Helping eradicate the medfly from Mexico

by G. LaBrecque*

The Mediterranean fruit-fly (medfly) is one of the more serious pests of agriculture. Its distribution is practically world-wide; the insect has been recorded in Asia, Australia, Africa, South, Central and North America, in addition to the Mediterranean basin and many Atlantic and Pacific islands. It attacks over 200 food plants, mainly fruits, and severely damages the agricultural economy of many countries. As the medfly continues to expand its geographic distribution, more fruit-producing areas throughout the world are threatened. The economic progress of many developing tropical and sub-tropical nations is hindered because these countries cannot start up valuable commercial fruit orchards where the medfly occurs or is a threat. Thus, the fly limits the potential for improving trade balances, hard currency reserves, and food supplies.

The medfly was first detected on the North and Central American continents in Florida, USA, in 1929. It was eradicated by 1930 and did not reappear until 1955 in Costa Rica, where it became established. It subsequently spread to Nicaragua by 1960 and Panama by 1963. Although its presence was suspected in El Salvador as early as 1973, it was not observed there until 1975. By this time it had advanced through Guatemala, and by January 1977 had penetrated into southern Mexico, where it was found in the Soconusco zone of the state of Chiapas, which borders on Guatemala. The Governments of Mexico and Guatemala immediately realized the gravity of the problem.

According to estimates by the Mexican Government, if the medfly became established in Mexico about US $500 million in export income would be lost annually. These losses would be sustained since the principal importers would not accept medfly-infested produce for fear that the pest might be introduced and established in their countries. Furthermore, an additional loss of US $300 million was projected due to loss of produce intended for national consumption.

What is the damage done by medflies?

The medfly causes damage primarily in its larval or maggot stage. Shortly after insemination, the female seeks a fruit or vegetable host on which to deposit its eggs. Finding a suitable host, the fly inserts its ovipositor (a syringe-like apparatus to transfer eggs) underneath the skin of the host. Within a few days (the normal incubation period is two days), the egg hatches and the larva begins to feed. This is the stage that causes rotting of the fruit. The larva will undergo three successive moults in 7 or 8 days, increasing its size at each moult. It will then migrate to the surface and leave the host to crawl into debris or earth, where metamorphosis into the pupa occurs. This quiescent stage will last 7 to 9 days, after which the adult will emerge, find its way to the surface, mate, and initiate another cycle or generation. The female lays about 125 to 300 eggs in her lifetime, which averages one month in the field. The actual adult life-span is largely dependent upon ecological conditions. Despite the fact that under optimal environmental conditions only 10 to 15% of all immature larvae survive to become the next adult generation, it is evident that by a simple increase in numbers, 1000 females could produce over 1 million progeny within three generations. Assuming a 30 km migration per generation, the agriculatural production of about 30 000 km^2 can be infested in 100 days.

Insecticides have been the principal method of controlling the medfly. However, public distrust of wide-scale insecticide programmes, excessive costs, hazard to the ecosystem, and the need for developing countries to pay for imported insecticide in hard currency have resulted in frequent opposition to this control method.

The Sterile Insect Technique (SIT) has been widely investigated as a principal component in Integrated Pest Management programmes and found to be ideal. The technique is environmentally acceptable, species-specific, readily adaptable to area-wide control schemes against low-density populations, and comparable in cost and efficiency to conventional techniques. Its successful application is a matter of tactics where surveillance, weather, and interaction of both pest and host within an ecosystem all play important roles. The size of the pest population that can be tolerated, pest population dynamics, and measurements of the influence of additional natural or introduced control measures are also critical parameters to be considered.

A SIT Project is not merely a matter of rearing, sterilizing, and releasing large numbers of insects into an infested environment. Although specific in approach, it can be readily transferred to a developing country

* Mr LaBrecque is Head, Insect and Pest Control Section, in the Joint FAO/IAEA Division of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development.

Some of the 76 ovipositional cages, each holding 700 000 medflies and producing about 60 million eggs a day.

having some technological expertise. More important than technology however, is the will and motivation to develop and implement such a project. This spirit was abundantly evident in the Mexican staff, as shown below.

