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Contents

One of the self-contained electrically powered low-energy X-ray machines being assessed as possible alternative to radioisotope irradiation sources for insect sterilization (courtesy of Rad Source Technologies, Inc., USA).

To Our Readers

All insect pest control programmes currently releasing sterile insects use radioisotope irradiators using either ^{60}Cobalt or ^{137}Caesium for gamma sterilization. This technology has proven to be extremely reliable for this purpose. However, the current situation regarding the growing complexities of the transboundary shipment of radioisotopes and the fear of terrorism (in particular of a 'dirty bomb') is increasingly presenting problems regarding the re-loading of existing sources, the acquisition of new sources, and their shipment to Member States.

In mid 2006 Nordion, one of the major producers of radioisotope irradiators, announced that it will no longer produce, replenish and market the Gammacell 220, the source most commonly used for insect irradiation. Not only will these sources be disconnected, but also most of the IAEA procurement requests for Gammacell 220s for various technical cooperation projects will not be honoured. This has placed us in a difficult position in relation to these Member States that have been waiting for their radiation sources.

IAEA International Atomic Energy Agency

Alternative technology using low-energy X-ray irradiation is fortunately under development and we have been following up the progress being made. Ironically, in the very early days of screwworm research in the 1950s, X-rays were all that was available to the early SIT community. Since then much progress has been made and current X-ray irradiators have a number of advantages over radioisotope irradiators, such as being electrically powered, requiring much less shielding, having simpler national legislation requirements, and having lower transport costs. For example, the average transport cost for a radioisotope source is ca. US$ 50 000, whereas the cost of shipping an X-ray irradiator is estimated to amount to some US$ 5 000. Thus it is likely that there will be significant increase in the development and use of X-ray machines for SIT programmes in the future.

Low-energy X-ray irradiators emit X-rays only when the electrical power is turned on, and consist of an X-ray tube and a device to transport the insect canister through the X-ray beam. The X-ray tube consists of an electron source, generally a heated wire, a filament which emits electrons as the cathode, and a converter to generate X-rays as the anode. These electrons are not additionally accelerated (thus no large and costly accelerators are needed), and so the energy will be in the range of a few hundred keV. Therefore these X-ray irradiators require much less shielding and are self-contained.

Such self-contained X-ray irradiators have been marketed for the past several years for the specific purpose of blood irradiation (which require a dose of about 25 Gy), and between 50 and 100 units are operating successfully at hospitals and medical institutes in North America. Canister volume is about 1.5 litres, and the dose rate for this irradiator is about 5 Gy/min, which is relatively small for insect irradiation (requiring a dose of about 100 Gy) on a commercial basis. Fortunately such irradiators have recently been upgraded to yield dose rates of as much as 100 Gy/min. This was achieved by changes in the design of the X-ray tube: an extended cathode is positioned centrally in a cylindrical, water cooled anode which allows for much higher power dissipation. In addition, the extended emission surface has improved dose uniformity substantially.

These irradiators can apparently be further configured to address the requirements of the programme/customer (dose and throughput). Such a semi-automatic unit has been recently developed for the screwworm facility in Panama with dose rate of 25 Gy/min for insect irradiation, and uses four tubes with a total power of 25 kW. This unit is about 1.5 m wide, × 2.8 m long, and 2 m high. It utilises a conveyor and the insects are continuously irradiated in flat trays. This low-energy X-ray irradiator uses tubes that generate X-rays with a maximum energy of 160 keV, with average photon energy in the range of 70-75 keV; thus penetration is not very deep. Hence, the canisters are smaller compared to those used for gamma irradiators; generally, flat trays are more suitable.

In view of the above, and in order to be able to respond to Member State requests for technical advice, training and hardware, the FAO/IAEA Programme is in the process of obtaining such an alternative radiation source for its Agriculture and Biotechnology laboratory at Seibersdorf. Experience with such sources and development of adequate physical and biological dosimetry and operational procedures are indispensable before being able to recommend them for any technical cooperation projects. A unit is under consideration with one horizontal tube and four, also horizontally aligned, irradiation canisters that rotate around the irradiation tube. Such a source with one tube consumes 10 kW during operation and costs ca. $ 140 000, plus transport. It would have the capacity to sterilize 20 litres of insects with 150 Gy in a little over three minutes, or to decontaminate 10 litres of blood as diet for tsetse flies with 1 kGy in about 22 minutes.

On a different subject, we are starting a new biennium (2007-2008) for our technical cooperation activities, and the new projects recently approved for this new cycle by the IAEA Board of Governors are given in this newsletter. These project proposals were submitted officially through the appropriate national authorities in our Member States in December 2005, and underwent during 2006 a thorough evaluation and selection process. Since proposals need to be submitted at the latest one year in advance of a new biennium, I need to draw your attention to the deadline for official technical cooperation projects under the 2009-2010 Programme, which will be in December of this year.

Also I would like to call attention to two new Coordinated Research Projects (CRP) that are scheduled to start in 2007. The first CRP on Improving SIT for Tsetse Flies through Research on their Symbionts and Pathogens was recommended by a Consultants Meeting and has now been approved for the period 2007-2011. It will focus on microbial associations, beneficial and pathogenic in nature that can influence the efficiency and implementation of area-wide integrated pest management programmes that integrate the SIT. It will include the development of methods to manage virus infections in tsetse colonies, assessment of natural incompatibilities related to the presence of *Wolbachia*, the development of improved population suppression methods using fungal pathogens and the development of tsetse strains refractory to infection by trypanosomes. The second new CRP on Field Biology of Male Mosquitoes in Relation to Genetic Control Programmes also follows a Consultants Meeting and has also been approved for the period 2007-2011. It will focus on key gaps in knowledge on adult male mosquito biology, and particularly those factors that affect the ability of males to attract, court, and inseminate females in the field. The ultimate goal of the CRP is to establish the specific biological and behavioural determinants that

contribute to male mosquito sexual competitiveness. We are encouraging relevant applications to these new CRPs.

In June this year Mr. B. Knols left the mosquito group to take up a position at the University in Wageningen, Netherlands. We would like to thank him for his excellent contributions and wish him well back in his home country. The vacant position in the mosquito project is being advertised but can probably not be filled until June next year. In order to maintain progress in the project during this interim period, Dr. Colin Malcolm has been recruited as a consultant for 9 months. Dr. Malcolm has been involved with the project from its inception in 2001 and has been on several expert missions to Sudan as part of his continuing support for, and interest in, the project.

Finally, I would like to take this opportunity, on behalf of myself and all staff of the Sub-programme, to thank all our collaborators for a fruitful 2006, and to wish you all the very best for the year 2007. We are certainly looking forward to an exciting and rewarding year, and hope that you can share successes with us in the next twelve months.

Jorge Hendrichs
Head,
Insect Pest Control Section

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The Insect Pest Control Subprogramme staff, consisting of those in the Section located in the Vienna International Centre, those in the Entomology Unit at the FAO/IAEA Agricultural and Biotechnology Laboratory in Seibersdorf, and field experts, is listed below.

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Forthcoming Events

I. Research Coordination Meetings (RCMs)

Coordinated Research Project (CRP) on Improved of Codling Moth SIT to Facilitate Expansion of Field Application. 19-23 March 2007. Vacaria, Brazil. Fourth RCM.

CRP on Improved and Harmonized Quality Control for Expanded Tsetse Production, Sterilization and Field Application. 7-11 May 2007 (tentative). Muguga, Nairobi, Kenya. Third RCM.

CRP on Development of Standardized Mass Rearing Systems for Male *Anopheles arabiensis* Mosquitoes. 4-8 June 2007. Khartoum, Sudan. Second RCM.

CRP on Improving SIT for Tsetse Flies Through Research on their Symbionts and Pathogens. 3-7 September 2007. Vienna, Austria. First RCM.

II. Consultants and Other Planning Meetings

Consultants Meeting on the use of geographic information system hard and software in support of tsetse and screwworm population genetic assessment. 26-30 March 2007. Vienna, Austria.

Consultants meeting to refine the guidelines/manual on operational procedures for codling moth rearing and quality control. Second half of 2007. Vienna, Austria.

III. Other Meetings/Events

Second FAO/IAEA Regional Training Course on Principles of Baseline Data Collection for Integrated Area-Wide Tsetse Control. 11– June - 6 July 2007 (Tentative dates). Dakar, Senegal.

FAO/IAEA Regional Training Course on principles of tsetse population genetic sampling and tsetse morphometrics. Planned tentatively for mid 2007, Tororo, Uganda.

Past Events (2006)

I. Research Coordination Meetings (RCMs)

Coordinated Research Project (CRP) on Improving Sterile Male Performance in Fruit Fly SIT Programmes, 4-8 September 2006, Salvador, Bahia, Brazil. Second RCM.

CRP on Development of Mass Rearing for New World (*Anastrepha*) and Asian (*Bactrocera*) Fruit Fly Pest in Support of SIT, 4-8 September 2006, Salvador, Bahia, Brazil. Second RCM.

CRP on Molecular Technologies to Improve the Effectiveness of the Sterile Insect Technique, 2-6 November 2006. Bangkok, Thailand. Third RCM.

CRP on Enabling Technologies for the Expansion of SIT for Old and New Screwworm, 11-15 December 2006, Canberra, Australia. Fourth RCM.

II. Consultants and Other Planning Meetings

Consultants Meeting on the Role of Symbionts and Pathogens in Relation to Tsetse SIT, 6-10 March 2006, Vienna, Austria.

Consultants Meeting on Assessing the Minimum Size Area for Application of an Area-wide SIT Programme Against Selected Insect Pests, 3-7 April 2006, Vienna, Austria.

Workshop on Design of Tsetse Fly Mass-Rearing Facility, 17-19 July 2006, Vienna, Austria.

Workshops on "The Development of an Action Plan for the Collection of Entomological Base Line Data on Tsetse", 12-20 June 2006 in Kampala, Uganda and 2-20 October 2006 in Bobo Dioulasso, Burkina Faso.

Consultants Meeting on Genome Characterisation of the Tsetse Salivary Gland Hypertrophy Virus, 18-20 November 2006, Vienna, Austria.

III. Other Meetings/Events

FAO/IAEA Regional Training Course on Principles of Base-line Data Collection for Integrated Area-wide Tsetse and Trypanosomosis Inervention Projects with a Sterile Insect Technique Component, 13 March-7 April 2006, Nairobi, Kenya.

Tenth Meeting of the Pan African Tsetse and Trypanosomosis Eradication Campaign (PAAT) Programme Committee. Istituto Agronomico per l'Oltremare (IAO), 26-27 April 2006, Florence, Italy.

FAO/IAEA Interregional Training Course on "The Use of the Sterile Insect and Related Techniques for the Integrated Area-wide Management of Insect Pests", 10 May-7 June 2006, University of Florida/USDA, Gainesville, Florida, USA.

International Fruit Fly Course, 21 August-8 September 2006, Metapa de Dominguez, Chiapas, Mexico.

Third meeting of the Fruit Fly Technical Panel of the International Plant Protection Convention (IPPC), 4-8 September 2006, Salvador, Bahia, Brazil.

Seventh International Symposium on Fruit Flies of Economic Importance and Sixth Meeting of the Working Group on Fruit Flies of the Western Hemisphere, 10-15 September 2006, Salvador, Bahia, Brazil.

Final Meeting of the Middle East Regional Coperation (MERC) Management Committee, 27-30 November, 2006, Vienna, Austria.

SIT for *Anopheles arabiensis* Mosquitoes: Sudan Planning and Coordination Meeting, 29 November-1 December, Vienna, Austria.

