

# Insect and Pest Control Newsletter



JOINT FAO/IAEA DIVISION OF NUCLEAR TECHNIQUES IN FOOD AND AGRICULTURE  
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

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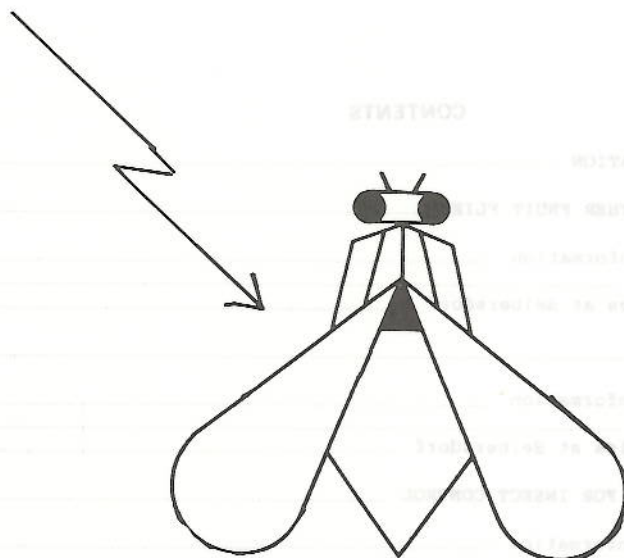
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# Insect and Pest Control Newsletter

## LOGO CONTEST

THE SECTION IS LOOKING FOR AN APPROPRIATE LOGO, ONE THAT DEPICTS INSECTS AND RADIATION. THE DRAWING MUST BE SIMPLE FOR EASY REPRODUCTION. AN EXAMPLE IS SHOWN BELOW.

ANY OF YOU WHO HAVE AN IDEA FOR A LOGO ARE ENCOURAGED TO SUBMIT A DRAWING TO THE SECTION. ONE DRAWING PER PERSON. THE WINNER WILL BE SELECTED BY THE STAFF OF THE SECTION AND WILL RECEIVE A PRIZE OF US\$ 50.00. THE CONTEST CLOSSES 30 JUNE 1989.



## I. GENERAL INFORMATION

### The New Look

This is the first issue of our "new look" Newsletter. As some of you know, the Newsletter/Information Circular was published in the previous format for more than 20 years with only minor changes. The Insect & Pest Control Section was one of the first to have a Newsletter; all six sections of the Joint FAO/IAEA Division now have newsletters.

### Name Change

Our Division has a new name: "Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture". The previous name was long and cumbersome. After considerable discussion between FAO and IAEA, the new name was selected.

### The Staff

Our staff, including both those in the Joint Division located in the Vienna International Centre and those in the IAEA's Seibersdorf Laboratory, are listed below with their nationality and the year they started working in Vienna. A few words describing their activities are included:

#### Name

#### Duties

#### Joint FAO/IAEA Division

Björn Sigurbjörnsson, Director  
L. LaChance, Deputy Director

#### Insect & Pest Control Section

D.A. Lindquist, (USA, 1980)	Section Head, fruit flies
A. Van der Vloedt (Belgium, 1974)	Tsetse Flies
B. Butt (USA, 1988)	F-1 sterility

#### Seibersdorf Laboratory

R. Gingrich (USA, 1980)	Head, Entomology Unit, microbiology
U. Feldmann (FRG, 1988)	Head, tsetse programme, tsetse mass-rearing
N. Lambremont (USA, 1988)	Sabbatical, tsetse biochemistry
R. Anouchinsky (Italy, 1987)	IAEA Jr. Prof. Off., tsetse isozymes
M. Vreysen (Belgium, 1987)	FAO Assoc. Prof. Off., tsetse mass-rearing
A. Economopoulos, (Greece 1985)	Head, medfly programme, medfly mass-rearing
E. Busch-Petersen, (Denmark, 1982)	Medfly genetic sexing
P. Kerremans (Belgium, 1987)	FAO Assoc. Prof. Off., medfly genetics.

B. Butt joined the IPCS staff in September on a one-year cost-free appointment from the USA. Bill retired as Director of the USDA Appalachian Fruit Research Station in Kearneysville, West Virginia in August. His assignment is the F-1 sterility programme and related activities.



N. Lambremont, Director of the Nuclear Sciences Centre at Louisiana State University, Louisiana, USA, is on a one-year sabbatical and working at Seibersdorf. He is studying the lipid composition of tsetse flies with the objective to find differences that may be used for separating the sexes in the pupal stage.

R. Anouchinsky, an IAEA Junior Professional Officer, is determining the role of heme in diets of the tsetse fly and developing immunological procedures for measuring the amount of albumin in the gut of tsetse flies and thereby the amount of blood ingested.

M. Vreysen, an FAO Associate Professional Officer, is determining methods and equipment for shipping puparia long distances. He is also studying the hybridization of tsetse fly sub-species with the objective to increase the efficiency of the SIT in areas where sub-species overlap.

P. Kerremans, an FAO Associate Professional Officer, is working on the cytogenetics of the medfly. He is developing methods for chromosome staining and banding and is constructing polytene chromosome maps.

FAO Associate Professional Officers' or IAEA Junior Professional Officers' positions are funded by the individual's home governments. The intention is that new university graduates work in an international atmosphere, gain experience and then will be better prepared to work in the UN or other international organizations. We are fortunate to be able to have a few of these young people at our Seibersdorf facility.

#### Evans Offori

This is an interview with Evans D. Offori, former staff member of the Insect & Pest Control Section of the Joint FAO/IAEA Division. Evans left the Section in July 1988 after almost 8 years service to join the Africa Section of the Division of Technical Co-operation and Assistance (TCAC). The interviewer is Bill Butt of the Insect & Pest Control Section.

Bill Butt (BB): When did you first come to the IAEA?

Evans D. Offori (EDO): My first tour was in 1971. I was a member of the entomology research team in the IAEA's Seibersdorf Laboratory. The main assignment was to develop techniques for mass-rearing insects of economic importance in developing countries.

BB: What did you accomplish at Seibersdorf?

EDO: First, I made a lot of friends among the staff. Scientifically, I would say that my main achievement consisted of contributing to the development of tsetse mass-rearing using mainly host animals-guinea-pigs, rabbits and goats. I also suggested the idea of using pig blood rather than cattle or horse blood for the artificial feeding of *Glossina morsitans*. As you are aware, this species prefers wild pigs to other mammals as source of food in the wild.

BB: Why did you leave the IAEA in 1974?

EDO: Simple, I had a 2-year contract in 1971. When the contract was renewed for another 2 years my employers in Ghana would not hear of it. So we bargained, and settled for a compromise of three instead of a total of 4 years. Why did I leave? Because I wanted to return to my Institute.

BB: What did you do when you returned to Ghana?

EDO: I returned to the Ghana Animal Research Institute as a research scientist. Unfortunately, before I could settle down to do any meaningful research, I was appointed the Institute's Director. I say unfortunate because I am sure you know what that kind of promotion does to one in terms of productive research, especially in a developing country. I have to admit however that it was a challenging job being in charge of an institute of some 400 employees including 23 research scientists.

BB: When did you return to the IAEA and why?

EDO: I came back in 1980 - originally to spend two years on sabbatical leave. Then, circumstances changed all round, and I stayed on a little longer. I am now in my 9th year. I should be heading back home shortly; this time not to return. I promise!

BB: What did you do during your second tour, that is, until you joined TCAC?

EDO: The job description contained something like this: "To assist the Section Head in executing the Section's programme and to undertake any other duties assigned by the Director". Well, there were quite a few duties and assignments, but let me just say that we ran a successful programme in a busy Section. With several field projects and co-ordinated research programmes, there was more than enough to keep busy for the 8 years that I was in the Insect & Pest Control Section.

BB: What was of most interest to you in the Section's programme?

EDO: BICOT (tsetse eradication project in Nigeria) was, without doubt, the one closest to my heart. However, I am pleased that the first phase was successfully concluded while I was still a member of the team.

BB: Would you like to comment on the entomology programme?

EDO: It is a good programme. The policy of concentrating efforts on only a few insect pests is a good one and should be maintained. I believe also that activities should always include one major field project in Africa. Finally, although it is necessary to keep abreast with modern developments in pest control, the Section's activities in the area of genetic engineering research for example, should be minimal. To be of real interest to developing countries in Africa, the entomology programme should aim to maximize practical insect control techniques such as the SIT.

