.*

Country	Total	% Virus (+)	% Trypanosome (+)	% Wolbachia (+)
Burkina Faso	1344	1.34	10.42	0.22
Ghana	227	0	58.59	0
Senegal	117	0	51.28	0
Mali	14	0	42.86	0
Guinea Conakry	339	0	1.77	4.13

Gisele Ouedraogo, a visiting scientist from Burkina Faso, has been studying the prevalence of SGHV, *Wolbachia* and trypanosomes in wild tsetse populations from West Africa. Preliminary data indicate low prevalence of the virus and *Wolbachia* in most of the tested countries, while the trypanosome prevalence varied from 1.8% in Guinea Conakry to 58.6% in Ghana (see Table).

MOSQUITOES

Phenotypic markers found in larvae of *Anopheles gambiae*

In the effort to contribute towards the Co-ordinated Research Project on exploring mechanical, molecular, behavioural or genetic methods of sex separation in mosquitoes, preliminary research has resulted in the detection of 2 distinctive phenotypic larval markers, black spot and white back (see Figure). Crossing experiments are in progress in order to establish pure mutant lines carrying these phenotypic markers.

The dieldrin resistance gene may be linked to temperature sensitivity in the *Anopheles arabiensis* genetic sexing strain ANO IPCL1

Morphological markers found in L4 larvae of Anopheles gambiae.

Following reports on other insect species where resistance to cyclodiene insecticides may be linked to temperature sensitivity, we tested a range of temperatures coupled with varying exposure durations on immature stages of *An. arabiensis* ANO IPCL1. Males of this strain developed at the IPCL are resistant to dieldrin - also a cyclodiene. We found that especially in the pupal stage the ANO IPCL1 is more sensitive to higher temperatures than is the wild type *An. arabiensis* Dongola strain, which lacks the dieldrin resistant gene. In response to these findings, further temperature exposure experiments are planned for at least 2 other *An. arabiensis* strains which are also resistant to cyclodienes.

Mating Competitiveness of Male *Anopheles gambiae* Mosquitoes

Male mating competitiveness is a crucial parameter in many genetic control programmes including the sterile insect technique. We evaluated competitiveness of male *Anopheles gambiae* in semi-field cages (1.7m x 1.7m x 1.7m) in a temperature controlled green house. Varying ratios of irradiated males to untreated males to virgin females were tested: 100:0:100 (as control of irradiated males), 0:100:100 (as control of untreated males), 100:100:100, 300:100:100 and 500:100:100.

As previously reported in other mosquito species including anophelines, irradiation of pupae reduced mating competitiveness to some degree. With a 1:1 ratio of irradiated to untreated males, the hatch rate of 64.0 % was higher than the expected 52%. Increasing the ratio to 5:1 did increase the sterility, however not in proportion to irradiated male numbers.

Effect of application of fluorescent powder to mark sterile males for SIT releases

The effect of two different marking methods was tested on mating ability and survival of *Aedes albopictus* males. In one technique, adult males were placed in a small paper carton cup (50 males per cup) and marked with fluorescent dust (RADGLO® JST, Radiant N.V., Houthalen, Belgium) one hour before the release. Fluorescent dust was placed in a 12 ml syringe with needle (Ava-med SD). One pressure on the piston delivered the quantity necessary for the dusting in each cup. The other method involved placing the 50 males in a tube with the powder and shaking to dust the males.

Fluorescent pigments could easily be detected (using a fluorescent microscope) on 100% of the males marked using the 2 methods up to 15 days after marking. Both methods slightly decreased the insemination capacity of males, however no significant difference in the percentage of females inseminated was observed using either method. Male mortality was higher using the cups compared to the tube.

Effect of blood feeding on competitiveness

In mosquito competitiveness experiments, classical steps include the separation of the sexes, emergence of the adults, resting period to allow sexual maturation, mating period, blood feeding and egg laying. These types of experiments take up to 8 days to produce the desired results and this entails risks of high female mortality at the end of the experiment. Reducing the duration of the experiment by two days by giving the blood before the actual mating period could be a good method to produce faster the results. Blood feeding before the mating of males and females increased egg production. Also the age of the female, when offered the blood meal, appears to influence egg production. Another hypothesis to be tested is that the blood feeding could stimulate the mating behaviour of females.

Validation of a new larval rearing unit for *Aedes albopictus* mass-rearing

The larval rearing unit developed for *An. arabiensis* was tested for the mass-rearing of *Ae. albopictus* at the Centro Agricoltura Ambiente, Bologna, Italy (CAA), which is an IAEA Collaborating Centre. The use of the mass-rearing trays and their position in the rack did not affect larval development, pupation and survival rates and allowed the management of large larval rearing colonies with a minimal amount of space (see Figure). With the use of this larval rearing unit, an average production of 100,000 male pupae per week can be achieved in about $2m^2$ of laboratory space. This method resulted in the same pupal productivity and sex separation efficacy as compared to the classical method of rearing used at the CAA, i.e. using 200 plastic trays which occupied two climatic-controlled rooms of 6 square meters each.