Note: Reports available upon request

Technical Cooperation Projects

The Subprogramme currently has technical responsibilities for the following technical cooperation projects that are managed by the IAEA Technical Cooperation Department. They fall under five major areas, namely:

- Tsetse
- Fruit flies
- Old and New World Screwworm
- F-1 Sterility for the Control of Lepidopteran Pests
- Mosquitoes

Project Number	Title Ongoing Projects	Technical Officer
ALG/5/019	Control of Date Moth Using the Sterile Insect Technique	Marc Vreysen
BGD/5/025	Studying the Feasibility of Integrating the Sterile Insect Technique in Sun-dried Fish Industry Project	Udo Feldmann
BKF/5/004	Feasibility Study on Applying the Sterile Insect Technique to Create a Tsetse-free Zone	Marc Vreysen
BRA/5/057	Establishment of Medfly, Fruit Fly Parasitoids and Codling Moth Rearing Facility	Walther Enkerlin Carlos Caceres
CHI/5/047	Upgrading Release Systems for Mediterranean Fruit Fly Containment in the Arica Region	Walther Enkerlin
EGY/5/025	Area-Wide Fruit Fly Control in Eastern Egypt	Jorge Hendrichs
ETH/5/012	Integrating SIT for Tsetse Eradication	Udo Feldmann
INT/5/145	Promotion of Insect Pest Control Using the Sterile Insect Technique	Jorge Hendrichs
IRQ/5/016	Field Monitoring and Rearing of Old World Screwworm	Udo Feldmann
ISR/5/011	Strengthening the Capacity for the Area-wide Control of the Mediterranean Fruit Fly Using the Sterile Insect Technique	Jorge Hendrichs
JOR/5/010	Stengthening the Capacity for the Area-wide Suppresion of the Mediterranean Fruit Fly Using the Sterile Insect Technique	Jorge Hendrichs
KEN/5/022	Integrated Area-wide Tsetse and Trypanosomosis Management in Lambwe Valley	Udo Feldmann
MAG/5/011	Feasibility Study of SIT-based Integrated Pest Management of Fruit Flies	Walther Enkerlin
MAL/5/020	Feasibility Study for the Creation of a Zone Free of Tsetse	Marc Vreysen
MAR/5/015	Feasiblity Study for Integrated Use of the Sterile Insect Technique for Area-wide Tephritid Fruit Fly Control	Jorge Hendrichs
MEX/5/029	National Prevention Campaign against the Cactus Moth	Walther Enkerlin
MOR/5/028	Assessing the Feasibility of Medfly Suppression through the Sterile Insect Technique	Udo Feldmann Walther Enkerlin
PAL/5/003	Strengthening the National Capacity for the Area-wide Suppression of the Mediterranean Fruit Fly	Jorge Hendrichs

PAK/5/043	Development of Biological Control for Cotton Pest Management Using Nuclear Techniques	Jorge Hendrichs
RAF/5/051	SIT for Tsetse and Trypanosomosis Management in Africa	Udo Feldmann
RAF/5/052	SIT Development for Control of Anopheles Mosquito	Bart Knols
RLA/5/045	Preparation for Pilot Fuit Fly-free Areas using the Sterile Insect Technique in Central America	Walther Enkerlin Jesus Reyes
SAF/5/007	Expanding the Use of the Sterile Insect Technique against Fruit Pests in the Western and Northern Cape	Jorge Hendrichs
SAF/5/009	Preparation for the Creation of Zone Free of G. *brevipalpis and* G. *austeni*	Marc Vreysen
SEN/5/029	Feasibility Study to Create a Tsetse-free Zone Free Using the Sterile Insect Technique	Marc Vreysen
THA/5/046	Area-wide Integrated Control of Fruit Flies	Walther Enkerlin
TUN/5/022	Implementation of the Pilot Programme Using Sterile Insect Technique Against the Mediterranean Fruit Fly, Phase II	Walther Enkerlin
URT/5/022	Assistance to a Feasiblity Study for the Use of the Sterile Insect Technique	Marc Vreysen
	New Projects Starting in 2007	
BOT/5/004	Integrating the Sterile Insect Technique into the national Tsetse and Trypanosomosis Control Programme	Udo Feldmann
BZE/5/002	Establishment of a Pilot Fruit Fly Free Area Using an Integrated Approach that includes the Area-Wide Sterile Insect Technqiue	Walther Enkerlin
CRO/5/002	Feasibility Study for the Suppression of the Mediterranean Fruit Fly by Integrating the Sterile Insect Technique on an Area-wide Basis in the Neretva Valley	Walther Enkerlin Jorge Hendrichs
GUA/5/016	Establsihment of Fruit Fly Free or Low Prevalence Areas using the Sterile Insect Technique	Jesus Reyes
ISR/5/012	Feasibility Study to Assess the Integration of the Sterile Insect Technique into Olive Fly Suppression Programmes	Jorge Hendrichs Carlos Caceres
MAR/5/016	Feasibility Study for the Supprtession of the Melon Fly (*Bactrocera cucurbitae*) in Selected Areas of Mauritius	Jorge Hendrichs
MYA/5/014	Support for a Feasibility Study on Using the Sterile Insect Technique against Diamond Back Moth	Marc Vreysen
PAN/5/016	Capacity Building for Suppression of Fruit Flies of the Genus *Anastrepha* from the Azuero Peninsula using an Area-Wide Pest management Approach	Walther Enkerlin Jesus Reyes
RAS/5/049	Sharing Regional Knowledge on the Use of the Sterile Insect Technique within Integrated Area-Wide Fruit Fly Pest Management Programmes.	Jorge Hendrichs
SEY/5/003	Feasibility of Integrating the Sterile Insect Technique to the ongoing Area-Wide Melon Fly Eradication Programme	Jorge Hendrichs
TUN/5/025	Use of Inherited Sterility as a Genetic Control Method Against the	Marc Vreysen

	Carob Moth	
UGA/5/027	Fesibility for a *Glossina fuscipes* Free Zone in the Lake Victoria Basin	Marc Vreysen
ZIM/5/012	Feasibility Study on the use of SIT to Eradicate Tsetse in Zimbabwe	Udo Feldmann

In keeping with our policy to highlight activities of a few of our Technical Cooperation Projects, the following projects are discussed in this issue:

Exports of Tomato and Bell Pepper from Fruit Fly Low Prevalence Areas in Central America (RLA5045)

Under the framework of the Technical Cooperation Project RLA5045, aimed at developing fruit fly low prevalence and free areas for fruit exports, a longtime vicious circle has been broken. This is that "fruit flies are not controlled because there is no industry to protect and there is no industry because of the presence of fruit flies".

The strategic alliance between national, regional and international organizations that was created under the framework of this project, the presence on-site of an IAEA regional coordinator and the approach of developing selected pilot areas for fruit production and exports rather than the unrealistic approach of first eradicating Medfly from the whole of Central America, has been the key for success.

Tomato production in fruit fly low prevalence areas in El Salvador.

The rules allowing exports of bell peppers and tomatoes from fruit fly free and low prevalence areas from Central America to the USA were published in the US Federal Register early this year. These add to the rule for exports of papaya from the entire region which was published in 2003. According to the rules the export potential and value of these commodities has been estimated for bell peppers at 31,000 metric tons per year with an estimated value of US $50 million, and for tomatoes 13,000 metric tons per year, with an estimated value of US $13 million.

Some of the Central American countries are already taking advantage of this unique opportunity and have invested substantial amounts of money in the required infrastructure to produce and exports these fruits. In just a few months substantial volumes of bell peppers have been produced and exported to the USA, as shown in this table:

Product	Nicaragua	El Salvador	Guatemala
Bell pepper	250 tonnes US $400,000	50 tonnes US $82,000	
Tomato	–	–	4.3 tonnes US $4,300

Exports of tomato from Guatemala to the USA started in October with 4.3 tonnes exported. It is estimated that one weekly container with a total volume of 1000 tons will be exported to the USA, shortly. To meet this volume 10 associations of tomatoes producers joined efforts and product. This will have a spearhead effect on exports of tomatoes which will very likely reach much higher figures in the near future.

Honduras has recently signed the protocol for exports of bell peppers to the USA as indicated by the invitation below from the Presiential Office:

Other fruits and vegetables produced in the region such as pitahaya, mangosteen, litchi, rambutan and guava may very likely follow the same path. Pest risk anaylsys have been conducted for pitahaya and guava and the possibility of implementing systems approach for these other fruits is being studied.

With this important achievement a unique opportunity has been created for the agricultural sector in Central America, a sector which is vital for the economy and social stability of the region, submerged in a deep crisis for the past 20 years as a result of the coffee, sugarcane and banana crises.

Feasibility Study for Integrated Pest Management of Fruit Flies (MAG5011)

A complex of fruit fly species exist in Madagascar. Nevertheless, of the various endemic species only two, the Madagscan fruit fly (*Ceratitis malagassa*) and *Dacus demmerezi* are considered to be of serious economic importance because of the type of crops they infest and the level of damage they inflict. Fortunately, Madagascar is still free of some of the major invasive fruit fly pests including the Oriental fruit fly (*Bactrocera dorsalis*), the melon fly (*B. cucurbitae*), the peach fruit fly (*B. zonata*) and others. This represents an important competitive advantage in terms of potential for trade of horticultural products. Madagascar is attempting to export fruits to Europe and has significant plans to develop pre- and postharvest treatment schemes and pest low prevalence zones with the cooperation of importing countries. Many exotic fruit flies, such as the ones mentioned above, are clearly established in other regions of the Indian Ocean and Africa; so additional exotic fruit fly quarantines will be a concern when new pests get established in Madagascar.

Madagascar is highly vulnerable to invasion by exotic pest from all parts of the world but most importantly from Mauritius, Reunion and East Africa (the Mediterranean fruit fly *Ceratitis capitata*, has recently been trapped in Toamasina). Restrictive import regulations exist and are enforced at the international airport in Antananariva but not at international airports in Tamatave, Mahajanga, Nosy-Be or Tolanaro. With only 20 inspectors to cover 5000 km of coast, major ports in Mahajanga, Toliary, Tolanaro, Toamasina and Antsiranana (Diego Suarez) and the regular arrival of cruise ships Madagascar the maritime ports or bays and harbors are only partially protected. At present there is not a functioning detection system to provide early discovery of exotic flies (traps were going up in Nosy-Be and are scheduled for Mahanjanga). Identification capabilities are very limited and would be overwhelmed in the event of an eradication project. Project response capabilities are very limited. The protection afforded by geographical isolation is being lost due to increasing movement of peoples and goods to the island. Growers and producers are anxious to initiate export but without a proper plan and resources to address the fruit fly problem they are finding it difficult to meet European or US regulatory requirements. The recent introduction and establishment of Mediterranean fruit fly (Medfly) in several locations in the island will further restrict their exports.

In order to alleviate the negative socio-economic impact caused by Tephritid fruit flies in Madagascar, IAEA assistance was requested to (i) assess the feasibility of an integrated pest management programme and design a country-specific project for the application of fruit fly control methods, and (ii) establish human capacity building.

The two main counterparts (Direction de la Protection des Végétaux; Institut National des Sciences et Techniques Nucléaires) provided project buildings, basic laboratories and a limited amount of professional staff. A steering committee was set up to facilitate collaboration and co-ordination among the counterparts. The IAEA provided expert services for (i) the technical assessment of fruit fly control in Madagascar, (ii) data collection on Tephridid fruit fly species and theirs host plants, (iii) the use of male annihilation technique and bait application technique, (iv) the transfer of GIS/GPS technology for fruit fly survey, (v) the selection of an area for implementation of a fruit fly suppression programme and preparation of an action plan, (vi) preparation of a strategy document that clearly indicates the way forward and (vii) assistance for a national expert to attend a FAO/IAEA International Conference on Area-Wide Control of Insects Pests held in Vienna in May 2005. The IAEA granted 4 fellowships and 1 scientific training in principles and applications of area-wide SIT and essential equipment and consumable items.

The feasibility studies that were conducted to assess the possibility of implementing an IPM approach for fruit fly control in Madagascar revealed the following: A coherent long range fruit fly prevention and control plan for Madagascar is not available. Involving the administra-

tors, producers and politicians in the fruit fly programmes should be the single most important goal. Further commitment from the Malagassi administrators and politicians can only come through their involvement in the fruit fly programmes. That involvement will require a direct effort to educate them in international fruit fly operations.

Enforcement of quarantine restrictions at the various ports of entry should be high in the list of government priorities. This is critical to prevent introduction and establishment of other invasive fruit fly species as has recently occurred in the case of the Medfly (*C. capitata*). Madagascar is anxious to enter the international market. Madagascar's major weaknesses at least in the ministry of agriculture are its lack of knowledge of pest prevention, the lack of cooperation between ministries especially customs, dependency on graduate students and loss of institutional memory associated with personnel turn over. Training was given to graduate students or retirees who have since left taking that knowledge with them. Expanding the permanent cadre is essential to maintaining institutional memory as is targeting training toward individuals with a long term commitment to the work. Translating manuals and international guides into either French or Malagassi is essential and will help reduce information loss due to turn over. So far a real understanding of the risk associated with exotic flies is localized and limited to a handful of managers and technicians.

At this stage the most important step is to create a general awareness of the risk, the potential gains, the science associated with exotic fruit flies and to develop an understanding of fruit fly biology in the pristine Madagascar environment. The methods available for detection and control of exotic pest are effective and relatively simple to implement. The use of a combination of bait application technique, male annihilation technique and sterile insect technique should be capable of eradicating small outbreaks of exotic fruit flies if implemented speedily and correctly. Speed, efficient effective communication, transparent and focused staff, a crisis mentality and staff without competing responsibilities are essential. Missing any one of these components is an invitation to failure. Speed, effective detection, eradication response and identification components are missing from Madagascar at this time as is the crisis mentality and staff without competing responsibilities. Donors should first focus their efforts on creating an immediate general awareness of fruit flies and their destructive potential.