BB: What do you do in TCAC?

EDO: I have responsibility for technical co-operation (TC) projects in 7 African countries. The job involves advising these countries in identifying meaningful projects for development, and assisting them in designing implementation strategies. Another way of putting it is that I am project manager for IAEA-supported projects in those countries, relying heavily on the advice and expertise of IAEA technical officers.

BB: What do you see as the IAEA's role in Africa?

EDO: The IAEA should not "wait" for requests from African countries for assistance, but should get involved in the initial stages of identifying the actual needs of individual countries. Secondly, the IAEA should resist the temptation of "being nice" to every country and all countries, irrespective of whether they have the infrastructure and are ready to undertake nuclear related research and development activities. In my view, the first priority is for the IAEA to assist African countries in training high caliber personnel.



**BB:** How do you feel about employment by the IAEA?

**EDO:** The employment conditions are good, inspite of the numerous complaints by some staff. The IAEA has a job to do, and I believe that the best talents should be employed from whatever source and country.

**BB:** Would you like to say anything to your friends receiving this Newsletter?

**EDO:** Yes. Remember my appeal in Newsletter No. 41 to contribute abstracts and articles for publication in the Newsletter? The appeal still stands. Make the Newsletter a more beneficial by contributing high quality material for publication and giving it a wide readership.

#### WHAT WE WANT FROM YOU

To make this Newsletter "News", we need your input. Please send us information on your SIT and genetic control programmes including plans and opportunities. We would also like each of you to send us slides, video tapes, reports or publications on your research. We would also welcome important citations or brief write-ups on action SIT programmes such as the two in this Newsletter.

As has been noted in the previous one or two issues of our Newsletter, the number of summaries of research activities has been declining. We will continue to reproduce the submission as long as they are a sufficient number to warrant doing so. However, if the number continues to decline we will stop including these in the Newsletter. Thus, it is up to you, our readers, to decide whether or not we continue to reproduce summaries of on-going research. We are enclosing the standard form for submission of your contribution. Please use a separate form for each contribution and type your name and address, in capital letters, in the upper left block. The text should be no longer than one side of the standard form and double-spaced. We are unable to edit submitted contributions. The abstracts in this issue should not be published or referred to in articles for publication without first obtaining permission from the authors. Direct contributions and request for information to:

D.A. Lindquist  
Head, Insect & Pest Control Section  
Joint FAO/IAEA Division  
P.O. Box 100  
A-1400 Vienna  
AUSTRIA

#### The Programme

The overall programme of the Section, including Seibersdorf is divided into 3 project areas: tsetse fly, medfly and newer methods of control which include F-1 sterility. We have active R&D programmes at Seibersdorf on tsetse fly and medfly. The limitation of space and resources prevent us from F-1 sterility R&D at Seibersdorf.

Currently the Section has the following Co-ordinated Research Programmes:

1. "Laboratory and Field Evaluation of Genetically Altered Medflies for Use in Sterile Insect Technique Programmes".
2. "Standardization of Medfly Trapping for Use in Sterile Insect Technique Programmes".

3. "Development of Practices for Area-Wide Tsetse Eradication or Control with Emphasis on the Sterile Insect Technique".
4. "Radiation-Induced F-1 Sterility in Lepidoptera for Area-Wide Control".
5. "Genetic Engineering Technology for the Improvement of the Sterile Technique".

A training course "Use of Isotopes in Entomology" is planned for 1990 in Gainesville, Florida, USA".

## II. MEDFLIES AND OTHER FRUIT FLIES

### A. General Information

The Mediterranean fruit fly (medfly) continues to occupy a significant amount of time for both the Seibersdorf Laboratory and the IPCS staff. The eradication of this pest by the SIT continues to be high-priority in a number of countries. In addition, countries with the medfly as well as other fruit fly species are starting to develop technologies to manage their fruit fly problems. Quarantine restrictions of fruit and vegetables because of fruit fly presence in the exporting country continue to cause very serious problems with developing major export markets. The loss of ethylene dibromide (EDB) because of toxicological problems has been a serious setback to exporting many agricultural commodities into certain major markets. Thus, it is anticipated that the elimination of the medfly and possibly other species of fruit flies will continue to be of high priority for many developing countries. In addition to medfly SIT programmes, there is a major SIT programme to eliminate the melon fly from Okinawa in Japan, an active programme using the SIT to prevent the Mexican fruit fly from emigrating from Mexico into the USA and a facility has just been completed in Gainesville, Florida, to mass-rear the Caribbean fruit fly with the intent of demonstrating the efficacy of the SIT against that pest. There is also considerable activity to look at the feasibility of using the SIT for eradication of various Anastrepha species.

At the request of the governments of Morocco, Algeria and Tunisia, the IAEA sent a two-men mission to review the medfly situation in those countries and to determine whether it is realistic to consider eradication of the pest from all three countries. The project, if it is funded, would be regional. The advantage of considering medfly eradication in North Africa is that it is the only fruit fly species attacking the vast majority of their fruits and vegetables. Thus, with the removal of the medfly, production costs drop very significantly and the potential for export is greatly improved or if export is already a major activity, such as in Morocco, the reduced production costs improve the competitiveness of the crop in the international market. Two consultants, Drs. T. Buyckx (Belgium) and G. Vita (Italy) spent about 6 weeks reviewing the situation in the 3 countries. Their report strongly recommends a preliminary phase to determine the distribution of the fly within each country, host distribution, economic analysis of losses and costs of control, and preliminary work on the SIT.



We were fortunate to have the services of Mr. J. Hendrichs (Mexico) to assist us in conducting cage tests of the mating competitiveness of the genetic sexing strain developed at Seibersdorf. This strain, based on pupal colour (male pupae are brown and female pupae are white), was developed by E. Busch-Petersen and is now being mass-reared (1 to 2 million per week) at Seibersdorf. Hendrichs spent about 10 days sitting in a cage at Seibersdorf observing the mating competitiveness of this genetic sexing strain in comparison with wild flies which had been brought from Greece. The results of these tests indicated that the genetic sexing strain is comparable to other mass-reared medfly strains. Field tests of the longevity and movement of this strain will be initiated on the Italian island of Pantelleria and in Greece in the spring. If funds can be found, a control test probably will be conducted in a small isolated fruit producing area in Israel during 1989. Work is continuing on the development of a genetic sexing strain in which the females can be killed in the egg or neonate larval stage and thus save rearing cost. However, until that strain is available we will use the pupal colour strain in limited field studies.

#### Our Man in Guatemala: Technology Transfer

Dominico (Niki) Bruzzone, our man in Guatemala, started at the IAEA Laboratory in Seibersdorf in 1984 as an FAO Associate Professional Officer. Niki was assigned to the medfly project in Entomology Unit at Seibersdorf and became interested in the possibility of recycling medfly larval diet. Previous work at Seibersdorf has demonstrated that the medfly larvae used very little of the nutrient ingredients of the diet; however attempts to recycle the diet were unsuccessful. At the same time there was work at the laboratory to determine whether a starter diet could be developed and whether it would result in better quality flies while at the same time using less space in a mass-rearing facility. The starter diet would be contained in very small trays and transferred to large trays containing a finishing diet after 48 to 72 hours. The work was successful and the starter diet was developed. Subsequent research demonstrated that a modest reduction in nutrient ingredients in the finishing diet did not adversely affect the final product, thus saving considerable money in medfly mass-rearing. Niki combined the use of the medfly starter diet with the idea of recycling the medfly larval diet and found that it would work very well. A test indicated that the technology could be readily transferred to large mass-rearing facilities. Niki was posted to Tapachula, Mexico in 1986 to initiate this technology. After considerable experimental work using a medfly larval diet which was very different from the one used at Seibersdorf, he demonstrated that the starter diet plus recycled diet could be used in Tapachula, Mexico. He was subsequently transferred to Guatemala to do the same job and is making very rapid progress. The diet used in Guatemala is quite similar to the one used at Seibersdorf so the transfer of technology is easier.

The managers of the Moscamed programme in Guatemala have estimated that the use of diet recycling in their facility will save about US \$ 20,- per million medflies reared. Targeted medfly production in Guatemala is about 400 million per week which would be a saving of \$ 400,000 per year. Similar savings would be realized if diet recycling is implemented in Tapachula, Mexico. This is an example of rapid development and transfer of technology to action programmes. We, are proud of Niki's work on diet recycling and his success in technology transfer.