The new (left) and old (right) larval tray rearing system for Aedes albopictus.

Mass production cage for mosquitoes

Mass production is an important component of any pest or vector control programme that requires the release of large number of insects. As part of efforts to develop an area-wide programme involving the sterile insect technique for the control of mosquitoes, the IPCL has developed a mass-production cage for *Ae. albopictus* and *An. arabiensis*.

Mass-rearing cages were already transferred to Sudan, Brazil, La Reunion, Mauritius, China, Italy and South Africa for evaluation and refinement on site.

Mass production cage for Aedes *(left) and* Anopheles *(right).*

Reports

13th Workshop of the IOBC Global Working Group on Mass-Rearing and Quality Assurance "Emerging Opportunities for the Mass Production & Quality Assurance of Invertebrates", 6–8 November 2013, Bangalore, India

The 13th MRQA Workshop of the International Organization for Biological Control Global (IOBC) Working Group was held with the participation of 120 researchers, plan protection officers and biological control experts from 14 countries. The meeting was extremely well organized by the National Bureau of Agriculturally Important Insects (NBAII) and Dr. Patrick De Clercq, Co-convener of the Working Group.

The programme consisted of invited papers presenting an overview of selected topics grouped in organized symposia and contributed presentations on the different aspects of arthropod rearing as it relates to production and quality control.

Preparing Mediterranean fruit flies to conduct quality control field cage tests.

FAO/IAEA activities in terms of developing and facilitating the integrated application of the SIT against fruit flies were very visible; a specific presentation on "Industrial Production of Fruit Flies for SIT Application" was made.

Standards Committee Meeting, International Plant Protection Convention. 18-22 May, Rome, Italy

The meeting took place at FAO Headquarters in Rome with the participation of 20 of the 25 officially nominated Standard Committee (SC) Members representing FAO's seven regions. Two fruit fly International Standard for Phytosanitary Measures were discussed: the draft on 'Determination of Host Status of Fruit to Fruit Flies (Tephritidae)' and the draft annex of ISPM 26 'Establishment of Fruit Fly Quarantine Areas Within a Pest Free Area in the Event of an Outbreak'.

The comments received from countries and institutions during the Substantial Concerns Commenting Period were addressed and both drafts were approved by the SC and recommended for adoption on the 2014 meeting of the Commission on Phytosanitary Measures.

12th PATTEC Coordinators Meeting. 25–27 November 2013, Dakar, Senegal

The 12th PATTEC Coordinators meeting was held in Dakar with the participation of more than 70 National Coordinators and Focal Points from 29 countries, representatives of international organizations and research institutions.

Progress reports from the different countries gave an overview of the current status of implementation of activities against tsetse and trypanosomosis across the affected countries. Case studies and regional approaches were also presented. The participants had the chance to visit the on-going field activities of the Senegal project against T&T in the Niayes Area, including the aerial releases of sterile males of *Glossina palpalis gambiensis*.

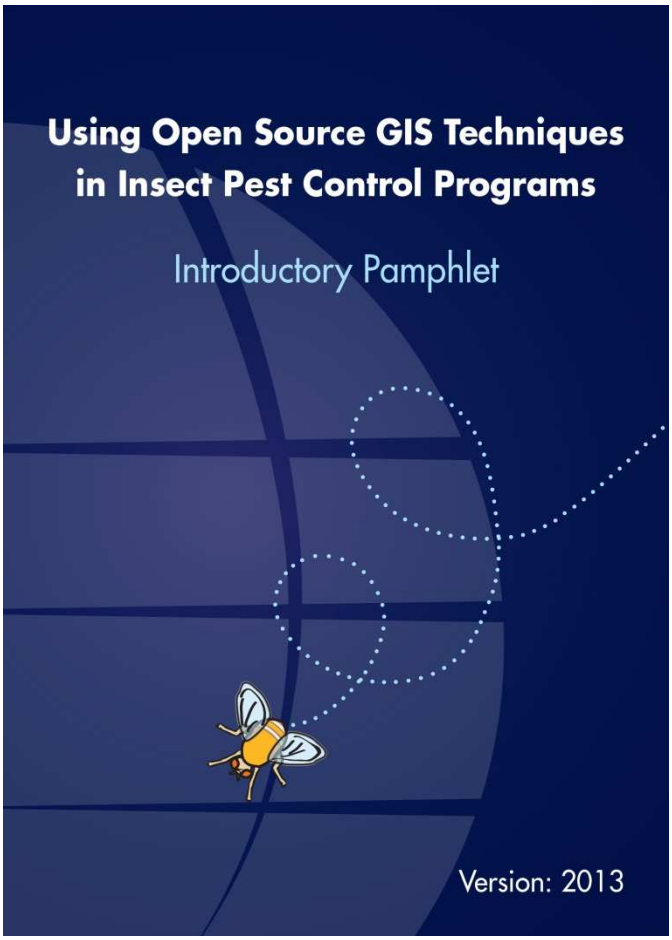
Participants of the PATTEC Coordinators Meeting in Dakar, Senegal.