Madagascar's leaders must be educated as to the developmental potential of Madagascar in the absence of exotic fruit flies and effective control of the endemic ones before strong support for pest prevention, suppression and eradication can be expected. Support for research, detection and port protection must follow the involvement of the countries leaders and news makers.

Through the project limited capacity building was achieved among professional staff of the Direction de la Protection des Végétaux and a group of farmer cooperatives that produce melon, one of the main agricultural fruit products produced in the island. Through technology transfer, training of staff and provision of equipment and supplies, melon producers are now managing the fruit fly problem more effectively through the application of a supervised bait treatment programme. This has resulted in increased yields and reduction in insecticide use. Nevertheless, the limitations described above have prevented the spread of this benefits among a larger group of farmers and more important, are limiting the possibilities of developing fruit fly low prevalence areas for fruit exports.

An important output of the project has been the preparation of a strategy document which clearly defines the fruit fly problem in Madagascar and indicates ways to address the problems in a sustainable manner. The strategy document identifies as one critical factor the need for creating awareness at the decision making level on the benefits of using an integrated pest management approach to prevent introduction and establishment of other exotic fruit fly species and to suppress populations of the endemic fruit fly pests. The document presents a one and ten year plan to address the fruit fly problem in a comprehensive manner. This plan was prepared jointly with the ministry staff and presented to the agricultural authorities.

Transfer of Genetic Sexing Strain Mass Rearing Technologies for Mexican Fruit Fly Production (MEX5027)

This project initiated at the request of the Mexican Government to extend the use of genetic sexing strain technology to the Mexican fruit fly *Anastrepha ludens*. The project started in 2002 and will be completed at the end of 2006. Very good progress has been made in terms of technology transfer, capacity building and sustainability of future efforts. A dedicated *Anastrepha* Genetic Sexing Laboratory has been constructed, equipped and is now fully operational. In addition, staff have received training in the various scientific disciplines necessary to continue the project in the future. The laboratory provides an excellent infrastructure for future work on the development of a genetic sexing strain for *Anastrepha* fruit flies. The self-contained laboratory is equipped for mutation breeding, cytology, genetic transformation and molecular biology.

*Mexican fruit fly (*A. ludens*) black pupa* (*bp*) *mutation*.

At the initiation of the project virtually nothing was known about the genetics and cytology of this species, no mutants were available and genetic transformation had not been started. At the end of 2006 many mutations have been isolated and genetically mapped, mitotic and polytene chromosomes have been prepared, translocation strains isolated and studied, and genetic transformation achieved. In the past year a new mutation, *black pupa* (*bp*) was isolated which could be very important for the development of a genetic sexing strain. These are considerable achievements and will form the basis for a concerted effort to isolate genetic sexing strains in this species in the coming years. Sustainability is assured through the know-how that has been transferred for developing GSS strains, availability of a procedures manual, and the continuing financial support of the national authorities to the project.

Control of Date Moth Using the Sterile Insect Technique (ALG5019)

Date moth is a serious pest of date palm and infestation levels can be very high (>20%) in dates grown in countries of the Mediterranean basin. The date moth has traditionally been controlled with broad spectrum insecticides, but stringent conditions on pesticide residue levels have restricted the export of chemically-treated dates to the EU and other countries. Several alternative control methods are being used or are under development, but all have their limitations, i.e. cultural sanitation requires the collaboration of the farmer community, physical bagging of the dates is very labour intensive and hence expensive, treatment with *Bacillus thuringiensis* requires accurate timing for the treatment, as the larvae of the date moth have a very limited free-living period and penetrate very quickly into the dates where they are inaccessible to the bio-pesticide (which has to be ingested), and post-harvest treatment with methyl bromide is being phased out in many countries. The use of the sterile insect technique (SIT) offers therefore a viable alternative to the use of broad spectrum insecticides, for area-wide integration with the other available control methods, which will increase the possibility for Algeria to market its dates to the EU.

In the past years, significant progress has been made with the development of the rearing of date moth in Tunisia, where the development of an artificial larval diet has allowed the shift from individual rearing on dates to mass-production (Mediouni and Dhouibi 2007)[1]. In view of the potential of SIT for date moth control, the Government of Algeria has established an experimental date moth rearing unit at the Station Régionale in Boufarik (Institut National de la Protection des Végétaux (INPV)), which is directed by Dr B. Dridi. The unit is now using the larval artificial diet that was developed in Tunisia and the cylindrical oviposition cages as was recommended following a mission of Drs S. Bloem and M. Vreysen in September 2003 under TC project ALG5019. Although these

Date moth (*Ectomyelois ceratoniae*)

improvements have been introduced in the rearing process, the number of moths produced remains limited. Problems with diet components, the correct type of paper for the cylindrical oviposition cages and the distribution of light in the oviposition room are currently being addressed, which should allow for a significant increase in the size of the colony in the near future.

In addition to the rearing, the further development of date moth SIT will require work on radiation biology, handling, transport and release methods and an assessment of

[1] **Mediouni, J. and M. Dhouibi 2007.** Mass-rearing and field performance of irradiated carob moth *Ectomyelois ceratoniae* in Tunisia. *In* M.J.B. Vreysen, A.S. Robinson and J. Hendrichs (eds.), Area-wide control of insect pests. From research to field implementation. Springer, Dordrecht, Netherlands (in press).

the competitiveness of the released insects. More importantly, at a given stage, the researchers will need to hand over the technology to a 'control programme' that can take responsibility for the large-scale rearing of the moths and effectively implement an operational suppression programme. This will require the collaboration, commitment and the financial drive of the date growers and agricultural authorities.

Reporting on Ongoing and Planned Coordinated Research Projects (CRPs) and RCMs

The Second Research Coordination Meeting (RCM) of the CRP on *Development of Mass Rearing Procedures for Anastrepha (New World) or Bactrocera (Asia/Pacific region) Fruit Fly Pests* was held in Salvador, Bahia, Brazil from 5 to 9 September 2006

Presentations by 19 scientists from 17 participating countries, showed that much progress has been achieved and an increased knowledge on fruit flies biology, colonization and mass rearing has enabled new species to be colonized, improved mass rearing protocols to be developed, and new quality control procedures to be proposed.

A number of fruit fly species have been studied under this project: from *Anastrepha* to *Bactrocera*, and *Ceratitis* through to *Dacus*. Currently colonies of *Anastrepha fraterculus* are being studied in Brazil and Argentina, however the coexistence of several *Anastrepha* species in some regions using the same host, has made colonization of certain species somewhat difficult. Currently there are SIT programs in operation for *Anastrepha ludens* in Mexico and US and for *Anastrepha obliqua* in Mexico. For fruit flies of the genus *Bactrocera* for which SIT is being applied, mass rearing methods need to be improved for *Bactrocera philippinensis*, *B. dorsalis*, and *B. correcta* in Bangladesh, the Philippines, and Thailand, respectively. One main topic discussed was the possibility of introducing the novel liquid diet recently developed and evaluated in mass rearing scale in Hawaii for *B. cucurbitae* and *B. dorsalis*. This would reduce the volume of waste diet and save on rearing space and energy for environmental control.

The current level of knowledge for difficult to rear, little known and/or new species of fruit flies of economic importance from the genera *Bactrocera*, *Dacus* and *Ceratitis* was reviewed. Most of these species have not yet been colonized or are maintained in small laboratory colonies, mainly on natural fruit or semi-artificial diets. Significant progress on the understanding of their biology was described. The species under study are *Anastrepha striata* and *A. serpentina, Ceratitis cosyra, C. fasciventris, C. rosa, C. anonae, Dacus ciliatus, B. pyrifoliae B. zonata*, and a new invasive *Bactrocera* fruit fly of Sri Lankan origin, *B. invadens*.

The Third Research Coordination Meeting of the CRP on *Molecular Technologies to Improve the Effectiveness of SIT* was held in Bangkok, Thailand from 2-6 November 2006

The first two days of the RCM were held in conjunction with the 18th Annual Meeting of the Thai Society for Biotechnology. S. Thanaphum (Mahidol University Bangkok) served as local organizer for the RCM (the organization and hospitality provided by Thanaphum and his staff was greatly appreciated by all participants). The CRP was initiated as a consequence of a recommendation from a Consultants Group Meeting in Capri, Italy, in May of 2003. The consultants recommended that the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture re-examine its activities on the impact that transgenic insect technology can have on the efficiency and further development of the SIT so that it can take advantage of "its position as the ideal coordinating and implementation agency for SIT technology transfer".

Twenty-one scientists from ten participating countries attended this third RCM. The attendees represented countries that both develop technologies for SIT and countries that apply it to insect pests of agriculture. Scientists actively working on fruit fly pests, sheep blowfly, mosquito pests and lepidopteran pests of crops were present. The breadth of the field of transgenic insect technology as applied to pest insect species was well represented, with all attendees being considered world experts in their respective areas.

RCM participants. Bangkok, Thailand.

A focus of the current RCM was the characterization of sex determination genes in several species. The basic knowledge of how these genes are regulated can be used to develop inducible/repressible sex-transformation or sex-lethal gene systems. Transgenic strains carrying such gene constructs could significantly increase the efficacy of SIT. Progress was also reported with other systems that could potentially augment SIT such as sex-lethal or

sex-separation systems. It was apparent that development of these gene systems is greatly facilitated in those species in which whole genome or EST gene sequencing projects have been undertaken. Transgenesis is now routinely successful in most of the species of interest to members of this CRP. Thus transgenic strains of several species that could significantly enhance SIT could be generated in the near future. It will be essential that the properties of these strains such as stability, penetrance, competitiveness etc be examined under mass-rearing conditions.

The IAEA has been at the forefront of fostering the development of this technology into SIT pest insects and continues to be in an ideal position to determine whether genetic engineering technology can, in reality and practicality, be applied to the SIT. Successful augmentation of the SIT through contemporary genetic technologies should increase the efficacy of the SIT and so should directly lead to increases in agricultural productivity and, in the case of insect vectors of human disease, decreased incidence of debilitating diseases such as malaria and dengue.

The Second Research Coodination Meeting of the CRP on *Improving Sterile Male Performance* was held in Salvador, Bahia, Brazil, from 5 to 9 September 2006

Twenty-seven scientists from 16 countries attended this second RCM, held in Salvador, Brazil from 5-9 September 2006. The excellent organization of the meeting and hospitality of Aldo Malavasi and his team is greatly appreciated.

This Coordinated Research Project (CRP) is based on a 2003 Consultants Meeting and addresses the critical post-production process during which the sterile males may be manipulated in a manner that will significantly improve their copulatory success following release. It begins with the arrival of pupae at the emergence facility and ends with their release in the field, and involves the biotic environment (hormones, nutrients, microorganisms, semiochemicals), as well as the abiotic environment and release methods.

Progress in achieving the specific objective of the CRP is very good. Excellent basic and applied research has been carried out in 16 Member States on 10 species currently targeted in SIT operations in the four areas that affect sterile male performance: a) hormonal supplements, b) nutritional supplements and microorganisms, c) semiochemical supplements, and d) fly holding and release conditions, in order to develop, improve and implement cost effective pre-release sterile male handling procedures. Specific progrees made includes:

1. Effects of hormone/analogue supplements assessed for *Anastrepha fraterculus, A. ludens, A. obliqua, A. suspensa,* and *Ceratitis capitata.*

2. Hormone supplements procedures developed for incorporation into pre-release protocols for ongoing *Anastrepha ludens* SIT operations.

3. Good progress made on optimal pre-release adult diet for sterile males for *A. ludens, A. obliqua, A. suspensa, Bactrocera dorsalis, B. philippinensis, B. tryoni,* and *C. capitata*.

4. Structure and possible function of microbial community in the gut of *C. capitata* determined.

5. Effects of semiochemical supplements assessed for *A. suspensa, B. correcta, B. cucurbitae, B. dorsalis, B. philippinensis, B. tryoni, B. zonata,* and *C. capitata*.

6. Delivery systems involving ginger root oil for *C. capitata* tested at operational scale and transferred to several SIT programmes. Also significant progress made on methyl-eugenol delivery system for *B. dorsalis* and other members of this species complex.

7. Emergence/holding systems compared for *C. capitata*. Sterile fly holding conditions at emergence/release centre manipulated in terms of diurnal light cycle for *C. capitata*. Beneficial effect of diurnal light cycles documented for *A. suspensa*. Manual developed on current state of the art of holding and release procedures.

8. Effects of fly immobilization by chilling assessed in *A. ludens* and *C. capitata* in terms of sexual performance. Effect of holding density on sexual performance determined in *C. capitata*. New release system developed.