## B. Meetings

### 1. Past

The final Research Co-ordination Meeting on the programme "Development of Sexing Mechanisms in Fruit Flies Through Manipulation of Radiation-Induced Conditional Lethals and Other Genetic Measures" was held in Colymbari, Crete, Greece, 4-7 September 1988. This meeting concluded five years of a co-ordinated programme on the genetics and genetic sexing of the Mediterranean fruit fly. We anticipate that the papers presented at this meeting will be published by the IAEA. As a result of the medfly genetic sexing programme. Very significant advances have been made in medfly genetics during the past several years, including:

- a. An extensive genetic linkage map of mutants and biochemical markers.
- b. Standards for cytogenetic studies that include maps of polytene chromosomes from both salivary gland and tritogene cells and descriptions of mitotic and mitotic chromosomes.
- c. Critical information on sex determination and sex distortion phenomena.
- d. Increased understanding of medfly origin and migration through population genetic analysis.
- e. Genetic sexing strains based on pupal colour mutants, null alleles of alcohol dehydrogenase and null mutants of xanthine dehydrogenase.
- f. Laboratory and field evaluations of several candidate pupal colour strains, including mass-production.
- g. Accumulation of basic information on recombinant DNA techniques that will be valuable in future work on genetic sexing through the manipulation of genes.

The group also strongly recommended that the medfly genetic sexing programme be continued and expanded by the IAEA.

### 2. Future

The International Medfly Working Group (IMWG) was started in 1982 by the Ministries of Agriculture of Guatemala, Mexico and the USA. Since the first meeting, representation of other countries have taken part in the meetings. The IMWG brings together managers of medfly eradication or control programmes and research scientists working on the medfly. The objective of the meeting is for managers of action programmes to identify major problems that they encounter so that the research scientists will know which problems they should be working on to assist in improving control or eradication of this pest.

At the initial meeting a list of priority of researchable topics was identified. The list has been slightly modified during the next several meetings and a major modification will take place at the 6th meeting in late February in Sao Paulo, Brazil. D.A. Lindquist is chairman of this meeting and the results will be briefly described

in the next issue of the Newsletter. A second International Working Group, dealing with Anastrepha species, had its first meeting in 1987 and will have its second meeting the same week and location as the medfly meeting.

There will also be a seminar "The Sterile Insect Technique for Fruit Fly Control or Eradication in Latin America", 17 - 21 April 1989 in Guatemala City, Guatemala. A Research Co-ordination Meeting on "Standardization of Medfly Trapping for Use in Sterile Insect Technique Programmes", will be held 8 - 12 May 1989 in Madrid, Spain.

### 3. Training Courses

The FAO/IAEA Regional Training Course on "the Sterile Insect Technique for Fruit Fly Control or Eradication" will be held from 27 March - 14 April 1989 in Guatemala City, Guatemala.

### C. Fruit Flies at Seibersdorf

A genetic sexing strain of the medfly based on dimorphic puparia is currently being studied under large scale mass-rearing and selection procedures. After 7 generations, the percentage females emerging from brown (male) pupae remained very low, while adult emergence and flight ability (as measured in the laboratory) improved. Egg production, percent egg hatch and pupal recovery from hatched eggs were considerably lower than those of previous normal strains reared at Seibersdorf. The mating behaviour of adults of the sexing strain was studied under natural light in large cages in a greenhouse. Also, several hundred thousands pupae were shipped to Greece and Italy for release to study dispersal and survival in the field.

Currently, another medfly strain, which carries a translocation linking Adh null mutation to the Y chromosome of males, is also being evaluated under mass-rearing conditions (strain kindly provided by the Dept. of Physiology of I.N.I.A., Madrid). The females of this strain can be selectively killed by allyl alcohol.

The time required for wild flies (both sexes) or wild males crossed with laboratory females to adapt to mass-rearing conditions is currently being studied. When both sexes are colonized for strain renewal, it takes 3 - 4 generations before high egg production-collection and survival of immature stages is achieved. The present experiments study the effect on egg collection and immature stages survival as well as adult quality when only wild males are introduced for partial strain renewal.

Male recombination between the Y-translocated loci or (orange eye) and wp (white pupae) has been studied in a genetic sexing strain of the medfly containing the T101 male-linked translocation. The strain normally produced wild type males while the females are homzygous for the or and wp alleles. Previous mass-rearing of a strain containing the same translocation showed this strain to be highly unstable. In the present study an overall male recombination frequency of 0.07% and 0.24% was observed between the or gene and the translocation breakpoint (T) and between wp and T, respectively. The or+ allele, but not the wp+ allele, appeared to be physically linked to the Y chromosome. All aberrant male phenotypes contained the translocation, thus indicating that no reversal to the normal karyotype had taken place. A strong positive interference on recombination was observed, a recombinant event



between T and wp leading in 1/3 of the cases to a recombinant event occurring also between T and or. Male recombination appeared to be responsible for the initiation of the breakdown of the mass-reared genetic sexing strain, but this could not account for the subsequent rate of breakdown. The role of other factors in accelerating the rate of this breakdown is now being investigated.

The induction and isolation of temperature-sensitive lethal (tsl) factors has been continued. More than 50 tsl factors have been induced but all proved unviable. Analysis of the data revealed a very high frequency of non-ts lethal factors. The presence of these latter lethal factors appears to have been responsible for the non-ts lethality observed in the tsl families. Induction of tsl is being continued with a dose of EMS equivalent to 10% of that previously used.

Strains of Bacillus thuringiensis isolated from soils in many countries produced spores and/or exotoxins that were pathogenic for adult medflies. Irradiation of some isolates has created mutants with altered pathogenicity but none with active endotoxins. Efforts are continuing to increase the virulence of existing strains and to induce mutants with desirable novel characteristics.

### III. TSETSE-FLIES

#### A. General Information

##### 1. Co-ordinated Research Programme

As referred to in the July 1988 issue of the Newsletter, the fourth Co-ordinated Research Programme (CRP) on tsetse flies (1984-88) entitled "Development of Methodologies for the Application of the Sterile Insect Technique for Tsetse Eradication or Control" was successfully concluded with the final research Co-ordination Meeting held in Vom, Nigeria, 6-10 June 1988. Original papers presented at the RCM have been assembled and Dr. I. Maudlin from the Tsetse Research Laboratory, Bristol paid a visit to the Section's office in August and assisted in editing the manuscripts, which will be published during 1989 as an IAEA priced document.

Meanwhile IPCS staff, in close collaboration with the Joint FAO/IAEA Divisional Office and the Contracts Administration Section did the groundwork for preparing a follow-up CRP entitled "Development of Practices for Area-Wide Tsetse Eradication or Control With Emphasis on the Sterile Insect Technique". Its main focus will be the refinement of existing methodologies, as well as the development of laboratory and field practices that would enhance the practicality of the SIT approach and increase efficacy of operations on a regional rather than individual country basis. Individual project proposals have been received from a number of qualified and enthusiastic scientists, and will form the backbone of the new CRP.

##### 2. Technical Co-operation and Assistance Programme

Several tsetse fly projects are currently operational under the IAEA's TCAC programme and we hope to initiate a few more during 1989. Most of the TC projects have both tsetse rearing and ecology



components relevant to future use of SIT in pilot project areas. The status of these projects can be summarized as follows:

#### Ghana (GHA/5/011)

This project, evolved from a technical assistance request submitted to IAEA in 1981 by the Department of Biology, Food and Agriculture of the Ghana Atomic Energy Commission. Fortunately it is becoming more and more a collaborative venture of the National Nuclear Research Institute (Legon, Accra), the Animal Research Institute (Achimota, Accra) and the Department of Veterinary Services with its Tsetse Control Unit at Pong Tamale. Adequate facilities for in-vitro mass-rearing riverine tsetse species have been established and routine monitoring of the tsetse distribution and the prevalence of trypanosomiasis in cattle in selected areas in northern Ghana is in progress. During 1989, tsetse colonies at the Accra facilities will be expanded. With the assistance of a short-term IAEA expert, ecological studies and tsetse monitoring will be intensified and a strategy developed for the combined use of insecticide-impregnated screens and release of sterile males around the Wa area (Upper West Region). It is anticipated that the project will also make use of tsetse puparia produced at and distributed from CRTA, Bobo Dioulasso, Burkina Faso. The planned tsetse activities along the Black Volta, will be part of the preparatory phase of an integrated campaign aimed at lifting constraints to agricultural production and enhancing improved land use and farming practices in Northwest Ghana.