The Coordinators Meeting was followed by the Second Steering Committee Meeting of the AU-PATTEC, held on the 28th of November 2013.

Announcements

The FAO/IAEA Tutorial DVD on Using Open Source GIS Techniques in Insect Pest Control Programmes

Area-wide insect pest control programmes rely on updated geospatial data for efficiently conducting and evaluating baseline data surveys and progress monitoring. Soft- and hardware available as geographic information system (GIS) packages are applied to analyse and understand these data for planning and implementing optimised pest intervention strategies.



Introductory pamphlet of the tutorial DVD on using open source GIS techniques in insect pest control programmes.

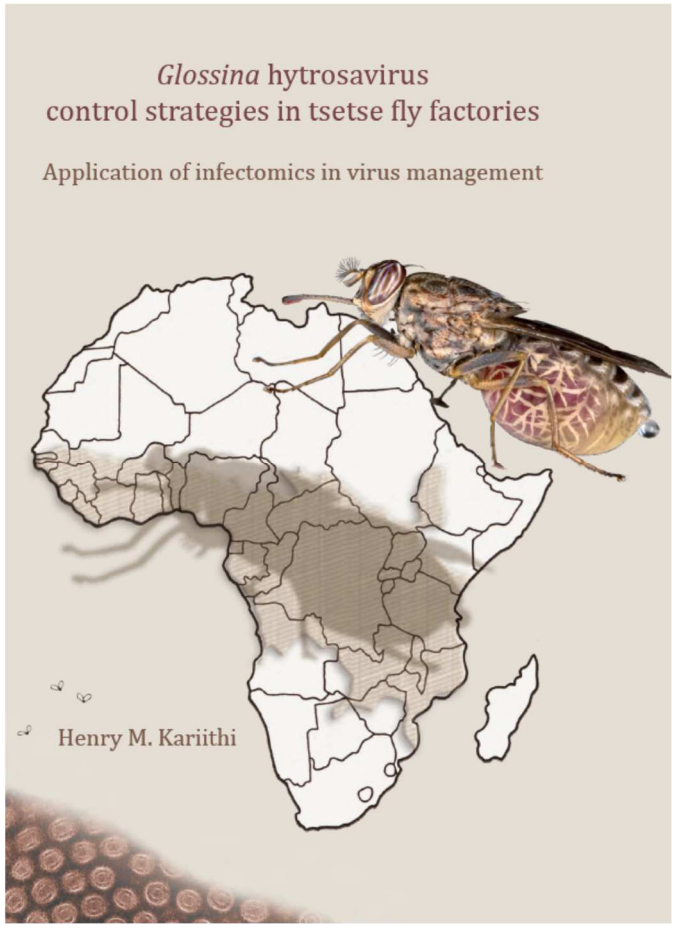
Many developing countries need to address major insect pest problems and face difficulties to fund licence extensions for commercial GIS-software. In recent years, the software development known as free open source software (FOSS) has made great strides in producing high quality software applications, and GIS is no exception. Insect pest control programmes can now take advantage of the development of the GIS FOSS.

The tutorial "Using Open Source GIS Techniques in Insect Pest Control Programmes", developed by the Joint FAO/IAEA Division, offers a practical hands-on learning experience. The video lessons include an introduction to GIS and provide special applied chapters for the use of GIS in programmes against fruit fly pests, screwworm flies and tsetse flies. The self-contained *LiveDVD* also includes a broad collection of pre-installed GIS software, ready to use in any computer without further installations.

The tutorial package is intended for use by senior personnel tasked with insect pest control and consists of an introductory pamphlet, a tutorial DVD with the video lessons and the GIS software and a USB flash drive to be used throughout the tutorial for saving the work done.

PhD Defence of Mr Henry M. Kariithi

Henry M. Kariithi from Kenya successfully defended his PhD thesis on November 20, 2013 in Wageningen University, The Netherlands. Henry did the research that culminated in a PhD under a sandwich programme, whereby he spent over 70% of his time doing his research at the Insect Pest Control Laboratory (IPCL) in Seibersdorf and the remaining time at the Laboratory of Virology of the Wageningen University.



Thesis of Henry M. Kariithi.

The title of his thesis is "*Glossina* hytrosavirus control strategies in tsetse fly factories: Application of infec-

tomics in virus management". The focus of the PhD research was basic research that would assist with the development of a management strategy for the salivary gland hypertrophy virus through understanding the virus proteomics, genomics and its mode of transmission.