Developments at the Entomology Unit Seibersdorf

FRUIT FLIES

Protein sources for larval and adult diets of *Ceratitis capitata*

Trials have been conducted by a fellow (Luciano Arnold) from the South African medfly SIT project to evaluate the viability of locally available brewers yeast for medfly rearing in South Africa. The main objective of this work is to reduce the production cost of male only sterile Medfly pupae by using locally found raw materials, thus eliminating the importation of an expensive product. The specific objective of these trials is to evaluate two types of dry yeast for the larval diet and four types of yeast hydrolizate as source of protein for adult food. Egg production, egg viability, pupae production, and pupae and adult quality during three consecutive generations are being used as comparison parameters. The successful evaluation of any of the above mentioned substitutes will result in a substantial saving in cost and will once again reduce substantially the cost of sterile pupae and make the pupae more affordable to areas of the fruit industry applying SIT in South Africa. Affordability of the technology will also enhance the expansion of the SIT in South Africa to new areas.

Improving sterile male performance of *Bactrocera cucurbitae*

Ihsan Ul Haq from Pakistan is currently a cost free intern at the Entomology Unit and is registered for a PhD at the University of Vienna. The objective of his internship is the implementation of the experimental part of his PhD thesis. His research will be focus on the enhancement of mating behaviour and acceleration of sexual maturity of male melon fly (*Bactrocera cucurbitae*). He will be assessing conventional methodology used for other fruit flies based on the utilization of protein in the adult diet, parapheromones (Cue Lure), and juvenile hormone anologues (methoprene). He will also study the physiological changes that are involved in the acceleration of sexual maturity in order to understand and explain the action of these chemicals on the physiology and behaviour of the insects.

Improving sterile male quality in *Anastrepha fraterculus*

Research efforts have been initiated in Argentina and at the Unit in order to support SIT programmes against *Anastrepha fraterculus*. Results from studies on mass rearing, sexual competitiveness, and survival of sterile males in the field have shown the potential of the SIT against this key pest of citrus in South America. In this context, studies on the sterile male sexual maturation have shown that the use of methoprene reduced significantly the mean time of male sexual maturation.

To continue these studies Diego Segura from INTA Clastelar, Argentina carried out field cage tests to evaluate the sexual competitiveness of methoprene treated males compared to untreated mature males. These studies were performed using two populations of *A. fraterculus* from Argentina and Peru. These two populations showed a high degree of sexual isolation according to previous studies conducted by Teresa Vera from Argentina. A second objective of the study was to assess if methoprene treatment of males would reduce the level of sexual isolation found between these populations. Methoprene treated males from one population were released into the same field cage with mature untreated males of the other population along with females from the two populations. The degree of sexual isolation was evaluated through the Index of Sexual Isolation. A control experiment was performed, in which untreated mature flies of both sexes and strains were released in the cage, repeating the experiments conducted by T. Vera in 2003. Young methoprene treated males from the Argentinian strain performed as well as untreated 10 d old males, while this as not the case with Peru males. This could indicate that the process of sexual maturation differs between the populations. Sexual isolation between the Argentinian and Peruvian populations remained very high even after three years of laboratory rearing at Seibersdorf, and this could not be reduced by hormone therapy.

Generation of new transgenic lines

In collaboration with Al Handler (USDA, Gainesville, USA) an attempt was made to introduce the 'suicide vector' described in the previous Newsletter into additional fruit fly species. Eggs from the following species were injected: *Anastrepha fraterculus*, *A. ludens* and *Bactrocera cucurbitae*. From the injected eggs, 250, 1 and 5 larvae were recovered respectively. The resulting adults will be mated with the corresponding recipient strain and the offspring will be screened for individuals where the transformation vector was successfully integrated into the genome.

In addition, two medfly strains, D53 and EgII, were injected with various constructs. One of the aims is to generate more *GFP* and/or *DsRed* labelled chromosomes that can be incorporated into the currently used genetic sexing strains (e.g. VIENNA 8). This became necessary because the existing D53 chromosomes labelled with a fluorescence marker show suboptimal performance when incor-

porated into a sexing strain, especially in the males where the marker is heterozygous and is present in a single copy, and when the rearing was expanded to ca. 2500 adults per generation. Until now these strains were reared up to 15 generations under these conditions. In all three strains analyzed so far, a significant fraction of the flies showed either very weak or even no fluorescence at all. In one case the fluorescence became only visible after aging the flies for several days.

In the next step of the characterization of these strains it was planned to increase the level of rearing to ca. 100,000 flies per week to determine, among other aspects, the stability of the transgene at this rearing level and during the rearing over several generations. However, the characteristics observed already at small scale rearing will make the quality control assessment of such strains very complicated. The currently used procedure is to collect pupae in Petri dishes and allow the adults to emerge and then die as no food or water is supplied, i.e. for the strains described above the flies would not live long enough to develop the fluorescence. Furthermore, if a certain fraction of the flies shows no fluorescence it will be rather difficult to determine the stability of the transgene over time. Considering the practical application of such strains, i.e. to replace the current methodology of marking the released flies with fluorescent powder, neither of the existing strains appears to be useful. It is expected that molecular/cytological data will become available soon that will allow to explain the reduction/lack of fluorescence in some flies.

TSETSE FLIES

Colony status

The high mortality and poor performance of the Seibersdorf *Glossina pallidipes* colony continued until the middle of September, but has since improved markedly. Mortality has returned to below 1% per day and fecundity to above 0.6 pupae/female/10 days so that the colony is starting to recover from a low point of 7200 females. Although growth is still slow, the much increased pupal production will lead to a rapid increase in input in the next few weeks and the colony is expected to reach about 12,000 (half the target size) by the end of the year.

After a short delay, shipments of *Glossina f. fuscipes* were started from Bratislava to Ethiopia in September. However substantial mortality and low fecundity forced a halt to the shipment of pupae. Poor performance was experienced in both the *G. f. fuscipes* and *G. pallidipes* colonies, with the *pallidipes* colony falling to one third of its level at the beginning of the year. Recovery of the Bratislava colony started in October, and a renewal of the shipments in the New Year is expected following this growth.

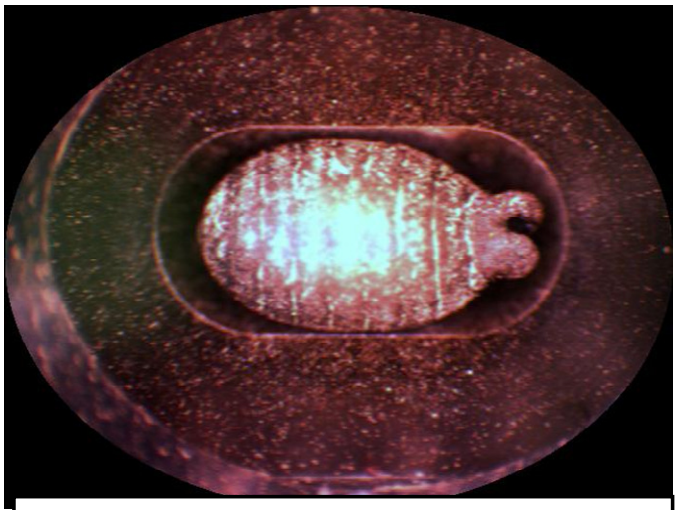
In the case of both the Seibersdorf and Bratislava colonies the improvement in the colony performance appears to be associated with changing the feeding to a new batch of blood, combined with very careful attention to the feeding and holding conditions. The blood batches that seem to cause the problems had passed all the quality control tests, but while the bioassay test has been used successfully over several years, this may indicate a shortcoming in our quality assurance protocol.

Samples of the blood are being chemically screened for pesticide and veterinary drug residues and the quality control protocols will be reassessed in light of these results. The changes in the *G. pallidipes* colony performance also seem to be correlated with changes in salivary gland hypertrophy (see below).

TPU3.2

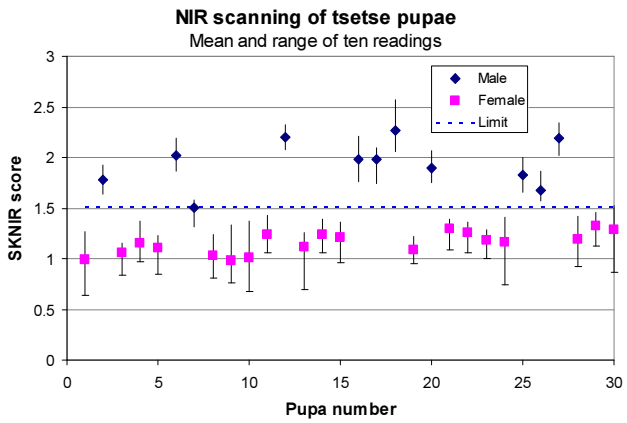
A number of issues in relation to the feeding, alignment of cages, feeding tray levelling and membrane shrinkage have been identified and we are working with the producer of the Tsetse Poduction Unit 3 (TPU3) to resolve these issues. So far modifications have been proposed or made to the brackets holding the cage frame, to the feeding trays and a new clip system has been introduced to hold the feeding trays firmly down on the heating surface. The initial high mortality on the TPU3 led to a substantial loss of *G. m. centralis* to the detriment of the overall colony and with renewed shipment of *G. m. centralis* pupae to TTRI, United Republic of Tanzania, loading of flies on to the TPU3 had to be discontinued. A consultant will be engaged for three months to speed up testing of the TPU3, and with the improved performance of the *G. pallidipes* colony testing will be moved back to this species.

Sexing of pupae



View of a G. pallidipes *pupa in the bucket of the SKNIR as shown by the in-built video camera.*

Work has continued on refining and calibrating the near infrared spectrometer (SKNIR) for sexing tsetse pupae.



Mean and range of repeated scans from individual pupae. The pupae were repositioned between each reading.

The main changes are a new design of the bucket to hold the pupa during scanning and improvements in the software to enhance several features. One of the main problems with the system originally was that occasionally a pupa would not lie flat in the bottom of the bucket. When the bucket rotated to discharge the pupa, the pupa could be caught in the mechanism and cut in half, resulting in the smearing of the pupal contents in the bucket system and consequent jamming. The new design of bucket has completely eliminated this problem by providing a deeper, shaped recess in which the pupa lies.

During this work we noticed that when a series of readings are taken from a single pupa the results can vary considerable. Several batches of pupae were selected and each pupa scanned ten times, with a repositioning between each scan. The figure shows the results of one run of 30 pupae, with the mean reading and the range of the readings. The scans were taken five days before emergence, when the threshold between males and females is expected to be 1.5. As the figure shows, all but one of the pupae would be correctly classified from every scan. However not all sets of scans give such clear results, and we are still working to try to understand the cause of this variability.

Salivary gland hyperplasia

As reported in the last newsletter, PCR analysis confirmed that the salivary gland hyperplasia virus (SGHV) infection rate was 100% in the *G. pallidipes* colony originating from Uganda, and the virus was also detected in the *G. pallidipes* colony established in Ethiopia at a very high level (93%). Subsequently the virus has been detected with various levels in several species from colonies in France and Belgium. Due to the negative impact of the virus infection on the colony productivity under certain stressful condition it is important to understand more about the virus with the goal to develop a management strategy for the virus.

As a step in this process we need to identify what type of virus is present and one way of doing this is to obtain the nucleotide sequence of this virus. After purifying the virus and extracting the viral DNA, two strategies were adopted to obtain the virus genome sequence. The first was the shotgun method by fragmenting the genome with EcoRI restriction endonuclease, cloning the resultant fragments in a plasmid vector and sequencing the inserted fragment using universal primers. Using this method, as we reported in the last newsletter, 415 colonies were sequenced totalling 60-90 kpb. The second approach was a new sequence technology announced at the end of last year to read the genome sequence in a microfabricated high-density picolitre reactor. We prepared sufficient quantity of purified viral DNA (8 µg) and sent the DNA samples to the company 454 in the USA. The sequences obtained were assembled by the company to give 402 contigs. Further assembly of these contigs using the program NTI Vector resulted in one large sequence of 181944 nucleotides and 15 small sequences with lengths from 138 to 1878 nucleotides. The sequences obtained from the two approaches were compared to confirm the sequence quality. The work to finalize the sequence and compare the sequence data from other viruses is under way.

In parallel to the sequence analysis of the viral genome, two approaches with the objective of understanding the virus biology and transmission were initiated. The first is selection of negative flies by PCR screening using a non-destructive assay by extracting DNA from the fly middle leg. PCR negative flies will be used to try to establish a virus free colony. The second is to assess the impact of two antiviral drugs on virus replication and prevalence in the tsetse colony. Several antiviral drugs have been selected and non-toxic concentrations when fed to tsetse in the blood diet have been determined. Using this approach tsetse flies will be fed blood containing anti-viral drugs and the level of virus infection determined, as well as the incidence of salivary gland hyperplasia.