The future of project GHA/5/011 lies in the hands of following scientific staff: at Pong Tamale (DVS): C. Doku, M. Mahama; at Achimota (ARI): D. Dankwa, J. Okine; at Kwabenya (GAEC): D. Adabie, J. Stiles (presently on a special course at Salford, UK), C. Boheene.

#### Tanzania (URT/5/007)

This IAEA TC project, approved in 1984, is supporting the efforts of the Tanzania Livestock Research Organization (TALIRO) and the Department of Livestock Development on Zanzibar and is directed towards eradication of the tsetse fly Glossina austeni from Unguja island. Baseline data on cattle trypanosomiasis have been collected under the FAO Livestock Development Project. More recently under FAO TCP/URT/6758, detailed entomological/parasitological surveys were conducted and the combined use of sequential deltamethrin pour-ons and trypanocidal drug treatment to cattle was monitored in the western part of the island. Simultaneously, field work in the south-eastern part of the island has been in progress. The work, which is guided by an IAEA consultant (L.C. Madubunyi, on 1-year expert assignment), focuses on improvement of current survey and monitoring techniques for detection of low density fly populations. Moreover, based on available information, a release strategy will be developed using male flies produced at the Tsetse and Trypanosomiasis Research Institute in Tanga.

It is expected that the combined efforts of FAO, IAEA and the national livestock services will lead to the development of integrated management practices for the control of trypanosomiasis and, eventually, the elimination of the tsetse fly from Zanzibar, thereby improving local livestock and milk production.

Amongst the key staff involved in on-going operations are: H.S. Hafidh, I.S. Khamis, K.M. Saleh (Livestock Development Department) and M. Gao, F. Makishe, P.C. Chuwa, W. Kitwika (Tanga). All of them have attended FAO and/or IAEA training courses.

#### Zambia (ZAM/5/009)

Under this TC project, studies are in progress on the feasibility of SIT for controlling/eradicating *G. morsitans* species in some infested areas of Zambia. Since 1983 and through assistance from the Agency, existing facilities at the Livestock and Pest Control Centre, Chilanga, were converted into rearing rooms for tsetse. The team, after the usual initial difficulties, has successfully introduced and adapted the *in vitro* (membrane) feeding system and is currently maintaining a thriving colony of *G. m. morsitans*. Further progress will depend on an improved infrastructure and additional manpower.

The field team of the National Council for Scientific Research, assisted by staff of the Department of Veterinary and Tsetse Control Services, has initiated ecological/entomological work in the Keembe area of the Central Province, about 200 km north-west of Lusaka.

Technical responsibility for activities under ZAM/5/009 is in hands of F. Simwanza (rearing) and J. Nondo (field).

#### Uganda (UGA/5/012)

Under this TC project, initiated in 1988, the Tsetse Control Department (Ministries of Animal Industries and Fisheries) in Kampala is receiving IAEA assistance to assess the tsetse and trypanosomiasis situation on the Buvuma islands and in lakeshore areas of south-eastern Uganda. During the first phase of the project, work will focus on collection of ecological, entomological and parasitological data that will permit the elaboration of an effective integrated control programme with an SIT component. IAEA staff, government authorities and relevant technical personnel have discussed plans for the infrastructure, material and project requirements and a work plan for the implementation of the project, including rearing of the important tsetse species at Makerere University and UTRO, Tororo. T.N. Kangwaye and L.M. Ogwal are the primary contact persons.

#### Zimbabwe ZIM/5/004

The project entitled "Tsetse Fly Movement and Behaviour" was initiated during 1988 and is executed by the Tsetse and Trypanosomiasis Control Branch. Activities are primarily directed towards using radioisotopes in mark-release-recapture studies with the objective of monitoring tsetse population dynamics and energetics under changing environmental conditions. It is expected that these investigations will contribute to efforts aimed at eradicating tsetse flies by means of odour-baited and insecticide-impregnated targets. J. Hargrove is charged with the execution of this TC project. During 1989 the isotope portion will receive short-term services from an IAEA expert.

#### Continuation of the Nigerian BICOT Project

The success of BICOT, i.e. the eradication of *G. p. palpalis* from a 1,500 sq. km area in the sub-humid zone, resulted in the Nigerian



Government requesting BICOT II, a much larger project, which will include approximately 12,000 sq.km. of the Plateau State Agricultural Development Project and the adjacent area of Benue State. This proposed BICOT II project was included in the 5th Nigerian National Development Plan (1988-1992), but unfortunately external funding from donor countries has not yet materialized. Recognizing the need for maintaining the existing project infrastructure and quarantine operations to protect the BICOT I area from re-invasion of tsetse flies from adjoining areas and to eradicate a second species (*G. tachinoides*) which still exists in low densities and constitutes a threat to full development of the area, the Nigerian Government and IAEA have agreed to implement a "bridging" project in anticipation of the large-scale campaign against tsetse in the originally proposed BICOT II area. In this respect, a 3-year project proposal has been prepared. This project has been proposed as a footnote "A" project for 1989-1990 in the IAEA technical assistance programme. It is expected that the project will result in a tsetse free area near Lafia which will be safe for livestock production and other agricultural activities. At present, tsetse fly mass-rearing, field surveillance and barrier maintenance with insecticide-impregnated screens are continuing at BICOT.

#### Zaire

A pre-project assistance mission to Zaire undertaken by a Joint FAO/IAEA staff member (A. Van der Vloedt) in March 1987, resulted in the formulation of a footnote "A" project. The project "Eradication of Tsetse Flies" was approved in 1988 but is not yet funded. Meanwhile, the IAEA has encouraged the authorities of the Centre Regional d'Etudes Nucléaires (CREN-Kinshasa) and the Institut de Médecine Tropicale, Université de Kinshasa to co-ordinate their efforts with the management of the Bureau Central de la Trypanosomiose and prepare a tentative work plan and schedule activities, including training. This will enable future implementation of a multidisciplinary campaign against tsetse and trypanosomiasis in the region of Bas Zaire where tsetse population suppression by means of Lancien traps is in progress or in a well-defined area in the region of Bandundu.

#### Ethiopia

The June 1988 tsetse SIT project formulation mission which went to south-western Ethiopia included representatives from Italy (A. Scirocchi), FAO (B. Hursey), IAEA (A. Van der Vloedt) and Ethiopia (I. Hussein, A. Eneyew). A project proposal for the control of trypanosomiasis in the Tana-Beles area through tsetse eradication by the combined use of SIT, insecticide-impregnated targets and treated animals has been prepared and submitted for external funding.

#### B. Meetings

##### 1. Past

The Joint Meeting of the FAO Panel of Experts on Ecological/Technical and Development Aspects of the Programme for the Control of African Animal Trypanosomiasis and Related Development, and the Fifth Session of the FAO Commission on African Animal Trypanosomiasis met from 7 through 11 November 1988, in Accra,



Ghana. A. Van der Vloedt represented the Joint FAO/IAEA Division and the IPCS at both meetings.

The Panel of Experts focused on visual and olfactory attractive devices, environmental aspects related to their use, insecticide-treated animals, SIT, insecticide spraying, protection of cleared areas, monitoring of control operations, socio-economic considerations, including costs and involvement of local human populations in tsetse control campaigns, planning and implementation of integrated control and area development programmes and research and training needs.

Comprehensive technical contributions on the above topics were made by tsetse control experts from Benin, Burkina Faso, Cameroon, Ivory Coast, Mali, Niger, Congo, Ethiopia, Somalia, Kenya, Uganda, Tanzania, Zimbabwe, Zambia, specialized institutes in Europe (UK, Belgium, France) and from the international organizations (FAO, WHO, and IAEA). Van der Vloedt presented data on basic and operational aspects of SIT campaigns for tsetse eradication with special reference to BICOT, Nigeria.

This well-organized meeting offered excellent opportunities for in-depth discussions on integrated tsetse control and resulted in very sound recommendations. Based on cost considerations, it was recommended that SIT programmes be considered on a regional basis through the establishment of centres for mass-rearing of required species in support of various on-going operations. This recommendation was strongly endorsed by the representatives of the West African countries who expressed interest in using sterile flies produced at the CRTA, Bobo Dioulasso, Burkina Faso, for use in their country's tsetse control programme.