The research conducted was very impressive, and the research findings were published in a total of eleven articles in peer-reviewed journals. Henry's research has also greatly contributed in setting up a platform on which he hopes to continue his research in collaboration with IPCL, his home institute (KARI-TRC), and other researchers in the field of tsetse and trypanosomosis control.

Henry's thesis provides a package of fundamental knowledge important to understand the biology of the salivary gland hypertrophy virus and also suggests a practical virus management strategy to eliminate the salivary gland hypertrophy problem from tsetse fly colonies, including a detailed standard operation procedure.

New Bioinformatics Platform at Insect Pest Control Laboratory in Seibersdorf

A 64-bit PC work station equipped with 16 high performance processors and 64 GB of RAM and CLC and Biolinux platforms has been established at the Insect Pest Control Laboratory in Seibersdorf. This bioinformatics platform will support the ongoing research activities of the laboratory towards the characterization and exploitation of symbiotic communities of insect agricultural pests and disease vectors for the enhancement of sterile insect technique programmes.

This platform will be open to scientists from all Member States who wish to run similar bioinformatics analyses for SIT targeted species.

Announcement of Upcoming International Meeting

9th ISFFEI 2014 BANGKOK THAILAND

"Cordial strong bond beyond *fruit fly* work"

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

Important dates: Registration: On-line registration will be starting from 1 May 2013 at: http://www.fruitflythailand.doae.go.th

Abstract submission: *1 May to 30 September, 2013.*

Papers acceptance announcement: *December 2013.*

Other News

Fruit fly research boost in South Australia

South Australia will step up its research efforts to remain free of fruit fly. Premier Jay Weatherill said a $3 million research and development facility will be set up over the next two years at Port Augusta.

Researchers will develop strains of male-only sterile Queensland fruit flies (Q-flies). Those sterile males, or Q-flies, will be used to eradicate outbreaks interstate where the pest is endemic in many regions and in South Australia if isolated outbreaks happen. "Sterile insects have been used with great success here and around the world but this will be a first for Q-flies," Mr Weatherill said. "It will transform the way we manage fruit fly here and interstate."

Queensland fruit fly, Bactrocera tryoni.

Research and development organisations such as Plant and Food Research Australia will contribute $15 million to the project over five years. The Joint FAO/IAEA Division was requested to provide technical support.

Source: ABC News (www.abc.net.au) (7 November 2013).

USDA-APHIS/PPQ News

CPHST collaborates to develop fruit fly bait station. The Center for Plant Health Science Technology (CPHST) efforts to develop and commercialize an attract-and-kill bait station for use in exotic fruit fly eradication and supression programmes recently resulted in the signing of a Cooperative Research and Development Agreement (CRADA) with Agricultural Research Service and DowAgroSciences. A meeting was held in Miami, Florida on 27 August 2013 to discuss testing protocols and next steps.

CPHST observes first southern state phytosanitary irradiation treatment. During the week of August 5, scientists from the Center for Plant Health Science Technology, Agricultural Quarantine Inspection (CPHST AQI), Raleigh travelled to the Gateway America irradiation facility in Gulfport, Mississippi to receive the first shipment of South African persimmons. This was the first phytosanitary irradiation treatment on an imported commodity in a southern state, and only the second in the United States. While in Mississippi, CPHST AQI also conducted validation studies for an industry-proposed procedure to replace the current APHIS process configuration approval method. The new procedure, which can be used for all facilities employing a batch irradiator, will greatly reduce the cost and time associated with process configuration testing.

CPHST improves diagnostic capabilities for Mediterranean fruit fly. The Mission Laboratory in Texas has improved molecular diagnostic methods for pathway analysis for Mediterranean fruit fly (*Ceratitis capitata*). The newly developed analysis is better able to discern genetic differences at the population level. Using these methods, the lab analyzed 316 historical Medfly captures from California and Florida. The results showed that Hawaii, once considered a likely source of Medfly introductions, can be excluded as a source for a portion of the captures. These methods are being further evaluated for use in the support of PPQ exclusion activities.

Source: USDA-APHIS.

A New Irradiation Unit in Uruguay

Through our Gamma Newsletter we would like to inform everyone involved in irradiation technology of the introduction of irradiation technology in Uruguay. The long-sought objective of entering the US market with Uruguayan fresh citrus fruits is close to materializing. Furthermore, from a regional perspective, we would like to highlight the initiative of our colleagues in Argentina to join regional efforts in order to promote export possibilities through the application of irradiation in the region, which we strongly support.