MOSQUITOES

Germline transformation as a supporting technology for genetic sexing

In the previous newsletter we reported the development of a transgenic sexing strain of *Anopheles arabiensis* based on a *piggyback*-derived construct. This construct is designed to express *DsRed* in the eyes and central nervous system of both sexes and green fluorescent protein (*GFP*) in the testis of male individuals. In the experiments reported previously, expression of *DsRed* and *GFP* was observed in larvae hatched from injected eggs, but not their progeny. In the past few months we have succeeded in establishing lines in which both traits are inherited. Positive larvae were selected from the first generation after injection session: four were obtained from one session and two from another. These were outcrossed to wild type females and six separate lines established. Similarities in the *GFP* phenotype amongst the lines de-

scended from the first four positive larvae suggest that these may have been from the progeny of a single female, but until molecular characterisation is complete all four lines are being maintained. The remaining two lines show marked differences in *GFP* expression, so at least three transformation events were achieved. In an attempt to make the lines homozygous for the transgenes, individuals that showed no *DsRed* expression were removed at each generation. Despite this selection, in five of the six lines, the frequency of the wild type phenotype was always considerably higher than expected, suggesting lethality amongst transgene homozygotes. In contrast the sixth line now appears to be homozygous.

Radiation biology

In the last newsletter we presented the dose-sterility curves for pupal and adult stage irradiation. Since then, experiments to assess the competitiveness of radio-sterilized males have been initiated. The original intention was to complete all of the competition experiments in large cages (1.2 × 1.7 × 1.2 m (h × l × w)) rather than the routine rearing cages (30 × 30 × 30 cm) to assess male performance under more challenging conditions.

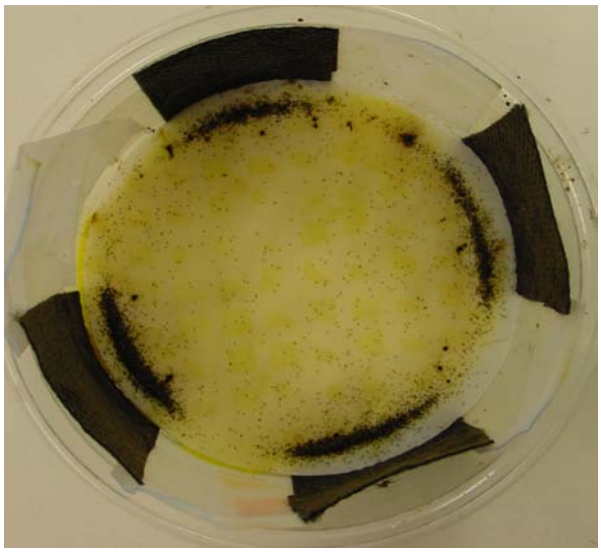
The experiments did not progress beyond the establishment of baseline data with non-irradiated males since the proportion of inseminated females was low compared to small cages. Mortality was also difficult to control. These problems appear to be related to climate issues in the rooms that affect the large cages far more than small cages. Until these issues can be resolved, data is now being gathered from small cage competition experiments.

Ultimately, male competitiveness will be assessed in large field cages currently under development using a large greenhouse facility and then in similar facilities in Sudan. For the time being the small cage competition experiments are being set up using, irradiated males in competition with normal males for normal females at a ratio of 1:1:1. Two irradiation doses are being tested; a high, almost fully sterilizing dose (>98% sterility) of 120 Gy, and a lower, semi-sterilizing dose (>80% sterility) of 70 Gy. Competitiveness is determined from egg hatch data from females inseminated by males irradiated as pupa or adult.

Mass rearing of mosquitoes

A number of activities are currently in progress to develop procedures and equipment for mass rearing of mosquitoes. The goal is a modular system with a fixed daily output of eggs sufficient to produce 100 000 sterile males that is as fully automated as possible, with minimal mosquito handling and built in checks on production quantity and quality. To this end various stages in the rearing process are being examined in detail and a large mass production cage has been built and evaluated.

In general, optimisation of rearing conditions involving modifications in water depth, food quantity and larval density have reduced rearing time from hatch to adult by 2 days. Work on artificial blood feeding was reported in the previous newsletter and studies are still in progress to compare the use of bovine and human blood. This includes an assessment of the long term impact of exclusively using one, or other, of the two blood sources.
Investigations are in progress on the scope to use larval and pupal cold tolerance to manipulate development time, to aid transportation, and as part of a pupal harvesting strategy. Early results indicate that both larvae and pupae will recover from exposure to a rapid drop in temperature, to short exposures (<1 hour) to 0ºC or less and long exposures (<5 days) to 4ºC, but all markedly reduce adult emergence. Exposures to temperatures in the region of 12-14ºC appeared to have little impact on overall survival, but were low enough to aid separation of larvae and pupae, or to significantly delay development.



Oviposition pots.

Past observations on An. arabiensis oviposition behaviour indicated a stark preference for a black rather than a white substrate. This was investigated further to determine if this could be exploited for mass rearing. In preliminary experiments, two oviposition pots were introduced in each cage, one lined with black paper and the other with white; the materials were of the same undulated texture and were fitted inside the walls of the pots. To ensure that only mosquitoes in a prepared physiological state for oviposition were used for these experiments, four day-old inseminated females that had not taken a previous blood meal were selected and then only those that probed an offered human arm placed were transferred to the experimental cages. The black lining was clearly preferred. The experiment was then repeated with oviposition pots divided into sections of black and white and again the results showed that the females preferred to deposit their eggs next to the black sections. In an alternative design the black and white sections were placed on the bottom of an oviposition tray that had very low walls, but egg laying on this appeared random.

Prototype of mass production cage.

We are now examining the use of a black strip held vertically above a white substrate to direct females to lay their eggs in long rows, which would aid counting and handling for mass production.

The evaluation of the first mass production cage was very encouraging and a second prototype has now been built. A central feature of the cage is to supply blood, pupae, and sugar water, and to remove eggs and dead mosquitoes without entering the cage. A series of tubes running from one side of the cage to the other can be accessed from outside where blood, pupae and sugar water are delivered. The tubes are visible in the picture, including the one carrying blood; large numbers of blood feeding females can be seen hanging from the membrane on the underside of the tube. For oviposition, instead of a tube, a long flat steel tray is used, visible towards the bottom of the picture, which carries a wet foam pad covered with filter paper. Another 'tube' provides a resting refuge. The floor of the cage is covered with a large sheet of filter paper, which can be easily removed and replaced when there is a need to remove dead mosquitoes.

ANNUAL REPORT 2005

For more detailed information on the 2005 R&D activities conducted by the Entomology Unit, Seibersdorf, see Annual Report 2005:

www.iaea.org/programmes/nafa/d4/index.html

Special News and Reports

7th International Fruit Fly Symposium on Fruit Flies of Economic Importance held from 10 to 15 September 2006, Bahia, Brazil

The International Fruit Fly Symposium is organized every four years and brings together scientists, action programme managers, the horticultural industry and other companies offering pest management services and products. This is the most important international fruit fly event for exchange of scientific information, to get exposed to the latest technological developments and current status of operational programmes, and to continue expanding the fruit fly network.

The Sympsoium was organized as follows: Eleven Workshops, 11 Sessions with oral presentations, and 221 poster discussions. The Workshops were: 1) Taxonomy of Dacini: where are we?, 2) The use of the IPPC (International Plant Protection Convention) Framework in the Regulation of Fruit Flies as Plant Pests, 3) The Tephritid Workers Database, 4) Pest Risk Assessment and Quarantine Mitigation, 5) New Weapons for Fruit Fly Work, 6) Male-Female Interaction in Tephritid Fruit Flies, 6) Taxonomy of *Anastrepha*: were are we?, 7) Genetics: from classic to molecular, 8) New Improvements on Biocontrol, 9) Plant Chemicals and Tephritid Behaviour, 10) New Approaches to the Taxonomy of Fruit Flies, and 11) New Developments for Mass Rearing.

The Sessions included the following: 1) Systematics, Morphology, 2) Exhibition of the Use of Dogs for Fruit Inspection, 3) Genetics Genomics, Biochemistry, 4) Semiochemicals and Attractants 5) Economics, 6) Behaviour, 7), Rearing, Quality Control and Nutrition, 8) Biocontrol and Other Control Methods, 9) Quarantine and Post-harvest Treatments, 10) SIT Principles and Applications and 11) Area-wide Action Programmes.

As this information shows, the Symposium covered the most relevant aspects of fruit fly research and development and its application in actions programmes as well as international regulatory procedures of the International Pnat protection Convention (IPPC). The Symposium was extremely well attended and organized, and was very successful. Our thanks to Aldo Malavasi and his efficient team.

We look forward to the 8th International Fruit Fly Symposium on Fruit Fly of Economic Importance to be held in Valencia, Spain in 2010.

Programme for the Integrated Pest Management of Codling Moth (*Carpocapsa pomonella*) and Oriental Fruit Moth (*Grafolita molesta*) in Mendoza, Argentina

The Province of Mendoza is located at the central-western part of Argentina, between parallels 31° 58´ and 37° 33´ southern latitude and meridians 66° 30´ and 70° 36´ western longitude. It limits with other Provinces on the north, south and east and with the Andes mountain range at the west, separating Argentina from Chile.

The climate in Mendoza is classified as desert-arid type with the mean annual temperature fluctuating according to the zones. The mountain range zone has a mean temperature of 12.4°C and the plains of 16.7°C. The annual mean rainfall oscillates around 200 mm.

Within the irrigated oasis, the following areas of agriculture development can be delimited: North, East, Central, and South Oasis. Stone fruits are produced in all oasis; however, it concentrates in the South and East Oasis, and the production of pome fruits in the Centre. The total surface planted with pome fruits (apple, quince and pear) amounts to 13,668 ha.

In 1999, through the Instituto de Sanidad y Calidad Agropecuaria of Mendoza (ISCAMEN), the programme against *C. pomonella* and *G. molesta* was launched. The general objectives of this programme are:

- Reduce the population levels of these pests below economic levels.
- Sustainability of the low population levels with the subsequent reduction of infestation and insec

  ticide residue levels to maintain current markets and gain new ones.
- Protect and improve the environment.

ISCAMEN has decided to implement an integrated pest management approach (IPM) for which the following strategies are being developed:

Monitoring

ISCAMEN continues with the monitoring network to aid the timely application of insecticides.

Sterile Insect Technique (SIT)

During the month of September 2006, the pilot facility for artificial rearing of *C. pomonella* was finalized (see Figure).
Plans have been made to implement, starting in January 2007, field trials for validation of SIT technology against this pest. The first sterile moths will be released during the third flight following the results of the radiation biology laboratory bioassays and adjusting SIT use as results from the field become available. At the same time, mass

Pilot facility for artificial rearing of codling moth C. pomonella.

rearing will be scaled-up, improving the production and quality indexes.

In the framework of the Coordinated Research Project with the IAEA, cross breeding studies have been conducted with populations from different geographical origins as well as mating ability tests using different radiation doses.

Biological control

With the approval by the Servicio Nacional de Sanidad Agropecuaria (SENASA) laboratory for the production of the parasitoid *Mastrus ridibundus,* ISCAMEN is conducting the trials for the establishment of this parasitoid which is specific to *C. pomonella*. In the first trials (2005/2006), 25,000 parasitoids have been released and acceptable adaptation of the parasitoid to the ecosystem has been observed. In addition, work is being done on the identification and feasibility of rearing and releasing native egg parasitoids (*Trychogramma spp*).

Mating disruption

With the implementation of the National Programme for Suppression of *Carpocapsa* (PNSC), based mainly on the mating disruption technique, it is expected that populations will be substantially reduced in the fruit production area.

Other field trials

Field trials continue for collection of base-line data on these two pests to assess the magnitude of the problem and generate information on population ecology. Bioassays with new hormonal baits (kairomons), viruses and specific nematodes are being intensified.

Mechanical control

During 2006, 300,000 host plants from abandoned orchards and backyards have been eliminated. This adds to the 100,000 that were eliminated in previous years. It is estimated that another 400,000 host trees need to be eliminated.

Public information

Public awareness efforts are being conducted on improved techniques for control of these pests including calibration of equipment for control of the pest in orchards by ISCAMEN.

Contibuted by: Gustavo Taret, Instituto de Sanidad y Calidad Agropecuaria Mendoza (ISCAMEN), Mendoza, Argentina.