The 5th Session of the FAO Commission on Animal Trypanosomiasis was attended by representatives from 21 African countries and 8 international organizations and specialized research centres. The working sessions of the Commission focused on the review of the report "Evaluation of the FAO Programme on the Control of African Animal Trypanosomiasis and Related Development" (prepared by Prof. Mortelmans and Dr. Gyening). Recent activities were reviewed, including co-ordination, training, research and field programmes, as implemented by FAO Member States and by the international organizations/centres. The Joint FAO/IAEA Division's recent and planned activities were outlined and special reference was made to co-ordinated research programmes, training and technical backstopping within the IAEA's TCAC tsetse-related projects.

## **2. Future**

The 20th Meeting of the International Scientific Council for Trypanosomiasis Research and Control will meet 10 - 14 April 1989 in Mombasa, Kenya.

## **3. Training Courses**

The seventh Organization of African Unity's (OAU) International Training Seminar on African Trypanosomiasis will be held 3 - 14 April 1989 in Mombasa, Kenya.

#### C. Tsetse Flies at Seibersdorf

The influence of various simulated temperatures and relative humidities during transport of Glossina palpalis palpalis puparia on the quality of adults was investigated. Low relative humidity (35%), or high temperature (27-31°C) during the first third of the pupal period reduced the ability of males to inseminate females.

First results of hybridization experiments and competitiveness tests show that under laboratory conditions G. p. palpalis and G.p. gambiensis mate randomly. Morphological differences among hybrids, particularly in the external reproductive apparatus, are being investigated.

To date there is no means for sex identification of Glossina in the pupal stage. Tests are underway to investigate possible correlations between the specific gravity of third instar larvae, resulting puparia, pupation time and the sex of adult Glossina spp.

There are also investigations to determine if physiological characters such as lipid composition can be used to distinguish between females mated with sterile and with normal males.

A flight mill has been developed as an additional tool for evaluating the quality of laboratory-reared tsetse flies. Efforts are directed on standardizing the test method particularly to determine the effects of various handling procedures on the flight ability of mass-produced sterile Glossina spp. males.

#### IV. NEW TECHNIQUES FOR INSECT CONTROL

##### A. General Information

The Co-ordinated Research Programme "Radiation-Induced F-1 Sterility in Lepidoptera for Area-Wide Control" has been reviewed. In the future the programme will be focused on one insect, the diamondback moth, Plutella xylostella. This insect has world-wide distribution and is a major pest in many countries where it has developed resistance to most pesticides.

Molecular biology and genetic engineering are becoming common-place in entomological research. New biotechnology will be integrated into existing programmes as practical techniques develop.

There is an interest in studying insect dispersal and migration using isotopes and neutron activation analysis.

##### B. Meetings

A Research Co-ordination Meeting on "Radiation-Induced F-1 Sterility in Lepidoptera for Area-Wide Control" will be held 22 - 26 May 1989 in Beijing, PRC and the Research Co-ordination Meeting on Genetic Engineering for "the Improvement of the Sterile Insect Technique" in September-October 1989, Vienna, Austria.



### C. Developments at Seibersdorf

There are plans to establish a Molecular Biology Unit at Seibersdorf. The unit would initially consist of one professional and 1 or 2 supporting staff who would serve the entire agricultural laboratory.

## V. SPECIAL REPORTS

### Status of the Melon Fly, (*Dacus Cucurbitae*) Eradication Programmes in Okinawa, Japan

Hiroyuki Kuba and Hiroyuki Kakinohana  
Okinawa Prefectural Fruit Fly Eradication Project Office,  
123 Maji, Naha, 902 Japan.

In Japan, there are two economically important fruit flies, the oriental fruit fly, *Dacus dorsalis*, and the melon fly, *D. cucurbitae*. The oriental fruit fly has been eradicated by the male annihilation method using methyl eugenol in the South-Western Islands (Koyama et al., 1984) or by the sterile insect technique (SIT) in the Ogasawara Islands. We also have been conducting an eradication programme of the melon fly in the South-Western Islands using SIT since 1972. Following the eradication on Kume Island in 1976 (Iwahashi, 1977), we also eradicated this species on Amami and Miyako Islands in 1986. We are now releasing large numbers of sterile flies on Okinawa Islands. This report is on the present status of the melon fly eradication project in Okinawa Islands and a brief discussion of the past successful eradication of the melon fly in Okinawa Prefecture.

The melon fly was first discovered in the Yaeyama islands in 1919, and 10 years later, it was found in the Miyako Islands. In 1970, it was discovered on Kume Island, and spread to the Okinawa Islands in 1972. On Kume Island, an experimental melon fly eradication project was started in 1972 using SIT (Iwahashi, 1977). Following a successful eradication on Kume Island, the eradication project for all of Okinawa Prefecture was initiated in 1979.

We have constructed the melon fly mass-rearing facility in Naha City capable of rearing about 200 million pupae per week. Sterile fly releases by helicopter were begun in the Miyako Islands in August 1984 and in the Okinawa Islands in November 1986.

#### Miyako Project

The population suppression of melon flies by lure-toxicant (cue-lure and naled) was conducted from December 1983 to October 1984. The release of sterile flies started in September 1984 at the rate of 30 million pupae per week. During the first year, the number of wild flies was not reduced. One possible reason for the inefficiency of the SIT was a shortage of sterile flies in some areas; therefore we conducted additional releases of sterile flies in these areas. After that, the number of wild male flies decreased remarkably and from February to July 1987 no wild flies were trapped. However, from July to October 1987 and in March 1988, a few wild male flies were caught by traps. These were considered to be introduced from another infested area because no



infested fruit had been found in the Miyako Islands since November 1987 in spite of large number of fruits inspected. There were no significant changes on the percentage infestation of host fruits until April 1986. After early summer of 1986, the infestation level decreased drastically and since November 1986 no infested fruits have been found. In November 1987, the eradication of the melon fly from the Miyako Islands was declared.

The outline of the eradication progress with SIT on the Miyako Islands is as follows; the spatial distribution of the wild flies is considered to be heterogenous. At first, we used the male annihilation technique with lure-toxicant for male population suppression. Lure-toxicant was distributed uniformly on the Miyako Islands. It is assumed that lure-toxicant reduces the wild flies population independent of density.

In the next stage, we started SIT. Sterile flies were released uniformly, but they did not distribute evenly because released sterile flies could move to the favourable environment as well as the wild flies. However, the releases were insufficient to suppress the reproduction of wild flies in certain areas. In these areas host plants were abundant and distributed continuously in both time and space; therefore, densities of wild flies were high. We call these areas "hot spots".

After releasing more sterile flies in hot spots, the ratio of sterile to wild flies caught by traps in these areas increased and infestation levels of host fruits decreased remarkably.

Finally, the ratio of sterile to wild melon flies caught by traps increased dramatically, and eradication is achieved on the Miyako Islands.

#### Okinawa Project

The Okinawa Islands project was started in November 1986. We divided the Okinawa Island into three blocks, southern, central and northern for strategic reasons. In the southern and central parts of Okinawa Island, the host plants for the melon fly are abundant, and the density of the wild fly was high. Thus, we have been distributing more than 60 million sterile flies per week in these areas. As the number of sterile flies increases the number of wild flies gradually decreases. Now ratio of sterile to wild flies caught by traps is beyond 1,000.

The northern part of Okinawa Island is a mountainous area, in which host plants are scarce and distribution of the wild melon flies were restricted to coastal areas. We started the SIT programmes in the area in March 1987 with 60 million sterile flies per week. Even though the density of released sterile flies are lower than the other areas, the SIT programme is going well and the density of the wild flies is now very low.

Hopefully eradication will be attained in the near future. Next year we will start the last eradication programme for the remaining areas of Okinawa Prefecture (Yaeyama Islands).

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## PINK BOLLWORM POPULATION SUPPRESSION WITH STERILE MOTH RELEASES

T. J. Henneberry

USDA-ARS-Western Cotton Research Laboratory  
Phoenix, AZ 85040, USA

### Brief History of the Pink Bollworm in the United States<sup>1/</sup>

The pink bollworm, *Pectinophora gossypiella* (Saunders), was first detected in the United States in Texas cotton in 1917. The source of infestation was traced to cottonseed shipped in 1916 from Mexico to Texas oil mills. The infestations were apparently eliminated by the use of cotton-free zones and extensive cleanup measures, as was an infestation discovered in Louisiana in 1919. The insect has persisted along the Mexican border adjacent to west Texas since 1918. In 1936, pink bollworm infestations, probably from windborne moths, occurred again the lower Rio Grande Valley of Texas and adjacent Mexico, eventually spreading to the rest of Texas, New Mexico, Oklahoma, and sections of Arizona, Arkansas, and Louisiana by the mid-1950's.