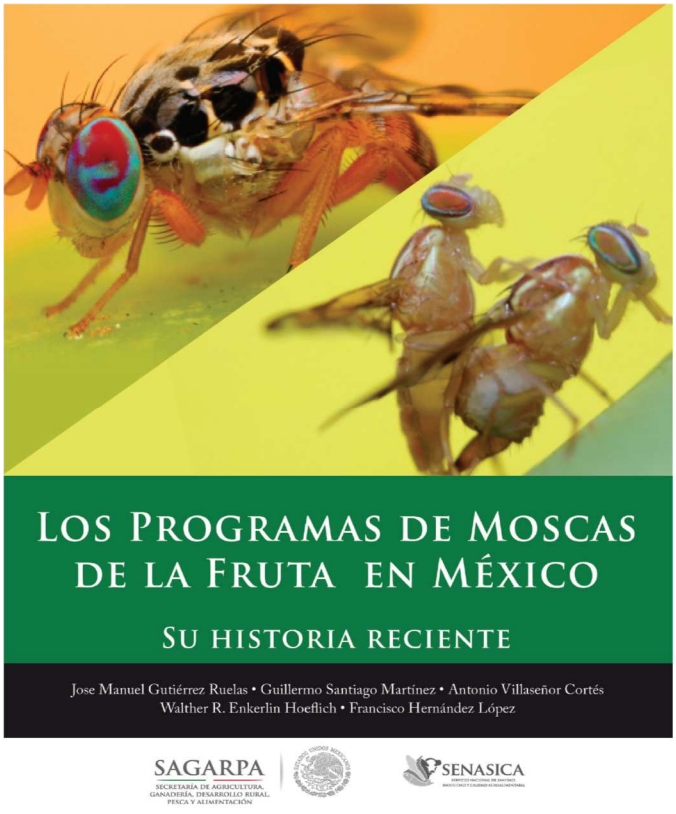
Source: Anibal Abreu, Unidade de Irradiacion LATU, Comite Nacional de Irradiacion, Uruguay.

New Book on Fruit Fly Programmes in Mexico

During the last 20 years, Mexican fruit fly programmes have achieved outstanding results contributing to the improvement of the phytosanitary status in the country and beyond its territory.

The management of the phytosanitary programmes faces recurrent problems. With this in mind, the present book was produced as a reference document and a tool for the managers and implementation staff of the Mediterranean fruit fly Programme ('Programa Mosca del Mediterraneo') and the National Campaign against Fruit Flies ('Campaña Nacional contra Moscas de la Fruta').

These are historical documents for the Mediterranean fruit fly Programme from the 1980's and 90's that require an update. In relation to the National Campaign against Fruit Flies, it is necessary to document its activities since its beginning in 1992. The collection and compilation of data was a challenge, constituing the input of the managers, technical staff and other stakeholders involved for future reference.



The present book reports the recent history of the Mediterranean fruit fly Programme and the National Campaign against Fruit Flies in Mexico to maintain the institutional memory of these programmes.

Source: SENASICA, Servicio Nacional de Sanidad, Inocuidad y calidad Agroalimentar de Mexico (March, 2013).

Misleading guidance for decision making on tsetse eradication

The paper entitled "Estimating the costs of tsetse control options: An example for Uganda" (Shaw et al., 2013, Prev. Vet. Med. 110:290-303) presents full cost estimates for eliminating or continuously controlling riverine tsetse species *Glossina fuscipes fuscipes* Newstead (*palpalis* group) in Uganda in order to facilitate decision-making and financial planning. Four tsetse control techniques were compared: "(i) artificial baits (insecticide-treated traps/targets or ITT), (ii) insecticide-treated cattle (ITC), (iii) aerial spraying using the sequential aerosol technique (SAT) and (iv) the addition of the sterile insect technique (SIT) to the insecticide-based methods (i–iii)".

While the economic approach as such might be sound to generate a basis for estimating the cost of tsetse control campaigns, the assessment is based on a disputed model that assumes that the above insecticide-based methods alone can succeed in eradicating riverine tsetse populations. The limitations of this model are both mathematical (appropriate criteria for using and publishing agent-based models were not respected) and ecological (important characteristics of riverine tsetse populations were neglected). The model was apparently developed based on experimental field data of the *morsitans* (savannah) group of tsetse fly species (*Glossina morsitans morsitans* Westwood and *Glossina pallidipes* Austen) that have fundamental different ecological characteristics as compared to riverine species such as a two-dimensional distribution pattern, a much higher sensitivity to landscape fragmentation and a lower opportunistic feeding behaviour.

Moreover, no matter what is suggested by a mathematical model, the authors should have carefully studied the real ecological situation in Uganda, should have provided an assessment of the population dynamics of *G. f. fuscipes* in the target area and should have substantiated their parameters with appropriate references. A review of past control efforts indicates there are no examples of successful operational eradication campaigns against riverine tsetse fly populations except those that included an SIT component (see summary in Table next page).

In conclusion, the above examples clearly indicate that the authors have based their economic analysis on various assumptions originating from a dodgy model and that are contrary to what has been experienced in the field against riverine tsetse in general and *G. f. fuscipes* in particular. This paper is thus misleading and provides wrong advice to governments and tsetse control operators.