Regional Conference on Approaches for the Integrated Control of the Desert Locust, 23 – 24 July 2006, Algiers, Algeria

At the invitation of the Algerian Commission of Atomic Energy, IAEA staff participated in the Regional Conference on Approaches for the Integrated Control of the Desert Locust, which was organised in Algiers on 23-24 July 2006 under the auspices of the Ministry of Energy and Mines. The conference was attended by representatives of the FAO, the IAEA, desert locust-affected countries such as Mauritania, Tunisia, Morocco and Chad, and by many researchers of Algeria.

During the conference, a series of presentations (on the control of desert locust, the work of the Department of Nuclear Sciences and Applications, on potential problems with any application of the sterile insect technique against the desert locust, on the state of the art of the sterile insect technique and its future perspectives, on biological control and on the use of low-risk insecticides) were delivered, followed by a discussion workshop.

The conference concluded with the following recommendations:

- Preventive control is the most promising control tactic against the desert locust — unfortunately, preventive control has not been implemented very effectively in the past, despite the fact that a preventive approach would probably be 100

times less costly than a curative intervention. The lack of preventive control seems mainly related to the reluctance of decision makers to invest resources during recession periods of the desert locust, when the insect does not constitute a problem.

- The SIT is not a suitable technique for the control of desert locust — in view of the following reasons: (a) the enormous economic damage that the released insects would inflict on crops, (b) the high numbers of sterile insects that would be needed to obtain adequate sterile to wild insect ratios, (c) the sterile insects would dramatically increase the total numbers of the locust population, which would stimulate the shift from the solitary to the gregarious phase, (d) the migratory behaviour of the insect, (e) the enormous surface area that would need to be covered, (f) the lack of knowledge on radiation biology and suitable mass-rearing techniques.

- More research is required on the solitary phase of the desert locust.

- Other nuclear techniques might be considered for research on the desert locust — in view of recommendation 3, the use of stable isotopes would be an option to consider as a tool to study the dispersal, behaviour and ecology of the desert locust in the solitary phase.

- A regional research and training centre to be established in northern Africa by the affected countries.

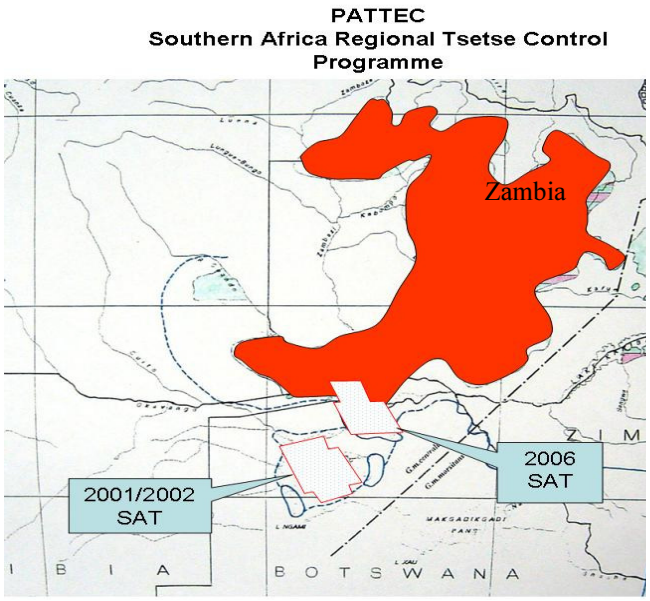
- More resources should be made available by the national authorities to existing desert locust control units.

In addition, it was stressed that the development of the SIT for date moth (*Ectomyelois ceratoniae*) deserves further support as a viable alternative to the use of insecticides, which restricts the expert of dates to markets like the EU.

Tsetse eradicated from the Okavango Delta in Botswana

Botswana eradicated tsetse flies from the Okavango Delta in 2001/2002. An area of approximately 16,000 km^2 was treated by aerial spraying using the secuential aerosol technique (SAT), applying a 0.35% deltamethrin ulv formulation at 0.3 g/ha. Eradication was successful due to the open vegetation and the use of GIS to direct the aerial operation. In addition wide barrier zones with targets were established that were also treated by SAT. This was followed up in 2006 by a similar operation in a second block, using the same technique and insecticide, (Figure). To ensure that tsetse flies could not reinvade into Botswana, the 2006 spray block extended into the Namibian Caprivi Province and over their northern border into Angola. This project, covering 10,000 km^2, was financed by the Botswana Government, with airport and other operational facilities provided by the Namibian Government. Regional collaboration was facilitated by the AU-Pan African Tsetse & Trypanosomiasis Eradication Programme (PATTEC).

The 2006 aerial spraying programme became the first phase in PATTEC's programme to progressively eliminate tsetse flies — predominantly *Glossina morsitans centralis* — from the common fly belt extending from Botswana, through the Caprivi, into southern Angola and



Map showing the common tsetse fly belt (red) and the areas where the Sequential Aerosol Technique (SAT) against tsetse was successfully applied in 2001/2002 (Okavango Delta in Botswana) and in 2006 (Caprivi Strip in Namibia and border area with southern Angola).

Zambia (red area in Figure). In order to protect the areas cleared in 2006 the aerial spraying programme will continue expanding, with other techniques such as impregnated targets used where appropriate, in adjacent areas. Specifically southern Angola and SW Zambia would need to be treated in 2007 and the remaining fly belt in Zambia progressively treated from 2008 onwards. The Angolan Government has commited US$13.5 million towards this 3 year initiative and the Zambian Government US$16 million.

A national tsetse re-emergence preparedness strategy should be developed for immediate implementation if / when tsetse flies re-appear in areas where they were assumedly removed. Besides expanded and intensified entomological monitoring, the preparedness strategy neces-

sitates some preparatory action, including the identification of a suitable site for a container-based mass-rearing centre and, possibly, the establishment of a local 'seed' colony of the target tsetse fly species.

Workshops to develop a detailed action plan for the collection of entomological base-line data of tsetse: an essential component of AW-IPM, held 12-30 June, Uganda (UGA5024) and 2-20 October, Burkina Faso (BKF5004)

The goal of each programme manager of an area-wide integrated pest management (AW-IPM) programme against an insect pest is basically the same, i.e. to be successful in suppressing, eradicating, preventing or containing the target pest. This cannot be attained without a solid foundation — basic data on population dynamics, densities, distribution, etc. of the pest — that will allow the development of an appropriate control strategy and the efficient implementation of the programme. Most insect pests are unfortunately not distributed evenly but occur in aggregated pockets. Their spatial occupation of the habitat and their densities in space and time are influenced by climate, vegetation, host distribution, etc. and will therefore be different for each specific control area.

The collection of these data requires funds and resources and a careful balance is required between data accuracy and cost efficiency. Decision makers, however tend to view these activities as 'academic' or 'research' and hence 'a waste of money' and 'unnecessary'. Similarly, the donor community often objects to the use of tax payers' money for this seemingly superfluous exercise "that doesn't bring any tangible socio-economic benefit to the poor". This attitude might result in the allocation of insufficient funds to conduct these surveys, forcing programme managers to start without the necessary knowledge about the target pest, which paves the way towards failure. Especially in tsetse projects, the argument is often voiced that lots of the essential research has already been conducted in the past and that most of the data are available. A more in-depth scrutiny of these data sets rapidly reveals that they originate from very small areas, are collected over short periods of time and for completely different research purposes than to serve an AW-IPM programme.

Most tsetse infested African nations are signatories of the PATTEC (Pan African Tsetse and Trypanosomiasis Eradication Campaign) initiative. As a result, several African countries have the intention to embark on the creation of a sustainable tsetse free zone on their territory. They are in the phase of conducting feasibility studies and in that respect, two workshops were organised in the past six months (in Uganda and Burkina Faso) to develop a detailed action plan for the collection of essential entomological base line data. Technical and financial support to these workshops was provided through two TC projects i.e. UGA5024 and BKF5004.

In Uganda, the Government has the intention to create a zone free of *Glossina fuscipes fuscipes* in the Lake Victoria basin, whereas the Government of Burkina Faso wants to create a sustainable zone free of *G. palpalis gambiensis*, *G. tachinoides* and *G. morsitans submorsitans* in the river basin of the Mouhoun. Although the topography and conditions in Burkina Faso and in Uganda are completely different, the basic principles and protocols of the action plan for the collection of entomological base line data were the same, i.e. the development of a grid-based sampling frame and the selection of Reference Survey Sites in each of these grids.

The entomological base-line data survey has the following objectives: to assess: (1) the distribution of the tsetse populations, (2) the number of tsetse species present, (3) the seasonal and spatial fluctuations in apparent densities of the tsetse populations, (4) the relationship between tsetse presence/densities and vegetation type, and (5) the temporal and spatial variations in the structure of the tsetse populations.

In both workshops, available processed Landsat 7 satellite imagery and the maps on the 'probability of presence' of the tsetse species in the target areas were used to demarcate the survey area, i.e. the entire *G. f. fuscipes* belt around Lake Victoria in Uganda (total surface area of 67,000 km^2) (Figure) and the river basin of the Mouhoun in Burkina Faso (total surface area of 95,000 km^2). The survey areas were sub-divided into four and five survey blocks in Uganda and Burkina Faso, respectively.

Both workshops focussed on the first survey block and an overlaying the Universal Transverse Mercator (UTM) grid, consisting of 10 × 10 km squares (each 100 km^2) was developed. Using the 'probability of presence' maps as a guide, a total of 160 (Uganda) (Figure) and 307 (Burkina Faso) grid squares were selected, which were deemed important for the survey and each grid square was given an ID. To enable the selection of Reference Survey Sites in each of these grids, available land use land cover maps were examined. In Uganda, excellent AfriCover maps exist, but the meeting participants had to reclassify the existing 67 vegetation or land cover classes into 18 classes, which were more user-friendly for the survey. AfricCover maps were unfortunately not available for Burkina Faso, and available land use land cover maps were deemed unsuitable for the tsetse surveys. New

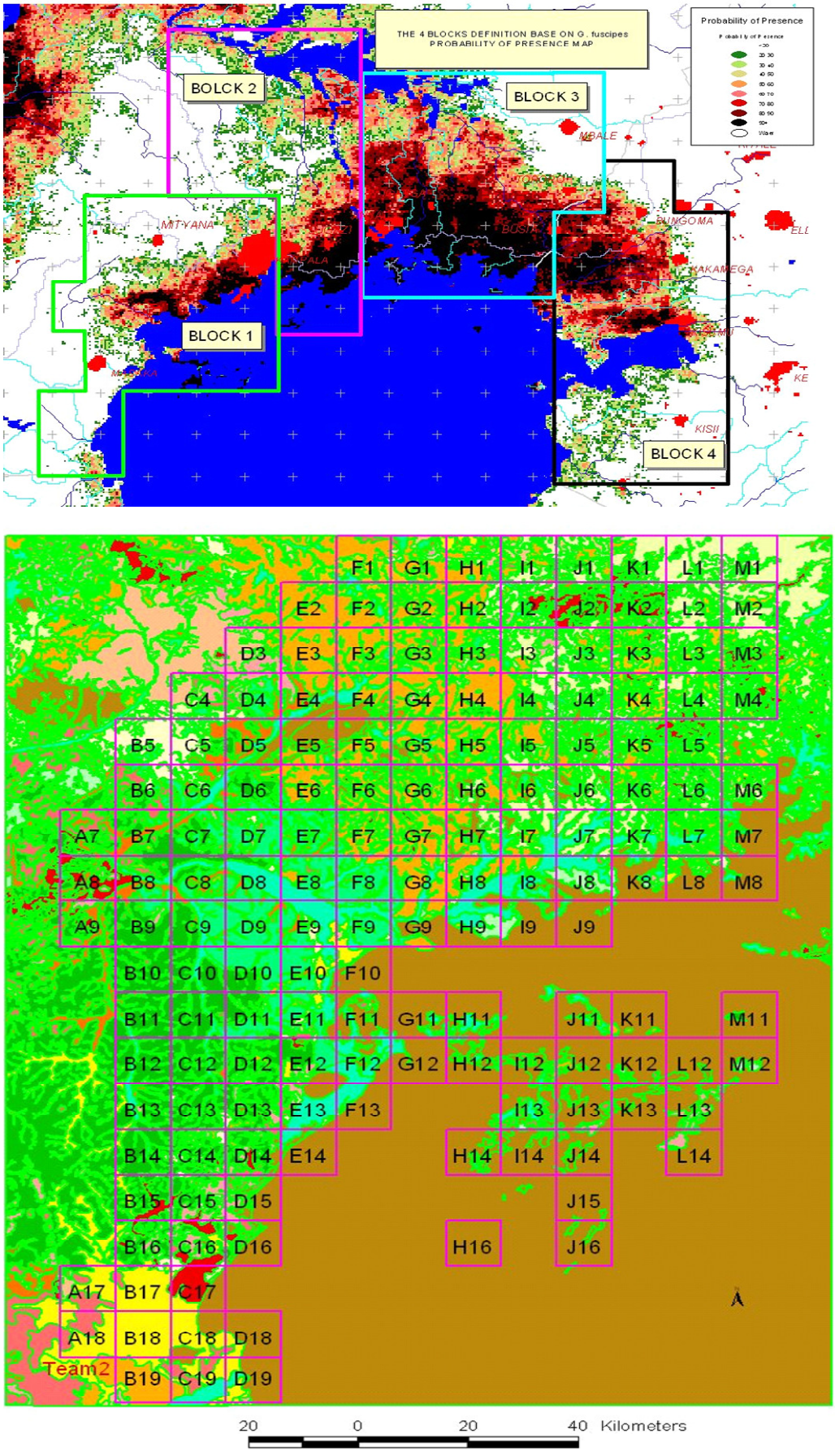


Figure. (upper) The probability of presence map of the G. f. fuscipes *in the Lake Victoria Basin in Uganda indicating the 4 survey blocks, and (lower) the Universal Transverse Mercator (UTM) grid developed for the first block.*

maps will need to be commissioned specifically for the purpose of tsetse surveys.