The first pink bollworm infestations in eastern Arizona were reported in 1926. The insect has persisted there since that time. At periodic intervals thereafter, infestations occurred in other parts of the State and were suppressed through cooperative Federal, State, and industry programs. These activities were terminated after the 1963 cotton harvest. Pink bollworm infestations were next found in California in the Imperial Valley in 1965. Spread was rapid throughout southern California and severe losses occurred by 1967. Infestations were detected in the high desert areas of Los Angeles and San Bernardino Counties in that year, and four moths and six larvae were found in the San Joaquin Valley near Bakersfield. Varying numbers of native moths have been trapped each year since 1967. A cooperative Federal, State, and cotton Industry-sponsored sterile pink bollworm release program was initiated in 1968, to prevent establishment of the pink bollworm in the area.

### Pink Bollworm Sterile Moth Releases to Prevent Establishment in Uninfested Areas as a Method of Insect Control

The concept of sterile insect release was first suggested by Knipling (1959) in 1937. It was successfully demonstrated as an effective technique for insect population suppression with the screwworm, *Cochliomyia homnivorax* (Coquerel), fly in 1955 (Baumhover et al. 1955).

Research with pink bollworm revealed that newly emerged moths exposed to 25 krad of gamma radiation or more and crossed with untreated insects produced no fertile adult progeny (Graham et al. 1972). Sterile moth releases (15-40 krad) in field cages with untreated insects reduced developing pink bollworm populations 72 to 91 percent over two generations (Richmond and Graham 1970, 1971). Results of similar field cage studies (Bariola et al. 1973a, Flint et al. 1974, 1975) also indicated that the method promise as a pink bollworm control technique.

Development of a pink bollworm artificial diet (Vanderzant and Reiser 1956) and mass rearing technology (Richmond and Ignoffo 1964) have led to a specialized use of the pink bollworm sterile release method in the

<sup>1/</sup> From unpublished Animal Plant Health Inspection Service reports.



uninfested San Joaquin Valley of California, where more than 400,000 ha of cotton are grown annually (USDA 1977). Moths are reared and irradiated at the Animal and Plant Health Inspection Service, Phoenix, Arizona, then shipped by air to the San Joaquin Valley, California. Releases have been made by air in areas ranging from 6,000 to 145,000 ha of cotton, where native moths were trapped or larvae found in bolls. The purpose of the releases is to provide a barrier zone of sterile insects to prevent reproduction of migrating native moths from infested areas.

Releases of sterile pink bollworm moths have been made during the cotton growing seasons in the noninfested area each year since 1968. Cotton fields are monitored beginning early in the growing season using gossypure-baited traps to detect native moths. Native male moths have been trapped in the valley each year of the program except 1968, and larvae found in bolls in each of 5 years. Further, overwintering pink bollworm larvae have survived and emerged in the spring in the Bakersfield area of the San Joaquin Valley (Bartlett and Staten, unpublished data)<sup>2/</sup>. Thus, based on indirect evidence that the insect has not become established, it appears the releases of sterile moths that maintain average sterile-to-native ratios of more than 200:1 (Knipling 1978) throughout the season have prevented the establishment of the insect.

Recently gossypure behavioral control technology has been integrated into the program. Pheromone applications are made when traps indicate low sterile release ratios, captures of unusually large numbers of native moths or larval infestations are found<sup>3/</sup>. Cotton plant destruction and crop plowdown to maintain a 90-day host free period is also a vital part of the program.

#### Potential for Suppression of Established Pink Bollworm Populations

Several field studies with releases of sterile pink bollworm moths to evaluate this method for suppressing established populations were unsuccessful (Bariola et al. 1973a, Graham 1978). This was attributed to the effect of lack of isolation from migrating native pink bollworm populations into the experimental areas and high native populations. Consequently, it was difficult to obtain ratios of sterile-to-native insects sufficient to achieve population suppression.

Pink bollworm moths were sterilized by exposure to 20 krad of gamma radiation in a Co<sup>60</sup> irradiator at the pink bollworm rearing facility of the Animal and Plant Health Inspection Service, Phoenix, AZ. Air shipments of 50,000 to 100,000 sterile moths were initiated 4 days weekly on December 28, 1980, from Phoenix to St. Croix, U.S. Virgin Islands (a relatively isolated location), and continued through March 31, 1982. Releases of sterile pink bollworm moths were made on 216 days from December 29, 1980 to April 1, 1982, and averaged about 100,000 per release day (Henneberry and Keaveny 1985).

<sup>2/</sup> A. C. Bartlett, Research Geneticist, USDA-ARS, Western Cotton  
R. T. Staten, Methods Development, Animal Plant Health Inspection  
Service, Phoenix, AZ.

<sup>3/</sup> Len Foote 1988, California State Department of Agriculture, Sacramento, Ca. "Pink bollworm program in the San Joaquin Valley, California". Unpublished report from the International Pest Work Committee, Puerto Vallarta, Mexico, November 10, 1988.



Prior (Jan. 1 to Dec. 28, 1980) to the initiation of the large-scale releases of sterile pink bollworm moths in cotton plots, larval infestations in bolls averaged about one larva per boll from January through July 1980, increased to over seven in August, and decreased to 1.5 in December 1980. Ratios of released sterile male to St. Croix male moths in gossypure-baited traps averaged about 1:1 during January to April 1981, and releases had no effect on larval infestations. Reductions of larval infestations in bolls began when ratios of released sterile male to St. Croix male moths averaged about 70:1. Numbers of larvae per boll decreased from 1.2 in May to 0.3 in August. Infestations increased and ranged from 1 to 2.9 larvae per boll during September 1981 to March 1982, when ratios of released sterile male to St. Croix male moths in gossypure-baited traps averaged 20:1. When releases of sterile moths were terminated on April 1, 1982, the pink bollworm larvae per boll increased from 1 to 3.7 over a 58-day period during April to late May 1982.

Several sampling techniques were used to demonstrate that released sterile moths were noncompetitive with native males in obtaining native female partners. However, when ratios of released sterile moths to native insects were high enough to overcome this disadvantage, larval infestations in bolls were reduced.

Assuming other management technologies can be effectively integrated into a systematic effort to suppress pink bollworm populations to low numbers and the quality of released sterile insects can be improved, the sterile-release system may be considered a viable component of a total management system in the future.

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#### C. Abstracts Received

FRANZ HENTZE  
PROGRAMA MOSCAMED GUATEMALA  
6a. Calle 1-36, Zona 10  
Edificio Valsari, Oficina 203  
Guatemala, Guatemala, C. A. 01010

TRAPPING EFFICIENCY OF Ceratitis capitata W. UNDER DIFFERENT CLIMATIC CONDITIONS IN GUATEMALA.

Considering the influence of climatic factors on the behavior and activity of the Medfly in the field, a survey was made in 72,000 hectares of coffee, located southwest of Guatemala, to evaluate the Jackson trap efficiency by means of successive sterile insect aerial releases during one year. Efficiency was measure as percentaje of fly capture per trap of the total releases under different climatic conditions recorded in the field.

Highly significant correlation was determined between capture efficiency and temperature, and significant between capture efficiency and humidity. However, between capture efficiency and precipitation, the correlation was relatively low.



It is possible to transform data of fly per trap to fly per hectare, using the multiple regression equation, if we know the temperature and relative humidity and supposing a trap influence area of an hectare. This transformation of lies per trap to absolute population will allow the development of a more effective and precise sterile insect release strategy, to reach Medfly eradication.