Part of the Letter to the Editor by J. Bouyer, M.T Seck and B. Sall, published in: Preventive Veterinary Medicine (2013) 112: 443-446.

Table 1
Impact of past tsetse control campaigns. The risk of false negative concerns only the cases when eradication was reported but flies were still present as the population had dropped below detectable level with the traps used; it is based on the probability of not detecting surviving flies (Barclay and Hargrove, 2005). This probability is provided in brackets in the corresponding colon. The risk of false positive concerns only the cases when eradication was achieved but not reported as rapid reinvasion occurred: it was documented qualitatively considering the data reported by the authors. A detailed explanation of the risk of false positives and negatives is provided in the supplementary file, section A. When eradication was not reported, the observed reduction rates are provided in brackets.

Method	Country	Area	Duration	Target species	Eradication obtained	False positive	False negative	Reference
ITT 11/km river	Ivory Coast	79 km river	2 months	*G. palpalis gambiensis*	No (98%)	No (barrier)		Laveissiere and Couret (1981)
				G. tachinoides	No (99.8%)	No (barrier)		Laveissiere and Couret (1981)
ITT 4/km^2	Zambia	3000 km^2	4 years	*G. morsitans centralis*	Yes		No[a]	Bart et al. (1993)
ITT 3–5/km^2	Zimbabwe	600 km^2	4 years	*G. morsitans morsitans*	No (99.99%)	No (central area)		Vale et al. (1988)
				G. pallidipes	No (99.99%)	No (central area)		Vale et al. (1988)
ITT 7/km^2	Uganda	32 km^2	4 months	*G. fuscipes fuscipes*	No (97.3%)	No (barrier)		Okoth et al. (1991)
ITT 5/km river	Ethiopia	150 km^2	1 year	*G. fuscipes fuscipes*	No (74%)	No (barrier)		Leak et al. (1996)
				G. pallidipes	No (92%)	No (barrier)		Leak et al. (1996)
ITT 4/km river	Nigeria	1500 km^2	>14 months	*G. tachinoides*	No (>90%)	No (barrier)		Takken et al. (1986)
ITC 10–20/km^2	Ethiopia	200 km^2	3 years	*G. fuscipes fuscipes*	No (no reduction)			Leak (1995)
				G. pallidipes	No (84%)	No (insufficient reduction)		Leak (1995)
				G. morsitans submorsitans	No (83%)	No (insufficient reduction)		Leak (1995)
SAT 5 cycles	Botswana	16,000 km^2	2 years	*G. morsitans centralis*	Yes		No ($p < 0.001$)	Kgori et al. (2006)
SAT 4 cycles	Ghana	6745 km^2	1 month	*G. tachinoides*	No (98%)[b]	No (central area)		Adam et al. (2013)
				G. palpalis gambiensis	No (98%)[b]	No (central area)		Adam et al. (2013)
SAT 9 cycles	Kenya	300 km^2	5 months	*G. pallidipes*	No (90–99.9%) [c]	No (central area)		Turner and Brightwell (1986)
ITT 60/km^2 + netting of pig pens 20/km^2 + ground spraying	Guinea	<20 km^2	17 months	*G. palpalis gambiensis*	No (100%)[d]	No (isolated island)		Kagbadouno et al. (2011)
ITC 6–18/km^2 + ITT 4/km^2	Burkina Faso	400 km^2	3 years	*G. tachinoides*	No (91.8%)	Yes (no barrier)		Bauer et al. (1999)
				G. morsitans submorsitans	No (98.4%)	Yes (no barrier)		Bauer et al. (1999)
ITC 9–28/km^2 + ITT 45–70/km^2	Unguja	1650 km^2	5 years + 18 months	*G. austeni*	No (80% fem, 98% males)	No (Island)		Höreth-Böntgen (1992) and Vreysen et al. (1999)
ITC 2.5/km^2 + ITT 1/km^2	Ghana	18,000 km^2	1 year	*G. tachinoides*	No (≈96%)	No (barriers)		Adam et al. (2013)
				G. palpalis gambiensis	No (≈96%)	No (barriers)		Adam et al. (2013)
(ITC 9–28/km^2 + ITT 45–70/km^2) + SIT	Unguja	1650 km^2	(6.5) + 3.5 years	*G. austeni*	Yes		No[e]	Vreysen et al. (2000)
I TT 2.4/km^2 + SIT	Burkina Faso	3000 km^2	3 years	*G. tachinoides*	Yes		Yes ($p = 0.43$)[f]	Cuisance et al. (1984) and Politzar and Cuisance (1984)
				G. palpalis gambiensis	Yes		Yes ($p = 0.56$)[f]	Cuisance et al. (1984) and Politzar and Cuisance (1984)
ITT 4/km river + SIT	Nigeria	1500 km^2	+3 years	*G. tachinoides*	Yes		No ($p < 0.001$)[g]	Takken et al. (1986)