A detailed protocol was developed, outlining the selection procedures of Reference Survey Sites in the most representative area of a given grid, taking into consideration accessibility.

Seven field teams would be needed to optimally survey the first block in Uganda and five teams were deemed optimal for Burkina Faso. This number seemed to provide a good compromise between cost efficiency and data accuracy. Each team would have the responsibility to survey 22-24 grids in Uganda and 62 grids in Burkina Faso. Each grid would be surveyed four times in one year in Uganda, whereas the colleagues in Burkina Faso opted for a strategy where each grid would only be surveyed once. A detailed daily working programme for each team was developed, i.e. each team would be engaged in field activities for 2-3 weeks, followed by 1 week for data analysis, maintenance etc. Except for the northern grids in Burkina Faso, traps would be deployed in each grid for 72 hours and each team would be able to survey 3 grids per week. Trap deployment would be done on Monday, Tuesday and Wednesday and trap/fly removal would be done on Thursday, Friday and Saturday. The traps in the northern grids of the Mouhoun would be deployed for 7 days, in view of the anticipated low fly density (limit of the tsetse distribution) and to increase the probability of trapping flies.

A grid allocation plan was developed for each of the teams and a potential field office location was identified. These field offices would be used as a base for the survey and would need store facilities, computing facilities for the data compilation and analysis, etc. In view of the remoteness of many of the working grids, camping equipment and HF radios in the vehicles will be needed to operate efficiently. These HF radios could likewise be used for the frequent data transfer from the field offices to the central project management office, in case email services are unreliable.

Each field team will be composed of 1 team leader (entomologist — veterinarian), 1 technician, 3 field assistants and 1 driver. The terms of reference of the teams were developed and the responsibilities of each of the team members debated. There was a general consensus on the need for data on tsetse population structure. This would entail the addition of a special team to carry out this activity or alternatively, to make additions to the existing teams.

Finally, a standard protocol for the deployment of traps was developed, existing data recording sheets reviewed, an improved data flow system developed, the needs in terms of logistics, equipment, and personnel identified, and a detailed budget developed.

These two documents not only will have practical importance for the efficient implementation of the collection of the entomological base line data, but will likewise be very relevant for the creation of awareness of what AW-IPM for tsetse in general, and the collection of base line data in particular, entails.

Third Meeting of the Fruit Fly Technical Panel (FFTP) of the International Plant Protection Convention (IPPC), September 2006

The technical panel on pest free areas and systems approaches for fruit flies (TPFF) was welcomed to Salvador by Maria Júlia Signoretti Godoy on behalf of the Ministry of Agriculture Livestock and Food Supply.

The steward updated the panel on the decisions of the Commission on Phytosanitary Measures (CPM). He outlined the process that led to the adoption of the International Standard for Phytosanitary Measures (ISPM) on *Establishment of pest free areas for fruit flies (Tephritidae)* (ISPM No. 26) and explained that more than 1000 comments had been received. The panel agreed that new draft standards should provide adequate technical detail, but should also be sufficiently broad to cover measures for fruit flies in all regions. The panel also acknowledged the need to balance requirements for developed and developing countries and to take into account different capacities in different areas.

The steward also provided an update on the work of the Standards Committee (SC), including the approval of the specification on *Trapping procedures for fruit flies of the family Tephritidae* (No. 35) and the draft specifications still to be considered on fruit fly free places of production and production sites (FFF POP/PS) and suppression and eradication procedures for fruit flies. The panel noted that the draft ISPM on *Establishment of areas of low pest prevalence for fruit flies (Tephritidae)* (FF-ALPP), which had been produced at the last TPFF meeting, was currently out for country consultation, and was on the Agenda for consideration during the meeting.

The panel discussed the work of other technical panels as they related to fruit flies. They noted that a diagnostic protocol was in development on the genus *Anastrepha* and that the SC had agreed at its last meeting to propose additional protocols for the work programme, including a protocol on the *Bactrocera dorsalis* species complex. This protocol had been recommended by the TPFF at their meeting in 2005.

The TPFF also noted that the IPPC Secretariat had issued a call for submissions of phytosanitary treatments for fruit flies and the next meeting of the technical panel for phytosanitary treatments (TPPT) would be held at the International Atomic Energy Agency (IAEA) in Vienna.

A major topic at this meeting would be to agree irradiation treatments to be incorporated into Annex 1 of ISPM No. 18.

Tephritid Workers Database (TWD) [www.tephritid.org]

The tephritid Workers Database (TWD) is a free, non-commercial web based database, providing information service to fruitfly workers worldwide on:

- The Directory of fruit fly workers (Who's who)
- Who's doing what
- The Virtual Fruit Fly Library
- News and Events
- Links

The philosophy of this service is that you MEMBERS ARE THE MAIN DEVELOPERS OF THE DATABASE by adding/updating regularly your TWD data including your publications related to tephritid fruit flies. TWD welcomes your continuous contributions and receiving information about upcoming events, news, job offers, research opportunities for students, URL of fruit fly web site you know, and any good ideas you would like to share with other fruit fly workers. TWD welcomes you to use its services and looks forward to be of interest and use to your activities. The database will continue expanding to meet your expectation and we look forward receiving your feedbacks.

Two years since it has been launched, TWD has reached more than 560 members from 84 countries and contains over 900 publications.

How to Join

1. Already a member:

You are heartily invited to update your profile and particularly, ADD REFERENCES of your publications on fruit flies to help build the Virtual Tephritid Library. Just LOG IN and then click on UPDATE PUBLICATIONS. Let me know if you do not remember your username and password.

2 . New member:

You need to create your profile (5 min!).

- Enter www.tephritid.org
- Click on Membership — fill out the form, enter your ANY username and password, then submit. Remember to save your password and username in a safe folder.
- Return to the main page of TWD and click on Log in and enter your username and password.
- New forms will appear at the left hand frame. Fill out each form and submit.
- Congratulation! You became a TWD member. No more forms to fill out! Next time you would like to add/update your profile just LOG IN. Your profile will hold your current contact information, background and skill, activities, and PUBLICATIONS.

Prof. Abdel Jelil Bakri
Database administrator
A. Bakri [bakri@ucam.ac.ma], University Cadi Ayyad, Marrakech, Morocco)

Guest Article:

Improving the Biological Control of Leafminers (Diptera: Agromyzidae) Using the Sterile Insect Technique

Roy Kaspi and Michael P. Parrella

Department of Entomology, University of California, One Shields Avenue, Davis, CA 95616.

J. Econ. Entomol. 99(4): 1168-1175 (2006)

ABSTRACT The leafminer *Liriomyza trifolii* (Burgess) (Ditpera: Agromyzidae) is a worldwide pest of ornamental and vegetable crops. The most promising nonchemical approach for controlling *Liriomyza* leafminer in greenhouses is regular releases of the parasitoid *Diglyphus isaea* (Walker) (Hymenopetra: Eulophidae). In the current study, we examined the hypothesis that the use of *D. isaea* for biological control of leafminer in greenhouses crops may be more practical and efficient when supplemented with additional control strategies, suc as the sterile insect technique (SIT). In small cages, our SIT experiments suggest that release of sterile L. trifoli males in three sterile-to-fertile male ratios (3:1, 5:1, and 10:1) can significantly reduce the numbers of the pest offspring. In large cage experiments, when both parasitoids and sterile males were released weekly, the combined methods significantly reduced mine production and the adult leafminer population size. Moreover, a synergistic interaction effect between these two methods was found, and a model based on our observed data predicts that because of this effect, only the use of both methods can eradicate the pest population. Our study indicates that an integrated pest management approach that combines the augmentative release of the parasitoid *D. isaea* together with sterile leafminer males is more efficient than the use of either method alone. In addition, our results validate previous theoretical models and demonstrate synergistic control with releases of parasitoids and sterile insects.

KEY WORDS biological control, *Diglyphus isaea*, integrated pest management, sterile insect technique, synergistic interaction.

Announcements

E-Learning Courses Available on-line

Two e-learning courses are available at the FAO and IAEA web-site [http://elearning.iaea.org/]. These are:

- Dosimetry System for the SIT Using Gafchromic® Film
- Field-Cage Comparative Assessment of Tsetse Fly Mating Compatibility and Competitiveness

To enter a course you have not yet enrolled in log in with your name and password and go to 'Browse courses' on the top of the page. This opens a list of course categories. Choose the course you are interested in, click on 'enter course'. This will open the home page of the course.

To enrol in a course go to the home page of the course and select the 'Enroll me' button to the right of the course title. This will open a new page with another 'Enroll me' button. Click on this 'Enroll me' button. This will automatically add you to the course enrolment list, without the need for instructor approval.

Computer Based Training Package in Support of GIS (Geographic Information System).

The package includes a set of 'flash' presentations demonstrating use of the various software applications covering GPS (Trimble Pathfinder Office), GIS (ESRI Arcview) and database (MS Access). The examples shown during the presentations focus on pest control programmes. In addition a small set of sample data for trainee practice are included with the presentations.

A limited number of tutorial CDs is available at the Insect Pest Control Section. For more information, please contact: Udo Feldmann (U.Feldmann@iaea.org)

Alert! New Invasive Bactrocera Species in Africa: *Bactrocera latifrons*

After *B.invadens*, a new *Bactorocera* has been detected in East Africa (United Republic of Tanzania). Identification process (Marc De Meyer, Ian White) confirmed that this species correspond to the Solanum fruit fly, *Bactrocera latifrons*. This is an Oriental species (China, India, Laos, Malaysia, Pakistan, Sri Lanka, Taiwan (China), Thailand) but also with adventive populations in Hawaii. It attacks mainly solanaceous crops such as chilli, eggplant and tomato.

In May 2006, two female specimens were found in a protein bait trap in Morogoro, United Republic of Tanzania during a collaborative project of Marc De Meyer from Royal Museum for Central Africa in Belgium with Maulid Mwatawala of the Sokoine University of Agriculture (SUA). The protein bait trap was placed in a citrus tree, but eggplants (of the African species *Solanum aethiopica*) were grown close by.

There is still some uncertainty on the actual presence of the fly throughout the Morogoro region. Eggplants are normally not grown at the horticultural unit where the fly was found. The eggplants were brought in for research purposes. They were grown from seeds that were extracted from fruits bought at other places throughout the country. Whether those initial fruits that were brought to Morogoro were already infested, or whether there was already an established population of *B. latifrons* in Morogoro prior to the introduction of eggplants at this specific site, is not clear. Several samples of eggplants were collected (Maulid Mwatawala) from the sites of origin in order to check any emergence of B. latifron from the collected material.

With financial and technical support from IAEA and USDA a survey is being initiated in United Republic of Tanzania (SUA) and Kenya (ICIPE). *B. latifrons* seems to be more restricted in host range and it is not clear whether it will spread as fast as *B. invadens*, but it is better not to take any risk in order to avoid a continental dispersal as with *B. invadens*. Threfore, one of the immediate actions to be taken is this regional survey for this species. It is important to keep in mind in this respect that *B. latifrons* is not known to respond to any of the standard lures, used in fruit fly monitoring (neither methyl eugenol, nor cue lure is attracting this species), which makes surveying a completely different matter compared to *B. invadens*.

For more information, please contact:

Marc De Meyer (marc.de.meyer@africamuseum.be)

Bactrocera latifrons monitoring information provided by ARS-USDA, Hawaii:

Latilure (alpha ionol) + cade oil were used for survey of *B..latifrons*. However, latilure is not as good as an attractant as cuelure for *B. cucurbitae*, melolure or methyl eugenol *B. dorsalis*.

Latilure + cade oil are used with Jackson traps. However if the environment is hot and dusty, more frequent trap servicing or different traps should be used.