The equation which determines the attractiveness and capture of Jackson traps baited with Trimedlure efficiency is as follows:

$$\text{Flies/Hectare} = \frac{(100)(\text{No. Flies/Trap/Week})}{0.09523(T) - 0.001867(HR) - 2.11}$$

T = Average weekly of Temperature °C

HR = Average weekly of relative humidity in %

A. K. Burditt, Jr.<sup>1</sup> and F. P. Hungate<sup>2</sup>

<sup>1</sup> Yakima Agricultural Research Laboratory  
USDA-ARS, Yakima, WA 98902, USA

<sup>2</sup> Pacific Northwest Laboratory  
Richland, WA 99352, USA

Gamma Irradiation as a Quarantine Treatment  
for Cherries Infested by Western Cherry  
Fruit Fly (Diptera: Tephritidae)

J. Econ. Entomol. 81(3): 859-862 (1988)

#### Abstract

Western cherry fruit fly (WCFF), *Rhagoletis indifferens* Curran, infests cherries in the northwestern United States. Exposure of naturally infested fruit to doses from 42 to 210 Gy reduced pupation and only one adult emerged (at 127 Gy). In a second test in which fruit were exposed to from 4.4 to 106 Gy, no adults emerged following irradiation of field-infested fruit at  $\geq 17.6$  Gy. When  $> 124,000$  naturally infested cherries were exposed to 97 Gy, gamma irradiation was an efficacious quarantine treatment. No normal adults and only one abnormal adult with vestigial wings emerged from a treated population of an estimated 84,369 WCFF larvae. This research demonstrated that irradiation would be a potential quarantine treatment for WCFF larvae in cherries. Parasites, *Pachycrepoideus vindemiae* (Rondani), emerged from many of the untreated puparia but not from those WCFF irradiated as larvae.

R. L. ROEHRDANZ and D. A. JOHNSON

BIOSCIENCES RESEARCH LABORATORY  
USDA/ARS, STATE UNIVERSITY STATION,  
FARGO, NORTH DAKOTA 58105

MITOCHONDRIAL DNA VARIATION AMONG GEOGRAPHICAL  
POPULATIONS OF THE SCREWORM FLY, *COCHLIOMYIA*  
*HOMINIVORAX*.

J. MED. ENTOMOL. 25(2): 136-141 (1988)

Levels of mitochondrial DNA (mtDNA) sequence divergence among different geographic populations of the primary screwworm fly, *Cochliomyia hominivorax*, were compared. Six different lines originating from the United States, Mexico, or Jamaica were analyzed using 15 different restriction endonucleases. The fraction of fragments in common (F) between pairs ranged from 0.69 to 0.98 ( $\bar{F} = 0.87$ ), while the estimated nucleotide sequence divergence (p) ranged from 0.1 to 2.7% ( $\bar{p} = 1.1\%$ ). The greatest differences observed were between the Jamaican line and the mainland lines ( $\bar{p} = 2.5\%$ ).

A. K. Burditt, Jr.<sup>1</sup> and F. P. Hungate<sup>2</sup>

<sup>1</sup> Yakima Agricultural Research Laboratory  
USDA-ARS, Yakima, WA 98902, USA

<sup>2</sup> Pacific Northwest Laboratory  
Richland, WA 99352, USA

Gamma Irradiation as a Quarantine Treatment  
for Apples Infested by Codling Moths  
(Lepidoptera: Tortricidae)

(Submitted to J. Econ. Entomol.)

#### Abstract

Codling moth (CM), *Cydia pomonella* (L.), larvae reared on thinning apples were exposed to gamma radiation at incremental doses up to 138 Gy. Adult emergence was reduced and the number of larvae that did not develop into adults increased as dose increased. At a dose of 39.2 Gy emergence of normal adults from irradiated younger larvae (first through third instars) was reduced and emergence of physically deformed adults increased. At higher doses, there was a further reduction in adult emergence, a significant increase in the ratio of male to female emergence and a reduction in overall survival of larvae. Similar results were obtained for older larvae (third through fifth instars), except that the doses required for comparable effects were 10 to 25% higher than those for younger larvae. These data predict that doses of 372 Gy would prevent first through third instars from maturing and forming cocoons. However, probit analysis showed that a dose of 187 Gy, or less, gave quarantine security based on preventing adult emergence from fruit infested by larvae. When an estimated 79,540 nondiapausing immature larvae infesting thinning apples were exposed to approximately 153 Gy only 15,501 formed cocoons. Of these, 256 pupated but none emerged as adults.

L. E. LACHANCE and GENEVA OLSTAD

BIOSCIENCES RESEARCH LABORATORY  
USDA/ARS, STATE UNIVERSITY STATION  
FARGO, NORTH DAKOTA 58105

SPERMIOGENESIS OF EUPYRENE SPERM IN PREPUPAE,  
PUPAE, AND ADULTS OF *HELIOTHIS VIRESCENS*  
(LEPIDOPTERA: NOCTUIDAE): AN ULTRASTRUCTURAL STUDY.

ANN. ENTOMOL. SOC. AM. 81(2): 292-300. (1988)

We have examined the ultrastructure of postmeiotic eupyrene sperm maturation in testes of prepupae, pupae, and adult *Heliothis virescens* (F.) males. Emphasis was placed on the structures present in the elongating sperm tail. In each young spermatid, each cell has a nucleus, acrosome derivative, and numerous mitochondria in a large volume of cytoplasm. These mitochondria coalesce to form a body, the nebenkern. As the sperm cell begins to elongate, the nebenkern divides into two mitochondrial derivatives (MDs) of unequal size. The MDs have an outer and inner membrane, and as they elongate and coil in the sperm tail, cristae develop on the inner membrane. Concurrent with cell elongation is the disappearance of most of the cytoplasm present in the cell. The axial filament has a typical insect system of 9 + 9 + 2 tubules and is present along most of the length of the sperm tail as are the MDs. A prominent system of tubules, the manchette, forms around the MDs in a later stage of development. Two extracellular structures, the satellite body and the radial mantle, also undergo a complex series of changes during the maturation of the sperm cell.



L. E. LACHANCE and GENEVA OLSTAD  
BIOSCIENCES RESEARCH LABORATORY  
USDA/ARS, STATE UNIVERSITY STATION,  
FARGO, NORTH DAKOTA 58105

SPERMIOGENESIS OF HELIOTHIS VIRESCENS (LEPIDOPTERA:  
NOCTUIDAE): AN ULTRASTRUCTURE STUDY OF EUPYRENE  
SPERM IN STERILE BACKCROSS MALES.  
ANN. ENTOMOL. SOC. AM. 81(2): 301-307 (1988)

Sterile backcross (BC) males originate from the hybridization of Heliothis subflexa (Guennee) females to H. virescens (F.) males followed by recurrent backcrossing of the fertile female progeny to H. virescens males. Ultrastructural transmission electron microscope (TEM) studies of the postmeiotic maturation of eupyrene sperm cells in BC males, and comparisons with the cells in normal H. virescens males, show that the early stages in cell differentiation and maturation are similar in BC and normal H. virescens males. In 3- or 5-d-old pupae, some of the BC spermatids contain large vacuoles in the cytoplasm or in the mitochondrial derivatives (MDs). Also, the MDs are greatly enlarged at certain levels in the sperm tail and appear normal in other sections. Other structures in the maturing sperm cell, such as the axial filament, cell membranes, manchette system, satellite bodies, and cristae, maintain normal morphology. In more mature eupyrene sperm bundles, it appears that cell membranes often rupture and some of the cells fuse to form abnormal structures with multiple axial filaments and malformed MDs. In any given section we commonly observe some cells with gross abnormalities of the MDs and neighboring cells in the section that are normal. As maturation of the eupyrene sperm bundle continues, the abnormalities become much more severe. In adult BC males, some cells appear normal in some sections. However, in other sections it is difficult to recognize any normal eupyrene sperm cells, and there is generalized breakdown of many cells in the sperm bundle.

A.J. TAMHANKAR and G.W. RAHAIKAR  
Pest Control Section,  
Bhabha Atomic Research Centre,  
Trombay, Bombay-400 085  
India

Host influenced reproductive behaviour  
of the female spiny bollworm Earias  
insulana.

Calling and mating behavior of females of Earias insulana  
Boisduval (Lepidoptera: Noctuidae) was studied in the presence and  
absence of okra fruit under a 14 L:10 D photoperiod. Data on  
oviposition and egg production was also recorded. Absence of host

had an adverse influence on all aspects of calling behaviour of a virgin female. Under this situation female longevity was also significantly more and there was reduced egg production as well as oviposition. Multiple mating was common in the presence of host and females with higher mating frequency laid more eggs. Once-mated females called again with a calling duration similar to that of virgin females. This fact and a significantly reduced fecundity of once-mated females compared to multimated females indicated that multiple matings were essential for the realisation of the full reproductive potential. Analysis of the data on both virgin and mated females indicated that egg production potential influenced the calling and mating behaviour of a female.

A.J. TAMHANKAR, K.K. GOTH and  
G.W. RAHAIKAR  
Pest Control Section  
Bhabha Atomic Research Centre  
Trombay, Bombay-400 085  
India.