[a] Monitoring using stationary traps, screen fly rounds, electric net fitted on a motorcycle during one year in one block, two years in the second.
[b] 22% of the adult females dissected after each cycle were survivors so that the number of cycles was limited to 4.
[c] Over 99.9% in main habitats and about 90% in conifer plantation.
[d] No fly was captured in July 2010 (low efficiency of the traps used) but then tsetse were captured with sticky traps in 2011–2012.
[e] 399leg-panel traps deployed in 55 fixed monitoring sites during 1.5 years.
[f] Considering the number of trapping events with 41 biconical traps set every month during 48 h until July 1985 (trap efficiency of 1.2% (±1.3%) and 0.9% (±0.9%)/km^2 per day for *G. t.* and *G. p. g.*, respectively).
[g] 384 sentinel traps were set permanently and collected every 24–48 h.

Relevant Published Articles

The Trojan female technique: a novel, effective and humane approach for pest population control

Neil J. Gemmell[1], Aidin Jalilzadeh[2], Raphael K. Didham[3], Tanya Soboleva[4] and Daniel M. Tompkins[5]

[1] *Centre for Reproduction and Genomics and Allan Wilson Centre for Molecular Ecology and Evolution,Department of Anatomy, University of Otago, Dunedin, New Zealand*

[2] *Department of Mathematics and Statistics, University of Otago, Dunedin, New Zealand*

[3] *School of Animal Biology, University of Western Australia and CSIRO Ecosystem Sciences, Perth, Western Australia, Australia*

[4] *Science and Risk Assessment Directorate, Ministry for Primary Industries, PO Box 2526, Wellington, New Zealand*

[5] *Landcare Research, Private Bag 1930, Dunedin, New Zealand, The New Zealand Institute for Plant and Food Research Ltd., Christchurch, New Zealand*

Abstract

Humankind's ongoing battle with pest species spans millennia. Pests cause or carry disease, damage or consume food crops and other resources, and drive global environmental change. Conventional approaches to pest management usually involve lethal control, but such approaches are costly, of varying efficiency and often have ethical issues. Thus, pest management via control of reproductive output is increasingly considered an optimal solution. One of the most successful such 'fertility control' strategies developed to date is the sterile male technique (SMT), in which large numbers of sterile males are released into a population each generation. However, this approach is time-consuming, labour-intensive and costly. We use mathematical models to test a new twist on the SMT, using maternally inherited mitochondrial (mtDNA) mutations that affect male, but not female reproductive fitness. 'Trojan females' carrying such mutations, and their female descendants, produce 'sterile-male'-equivalents under natural conditions over multiple generations. We find that the Trojan Female Technique (TFT) has the potential to be a novel humane approach for pest control. Single large releases and relatively few small repeat releases of Trojan females both provided effective and persistent control within relatively few generations. Although greatest efficacy was predicted for high-turnover species, the additive nature of multiple releases made the TFT applicable to the full range of life histories modelled. The extensive conservation of mtDNA among eukaryotes suggests this approach could have broad utility for pest control.

The full paper was published in: Proceedings of the Royal Society B (2013) 280: 20132549.

Sterile males of *Ceratitis capitata* (Diptera: Tephritidae) as disseminators of *Beauveria bassiana* conidia for IPM strategies

Salvador Flores[1], Sergio Campos[1], Antonio Villaseñor[2], Álvaro Valle[2], Walther Enkerlin[2], Jorge Toledo[3], Pablo Liedo[3] and Pablo Montoya[1]

[1] *Programa Moscafrut SAGARPA-IICA, Camino a los Cacahotales S/N, Metapa de Domínguez, Chiapas 30860, México*

[2] *Codirección México, Programa Regional Moscamed México-Guatemala-Estados Unidos, Guatemala*

[3] *Departamento Agricultura Sociedad y Ambiente, El Colegio de la Frontera Sur. Carretera Antiguo Aeropuerto, Tapachula, Chiapas 30700, México*

Abstract

Sterile Mediterranean fruit fly, *Ceratitis capitata* (Wied.), males were evaluated as vectors to spread *Beauveria bassiana* (Bals) conidia to wild *C. capitata* populations under field conditions. The inoculated sterile males were released by air, using the chilled adult technique over 7000 ha of coffee growing in Chimaltenango, Guatemala, Central America. The impact of releases was determined using dry traps baited with a food attractant. The effects of these releases on *Apis mellifera*, Linnaeus (honey bee), *Hypothenemus hampei*, Ferrari (coffee berry borer) and the parasitic mite *Varroa destructor* (Oudeman) were also evaluated. Inoculated sterile males were able to transmit fungal spores to 44% of the wild *C. capitata* flies captured in traps, which likely were infected through intra- and intersexual interactions during leks, mating or mating attempts. There was no transmission of the fungal spores to non-target insect species such as coffee berry borer, honey bees or varroa. We conclude that sterile males of Mediterranean fruit fly inoculated with *B. bassiana* can act as effective vectors of conidia to wild populations, constituting a safe, environmentally friendly and selective alternative for suppressing the medfly under a Sterile Insect Technique-based IPM approach.