Supplier names and addresses of alpha ionol and cade oil as well as the pdf files of papers on *B. latifrons* detection can be obtained from ARS-USDA, Hawaii.

There has also been some work done on biocontrol of *B.latifrons* in Hawaii using *Fopius arisanus*.

For other technical information on *B. latifrons*, please also contact:

Grant T McQuate (gmcquate@pbarc.ars.usda.gov)
Eric Jang (ejang@pbarc.ars.usda.gov)

Anastrepha manizaliensis: a new fruit fly species in Colombia

In Colombia, a new species of fruit fly called *Anastrepha manizaliensis* (Diptera: Tephritidae) has recently been described. *A. manizaliensis* can breed on fruit of *Juglans neotropica* (Juglandaceae) which is the only known host plant, so far. It has been found in the Andean region of Colombia and specimens were collected from localities from middle elevations up to 2150 m altitude. This new species was previously confused with *Anastrepha ludens* leading to a few doubtful records of this species in Colombia. It is now considered that the currently known southern limit of *A. ludens* is western Panama and that it does not occur in Colombia.

Source: Norrbom AL, Korytkowski CA, Gonzalez F, Orduz B (2005) A new species of *Anastrepha* from Colombia related to Mexican fruit fly (Diptera: Tephritidae). *Revista Colombiana de Entomología* **31**(1), 67-70.

Workshop: Insect Diet & Rearing Technology Presented by Insect Diet and Rearing Research, LLC (submitted by Allen C. Cohen) April 2-6, 2007 in Raleigh, North Carolina, USA

Hands-on training on rearing techniques.

Insect Diet and Rearing Research, LLC (IDRR) www.insectdiets.com will offer its first workshop in Raleigh, North Carolina, USA, April 2-6, 2007. Led by Allen Cohen, the intensely hands-on workshop will be better than ever thanks to its new location at North Carolina State University Technology Incubator http://techincubator.ncsu.edu with all of its resources. The workshop will be an introduction to scientific rearing methods, the scope of rearing practice and research, and will present a transition from typically modestly equipped insectaries to state-of-the-art high bio-tech rearing science.

Workshop Features:

- The workshop goal to take rearing specialists from 'what is' to 'what CAN be' by providing a transition or link from the poorly equipped lab to high tech. Students learn to use some of the low/moderate-tech techniques to help them until they can make the transition to high-tech.
- New location for workshop has a comfortable conference room a few steps away from the new IDRR lab for hands-on student exploration and experimentation.
- Alan Bartlett will lecture and involve you in simulations to answer the question, 'Should we infuse new insects from the field to help our colony's genetic diversity?' He talks about many other aspects of domestication you may never have thought of.
- Dr. James Harper, insect pathologist and Department Head, Department of Entomology, NCSU, will give the lectures on pathology in the insectary.
- Students have a chance to use many instruments and materials *every day* throughout the workshop to fully explore and internalize what they are learning.
- Quality Control is taught using measurable, quantitative tests (microbial, environmental, etc.) to help you make *data-driven* decisions in the laboratory and insectary.
- We will visit technology rich labs including a state-of-the-art Insectary, the Food Science Department, a Forest Entomology analytical lab, Fluorescence microscopy, and Electron microscope.
- See how rheology and other aspects of food science apply to the development, improvement and quality control of insect diets.
- We give you techniques to take back to your workplace for immediate implementation.
- Students have an opportunity to problem-solve for their own individual situations.
- IDRR conducts cutting edge research on diet development, diet improvement and quality control. Participation in this workshop allows you to learn

about these cutting edge approaches & techniques.
- Get together in the evening at a near-by lake with trails and rental boats.

Comments from Students attending previous IDRR workshops:

- "I can't wait to get back to my insectary to use the things I've learned here."
- "This is my second time at the workshop and I learn more things each time. I can't wait 'til my lab manager lets me go again."
- "The microbiology work was really eye-opening. We're going to go back and change all kinds of things."
- "All the hands-on esperiences made the learning fun and it really made things stick in my mind."
- "I just got off the phone with the people back in my lab to tell them some of the things we just learned. I didn't want to wait until I get home; this is too good to wait!"
- "Your hospitality was the best."

Source: Insect Diet and Rearing Research, LLC

North Carolina State Address:
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New publication! Taxonomy of the Dacina (Diptera: Tephritidae) of Africa and the Middle East by I. M. White. African Entomology, Memoir No. 2, 2006.

There are over 4000 species of true fruit flies (Diptera: Tephritidae), of which about 100 are pests of commercialluy grown fruit. Most of those belong to a few large genera, including *Bactrocera* and *Dacus* (Dacinae: Dacini). This Memoir provides the first comprehensive taxonomic review and identification guide of the 192 African species of these two genera. An interactive CD-ROM is included, which provides over 1400 photographic images. The CD also includes a colourful non-specilist introduction to the group and its unsual biology, featuring the life-study photographs of Dr. Robert S. Copeland. The illustrations on the CD-ROM are outstanding. An extensive range of photographs of both gross morphology and specialized features helps to reduce the endless uncertainty that anyone who has tried to interpret a key experiences.
The innovative combination of printed copy and electronic images provides a unique reference work that will set the standards for similar future monographic revisions. The work is the culmination of many years of meticulous research by Dr. Ian M. White, one of the world's leading authorities on the dacine fruit flies.

Fruit Fly Pests of the World Posters — Available soon in Spanish and Portuguese

The two poster set - Fruit Fly Pests of the World 1 & 2 which was first produced in English in 2002 will soon be available in both Spanish and Portuguese languages. The Joint FAO/IAEA Programme have provided funding and technical input to assist the small Australian company, Scientific Advisory Services Pty Ltd to produce these posters.

There has previously been great interest in having a Spanish version available from a number of countries and a number of enquiries for a Portuguese version. Regina Sugayama and Walther Enkerlin kindly provided the Portuguese and Spanish translations for the poster text.

The 7th International Symposium of Fruit Flies of Economic Importance in Bahia Salvador, Brazil in September 2006, provided an opportunity for Scientific Advisory Services to display drafts of both versions at a trade display. Delegates were given an opportunity to review the drafts and comment on any corrections or changes required which resulted in great feedback and a number of changes to the text.

A number of new photographs of adult flies have been included on the new versions of the posters where better quality photographs have been obtained. *Bactrocera invadens* a species fast becoming important throughout Africa has been added to the posters which include 64 economically important species.

The two posters are intended to provide a pictorial guide to fruit fly pests for use by quarantine officials and to increase awareness among the travelling public of the potential risks of moving fruit pests in infested fruit. Information provided for each species includes a photograph of the adult (generally a live adult), lures used for monitoring purposes, major hosts and a map showing the world distribution.

Both posters should be available in early February 2007.

The posters can be obtained by contacting Scientific Advisory Services info@saspl.com.au.

Source: Richard Piper. Scientific Advisory Services PTY Ltd. Queensland, Australia.

In Memoriam

Donald E. (Don) Weidhaas

Donald E. (Don) Weidhaas was born in Northampton, Massachusetts on February 12, 1928. After growing up in Northampton, he lived in Gainesville, Florida for 36 years. He more recently was a resident of Murfreesboro, Tennessee, where he died August 20, 2006. He was preceded in death by infant son, David John Weidhaas, and he is survived by his wife, Helen Louise Mills Weidhaas; his daughter and son-in-law, Kathy and Scott Corlew, and their two children, Christopher James and David Andrew, of Murfreesboro; and his son and daughter-in-law, Jim and Amy (Blackwelder) Weidhaas and their two children, Mary Caroline and Joel Donald of St. Simons Island, Georgia. He also is survived by three nieces and two nephews, children of his brother, John Weidhaas, who, too, was an entomologist.

After starting college at Harvard, he served in the Army in Korea. He received his undergraduate degree in chemistry from the University of Massachusetts, and his Ph.D. from Cornell University in Entomology.

Don worked his entire career as a research Entomologist for the United States Department of Agriculture, serving the last twenty years as Director of the USDA Insects Affecting Man and Animals Research Laboratory in Gainesville, Florida. He served as an adjunct professor of Entomology at the University of Florida. Don authored or co-authored 140 scientific publications including one book and several book chapters. His work involved collaboration with the Department of Defense, the World Health Organization, U.S. AID, and the International Atomic Energy Agency. A staunch supporter of research on alternative methods of control, Don led a 20-year, multi-targeted team effort to determine the feasibility and practicality of the sterile insect technique for vector mosquito control.

This led to travel and work in various parts of the world on a variety of insect-transmitted diseases including the Onchocerciasis Control program, malaria, and others. He was part of the US scientific delegation to China in 1975, which opened Sino-American diplomatic relations for the first time since 1948. As Director of the Research Laboratory in Gainesville, he enthusiastically embraced computer technology in its infancy, coordinating the transition to computer usage and writing computer programs for insect modeling and other functions. After Don retired in 1984, he continued to work on the biannual FAO/IAEA Interregional Training Course, which brought together visiting professors and students from all over the world.

Don Weidhaas had a passion for life that was demonstrated in his love for his family, his church, and for his profession.

Source: Helen M. Weidhaas and Kathy Weidhaas Corlew.

List of Official IAEA Publications
Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture

Insect Pest Control Subprogramme

Title	Year	Type of Publication	Reference number (ISBN/ISSN)	Price (Euros)
EASTMED A Proposal for Medfly Control or Eradication with the Sterile Insect Technique	1995	Non-serial publication	STI/PUB/982	unpriced
Economic Evaluation of Damage Caused by, and Methods of Control of, the Mediterranean Fruit Fly in the Maghreb	1995	IAEA-TECDOC-830	ISSN 1011-4289	€15
Standardization of Medfly Trapping for use in Sterile Insect Technique Programmes	1996	IAEA-TECDOC-883	ISSN 1011-4289	€15
A Farewell to TSETSE	1996	Video Available in English PAL format in Cassette		unpriced
Evaluation of Genetically Altered Medflies for Use in Sterile Insect Technique Programmes	1997	Proceedings of Symposium	92-0-103897-6	€29
Control of the Mediterranean Fruit Fly in the Near East Region Using the Sterile Insect Technique	1997	Non-serial publication	STI/PUB/1020	unpriced
Genetic Engineering Technology for the Improvement of the Sterile Insect Technique	1998	IAEA-TECDOC-993	ISSN 1011-4289	€15
Development of Female Medfly Attractant Systems for Trapping and Sterility Assessment	1999	IAEA-TECDOC-1099	ISSN 1011-4289	€15
The South American Fruit Fly, *Anastrepha fraterculus* (Wied.), advances in Artificial Rearing, Taxonomic Status and Biological Studies	1999	IAEA-TECDOC-1064	ISSN 1011-4289	€15
Evaluation of Lepidoptera population suppression by radiation induced sterility	2002	IAEA-TECDOC-1283	ISSN 1011-4289	€15
Proceedings of an FAO/IAEA Research Coordination Project on Medfly Mating. Florida Entomologist. March 2002, Vol. 85, No. 1.	2002	Special issue in Scientific Journal	ISSN 0015-4040	unpriced
The Sterile Insect Technique An Environment-Friendly Method of Insect Pest Suppression and Eradication	2002	Video available in English, Spanish and French (NTSC and PAL format in Cassette and CD)		unpriced
Trapping Guideline for Area-Wide Fruit Fly Programmes	2003	Non-serial publication (English and Spanish versions)	IAEA/FAO-TG/FFP	unpriced
Improved Attractants for Enhancing Tsetse Fly Suppression	2003	IAEA-TECDOC-1064	ISBN 92-0-110403-0	€15

Title	Year	Type of Publication	ISBN/ISSN/reference number	Price (Euros)
Automation for Tsetse Mass Rearing for Use in Sterile Insect Technique Programmes	2003	IAEA-TECDOC-1353	ISBN 92-0-104303-1	€15
Biology, History, Threat, Surveillance, and Control of the Cactus Moth, *Cactoblastis cactorum*	2004	Non-serial publication	ISBN 92-0-108304-1	€30
The Cactus Moth, *Cactoblastis cactorum*: An Economic, Social and Ecological Threat	2005	Video Available in English NTSC format in Cassette and CD		unpriced
Environmental Benefits of Medfly SIT in Madeira and Their Inclusion in a Cost-benefit Analysis	2005	IAEA-TEC-DOC-1475	ISBN 92-0-110505-3	€15
Status and Risk Assessment of the Use of Transgenic Arthropods in Plant Protection	2006	IAEA-TEC-DOC-1483	ISBN 92-0-113005-8	€15
Designing and Implementing a Geographical Information System. A Guide for Managers of Area-wide Pest Management Programmes.	2006	Non-serial publication Printed by the IAEA		unpriced

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