Responsiveness of Earias vittella  
and Earias insulana males to their  
conspecific female sex pheromone.

Influence of age, sex pheromone concentration and mating status on the response of Earias vittella and Earias insulana males to conspecific female sex pheromone was studied using a 'T' shaped olfactometer. Males of both the species showed age related variation in their response to female sex pheromone and 4 day old males were maximally responsive. Response of males of both the species to the female sex pheromone was concentration dependant and the level of response generally increased with an increase in pheromone concentration. In E. vittella, response of mated males was comparable with unmated males. In E. insulana, mating caused some reduction in the response of males.



Low dosages of gamma radiation affected the development of immature stages of the bean weevil, Acanthoscelides obtectus Say. When beans infested with eggs were irradiated with 0.09 kGy or higher doses after 1-3 weeks post-infestation, no adults emerged. No emergence was also noted when beans were given a dose of 0.35 kGy at the 4th week after infestation. Thus, this dosage is considered to be lethal for all larvae and pupae. At lower dosages, some immatures completed their development. A dose of 0.26 kGy and lower dosages did not prevent full development of the older stages (last instars and pupae) to adults, but killed the young larvae.

Radiosensitivity of the bean weevils decreased during their development, and adults seemed to be the most resistant stage for gamma radiation, especially if the dose for killing was the basis for comparison. Longevity of treated beetles varied inversely with the radiation dosage. Irradiation of bean weevils with 0.26, 0.53, 0.79, or 1.06 kGy caused 100% mortality of adults after 19, 14, 12 and 9 days, respectively. A dosage as high as 2.23 kGy did not cause immediate death in the treated insects; 100% mortality occurred after 3 days. However, adults of the bean weevil seem to be more sensitive to irradiation than adults of Callosobruchus analis (Fabr.), a related species.

Of all stored product pests, the bruchids (Bruchidae) appear to be the most sensitive to sterilizing action of ionizing radiation. When young adults of both sexes were irradiated with a dose of 0.06 kGy or higher, no eggs hatched. A 0.06 kGy dose was the sterilizing dosage of gamma radiation for the bean weevil, because at lower dosages females produced some viable eggs (e.g., at 0.04 kGy there were about 5% of viable eggs). Various sterilizing doses for the bean weevil have been determined by different investigators. This considerable variation in results on sensitivity of the bean weevil to ionizing radiation seems to be caused by many factors, including age, sex, strains, food, temperature, humidity, type of radiation, dose rate, and dosimetry. Anyway, most investigators agree that males and females of the bean weevil irradiated with a 0.1 kGy under prevalent conditions would be sterile.

Irradiation of beans infested by the bean weevil at 0.1 kGy could be the treatment required to produce an acceptable level of quarantine security. At this dosage, adult survivors of the pest will be present in the treated beans but they will not give rise to offspring.

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M. BERATLIEF  
Research Institute for  
Plant Protection  
Bucharest, Romania

Argon laser irradiation effects on  
some parameters of Tribolium castaneum Hbst. biology

#### Abstract

Laser irradiation applied to T. castaneum adults was able to influence some parameters of reproductive biology in this species.

Mortality of adults was not affected by any dose level.

For doses ranging between 0.15 and 1.39 J/cm<sup>2</sup> emergence dynamics of progenies was not altered, duration for 50% emergence being 32 days, equal to that of check. A dose of 9.24 J/cm<sup>2</sup> induced increase of duration by 3 days.

The first 2 doses ( 0.15 and 0.46 J/cm<sup>2</sup> ) stimulated significantly fecundity in terms of higher rate of F<sub>1</sub> progeny population increase (18.27 and 17.83, respectively, over 12.70 in check). The highest dose applied ( 9.24 J/cm<sup>2</sup> ) lessened definitely fecundity, the rate of population increase dropping to 6.05, this treatment showing, presumably, a substerilizing effect.

Data obtained enabled calculation of equation of regression line between dose and rate of population increase.

These preliminary results allowed choosing a laser radiation dose domain inducing either complete sterilization or causing substerilization, with eventual genetic consequences on subsequent progeny generations.

The experiment is going on with checking in practice these doses, also having in view biochemical and genetic influences induced, and long-term effects of radiation.

M. Khalequzzaman and Mahbub Hasan  
Department of Zoology  
Rajshahi University  
Rajshahi, Bangladesh.

Effect of gamma-radiation  
on the different ages  
larvae of Tribolium anaphe  
Hinton.

The effect of gamma-radiation (1, 2, 4 and 6 Kr) were assessed on the different ages viz. 1, 8 and 14- day old larvae of Tribolium anaphe. 14-day old larvae was more resistant to all levels of treatments than that of 1 and 8 day old. The larval, pupal and adults weight were



drastically reduced at 4 and 6 krad in all the age groups. The growth indices of T. anaphe on various age groups were in the order: control) 1 Kr ) 2 Kr ) 4 Kr ) 6 Kr.

None of the doses could prevent pupation and adult emergence except at 6 Kr in 1- day old larvae but the frequency of deformed individuals increased as the dose increased. Lengthened larval and pupal periods were observed at higher doses (4 & 6 Kr) in all age groups. Gamma-radiation had no significant (P > 0.05) effects on the sex-ratios of T. anaphe.

Egg production and percentage of hatching gradually decreased with the increase in dose but at 6 Kr no egg laid by the female in all the age groups.

A.K.Garg, Parvathy Bhatia and  
G.R.Sethi, Nuclear Research  
Laboratory, Indian Agricultural  
Research Institute, New Delhi-12  
(INDIA)

Metabolism of Methyl Parathion  
in Desert Locust, Schistocerca  
gregaria Forskal

Knowledge of the anticholinesterase activity of organophosphorus insecticides alone is not a reliable guide to toxicity of an insecticide, because it is affected by other phenomena, which include entry of the poison into the insect system and its metabolism to compounds of greater toxicity. Slow penetration of insecticide through cuticle has been found, on several occasions, to be the possible cause of resistance. Results of our earlier studies indicated a biphasic pattern of penetration of <sup>14</sup>C-labelled methyl parathion when the insecticide was applied topically to the desert locust, Schistocerca gregaria Forskal. From toxicological point of view, excretion is only pharmacokinetically significant and it contributes to the elimination of the parent compound and its metabolites. Work on the rate of excretion of methyl parathion by the desert locust has already been reported by the present workers.

The study was further extended to evaluate the metabolic fate of the insecticide in the desert locust when the radioactive methyl parathion was applied topically or by feeding or by injection (@ 1.11 µg methyl parathion in 5 µl acetone per insect). Results revealed that major portion of the radioactivity (30% to 60%) was excreted in polar (non toxic) form. It was further noted that though there was not much difference in the amount of polar metabolites recovered from ethyl acetate extract (14% to 20%) in the three treatments, it varied considerably in the aqueous phase (topical: 10.2%; feeding: 21.8% and injection: 43.8%). Similarly, there was no significant variation in the amount of methyl parathion (1.0% to 2.8%) and its non polar metabolites (1% to 5%) recovered in ethyl acetate extract from the three treatments. Since no significant differences were observed in the excretion of methyl parathion and its toxic metabolites in the three methods tested, it can be assumed that the gut offers a barrier for the build up of higher concentration of the insecticide in desert locust. Further, the excretion of comparatively more hydrophilic polar metabolites in injection followed by feeding experiments indicated that most active site of methyl parathion degradation in the desert locust is the haemolymph.

Gradually reduced at 4 and 6 hr in all the age groups. The growth indices of *T. angustatus* on various age groups were in the order: control > 1 hr > 2 hr > 4 hr > 6 hr.

None of the doses could prevent pupation and adult emergence except at 6 hr in 1-day old larvae but the frequency of deformed individuals increased as the dose increased. Prolonged larval and pupal periods were observed at higher doses (4 & 6 hr) in all age groups. Dose-response had no significant ( $P > 0.05$ ) effects on the sex-ratio of *T. angustatus*.

Egg production and percentage of hatching gradually decreased with the increase in dose but at 6 hr no egg laid by the female in all the age groups.

A.K. Gupta, Purnima Bhatia and  
D.R. Jaiswal, Nuclear Research  
Laboratory, Indian Agricultural  
Research Institute, New Delhi-11  
(INDIA)

281 I 8922 1E

MR B.A. BUTT  
RIFA  
A-2215

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