The full paper was published in: Biocontrol Science and Technology (2013) 23: 1186-1198.

Achievement of Eradication of the Solanum Fruit Fly, *Bactrocera latifrons* (Hendel) from Yonaguni Island, Okinawa, Japan

Akira Fukugasako[1] and Masahiro Okamoto[2]

[1] *Plant Protection Division, Food Safety and Consumer Affairs Bureau, Ministry of Agriculture, Forestry and Fisheries, Japan*

[2] *Naha Plant Protection Station, Ministry of Agriculture, Forestry and Fisheries, Japan*

Abstract

Solanum fruit fly, *Bactrocera latifrons* (Hendel), (hereinafter referred to as SFF) was recorded for the first time from Yonaguni Islands (westernmost island of Japan located near Taiwan) on August 1984. After that record, SFF was not detected from 1987 to 1998 in Okinawa Prefectural Government (OPG) survey. Infested fruits by SFF were collected again on October, 1999, and SFF was found to be present throughout the Island in 2004 and OPG issued pest alert on SFF in the same year. The Ministry of Agriculture, Forestry and Fisheries (MAFF) issued the notice on November, 2004 based on the Plant Protection Law to order OPG to control SFF and to prevent the spread of SFF to Japan's mainland. OPG inaugurated SFF control program (including development of technologies for suppression and Sterile Insect Technique (SIT) use and implementation of suppression and SIT control) on October, 2004. As a result of the eradication program, no SFF has been recorded since 2004. Naha Plant Protection Station (branch of NPPO in Naha, Okinawa Pref. = Naha PPS) conducted confirmation surveys in 2011 (April - June) MAFF, based on the result of confirmation surveys by Naha PPS, declared the eradication on 19th of August in 2011 after authorization by experts. OPG successfully achieved the eradication of SFF by applying SIT for the first time in the world against this pest.

The SFF control program by OPG is as follows: (1) **Suppression control**: Protein bait spraying and host plants removal were conducted from Oct., 2004 to Dec., 2006 to reduce the population prior to conducting SIT control. (2) **SIT R&D and control**: Several technologies and other things related to SIT control were developed or determined (2004 to 2007). These include development of artificial diet for SFF mass rearing, determination of both appropriate irradiation dose and developmental stage for SFF colony. Nurturing of SFF transport adapted for artificial egging devices, carrying method of SFF from Naha city to Yonaguni Island, and method for releasing SFF in the islands.

The full paper was published in: Plant Protection (2012) 66:13–17 (in Japanese).

An Evaluation of the Species Status of *Bactrocera invadens* and the Systematics of the *Bactrocera dorsalis* (Diptera: Tephritidae) Complex

Michael San Jose[1], Luc Leblanc[1], Scott M. Geib[2] and Daniel Rubinoff[1]

[1] *Department of Plant and Environmental Protection Sciences, University of Hawaii at Manoa, Honolulu, HI 96822, USA*

[2] *U.S. Department of Agriculture Pacific Basin Agricultural Research Center, Hilo, HI 96720, USA*

Abstract

The genus *Bactrocera* (Tephritidae) contains 500 species, including many severe pests of fruits and vegetables. Although native to tropical and subtropical areas of Africa, India, Southeast Asia, and Australasia, a number of the pest species, largely members of the *Bactrocera dorsalis* (Hendel) complex, have become widespread through accidental introduction associated with agricultural trade. The *B. dorsalis* complex includes several morphologically and ecologically similar pests, making species designations uncertain. One of these, *Bactrocera invadens* Drew, Tsuruta, and White, endemic to Sri Lanka, has spread across Africa in the last decade and become a major agricultural pest. We sequenced one mitochondrial and two nuclear genes from 73 specimens, belonging to 19 species to construct phylogenies and examine species relationships and limits within the genus *Bactrocera* and several species of the *B. dorsalis* complex specifically addressing the placement of *B. invadens*. Results indicate the *B. dorsalis* complex is polyphyletic. *B. invadens* and several other species within the *B. dorsalis* complex (*B. dorsalis*, *Bactrocera papaya* Drew & Hancock, and *Bactrocera philippinensis* (Drew & Hancock) are also paraphyletic with respect to each other and probably represent a single genetically indistinguishable, phenotypically plastic, pest species that has spread throughout the world.

The full paper was published in: Annals of the Entomological Society of America (2013) 106: 684-694.

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In Press

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

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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).

BALESTRINO, F., A. PUGGIOLI, R. BELLINI, D. PETRIC and J.R.L, GILLES. Mass production cage for *Aedes albopictus* (Diptera:Culicidae). Journal Medical Entomology (in press).

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

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

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