The Moscamed project in Mexico

When the medfly was detected in the Mexican state of Chiapas, a fruit-fly preventative programme initially conceived in 1972 was reactivated. This programme was reinforced by the experience gained in Guatemala by the joint Mexican-Guatemalan commission set up in 1975. By the latter half of 1977, both governments had decided to co-operate in an integrated pest-management programme to eradicate the pest from their countries. The programme would use the SIT supplemented by insecticidal baits, quarantine, trapping, and fruit sampling. The plan was realized under the aegis of the Directorate General of Plant Health, Ministry of Agriculture and Water Resources of the Government of Mexico; the Animal and Plant Health Inspection Service of the United States Deparment of Agriculture; and the IAEA's Joint FAO/IAEA Division of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development. The project, code-named *Moscamed,* was intended to stop the northward movement of the fly in Mexico; eradicate the medfly from Mexico and Guatemala; and eradicate the medfly from all of Central America. The IAEA is essentially the only place where complete medfly expertise in SIT research, training, and implementation

Some of the stacks of trays holding maturing larva.

is available to support such programmes in developing countries.

Although the large-scale programme outlined by Moscamed only got underway in January 1979, segments of the programme, such as ecological studies to determine population densities, movement, and dynamics; the planning and erection of a mass-rearing facility; putting down insecticide baits and spraying pesticides; quarantine measures; and training personnel in expertise necessary to carry out these programmes; were started shortly after the flies were first observed in 1977. For its part, the Agency trained personnel and developed a system for the quality mass-rearing, sterilizing, and release of 500 million flies a week. Although the Agency had been involved in medfly SIT projects before Moscamed, it had never encountered one of this magnitude (see Table).

A factory had to be built

All previous concepts, techniques, and methods were still applicable, but in this instance they now had to work on a scale never before considered. Likewise, new concepts of mass-rearing had to be developed and new equipment engineered. The 12-day production of 2 thousand million medfly eggs involved 700 000 breeding flies in each of 76 cages. The bubbling system to ensure synchronous hatching involved five hundred 8-litre bottles containing 5 million eggs each. Six and a half tonnes of larval medium (yeast, sugar, wheat bran, sugar-beet waste, citric acid, sodium benzoate, and water) had to be mixed daily. Irradiation facilities to sterilize this number of insects had to be specially designed. All areas of SIT expertise were brought into play to design ovipositional cages, egg-aerating systems, larval-rearing methods, larval/pupal isolation systems, pupal holding, sterilization, packaging, and marking systems, and adult holding and release systems.

Agency involvement in medfly SIT projects

1965	Medfly SIT project initiated in Central America (Costa Rica – Panama – Nicaragua) (control)
1967	Capri SIT experiment (eradication) Peru SIT experiment (control)
1968–69	Procida SIT pilot study (eradication)
1969	Tunisia SIT pilot study (control)
1969–70	Spain SIT field experiment (control)
1970–73	Cyprus IPM-SIT study (discontinued because of unrelated political conflict)
1972–73	Israel SIT study (control)
1975–date	Mexican quarantine and eradication programme (eradication)

Before this programme, research-type irradiators were used to sterilize medflies, however, the number of flies to be sterilized in the Moscamed project was so large that multiple units would have been necessary. Moreover, to guarantee that no fertile flies would be liberated from the tons of spent larval medium and adult diets used daily, these too would have to be irradiated before disposal. A commercial unit designed for food irradiation was installed, and served both purposes adequately.

The medflies were irradiated under reduced atmospheric pressure and placed in chilling units until the time of release. The flies were released in paper bags and by a method developed by the US Dept. of Agriculture.

Seibersdorf laboratory as back-up

The medfly technology developed at the Agency's Entomology Laboratory was for the most part used. All systems were pilot-tested there. Except for the increase in numbers, the ovipositional cages, diets, egg-aeration system and larval-rearing technique were transferred directly to the Mexican programme. The larval-rearing medium was slightly altered to utilize indigenous materials. The larval/pupae selection system was specifically designed by Agency scientists for Mexican conditions. The unit was designed to take advantage of a particular phenomenon that occurs when the larvae are about to undergo metamorphosis into the pupa stage. The larvae rapidly expand and contract ("pop"), causing them to jump about 1 cm above the larvae medium. When the mature larvae reach this excited state, the medium is transferred into the drum of the selection unit. This drum is fitted with perforated panels and as it slowly rotates, a fresh surface of the larval medium containing active larvae is constantly exposed to the inner surfaces of the drum. This allows the active larvae to "jump" through the orifices in the drum into a collection container below. By this means, millions of larvae are rapidly isolated from their growth medium and collected.

Had all this technology not been available, the SIT programme would have been too late for the Moscamed project or would have been much more costly. The Agency, including its Seibersdorf Entomology Laboratory, was the primary back-up for the programme and when problems arose, Agency experts were immediately dispatched to the site. If necessary, solutions were developed at the laboratory.

Research still needed

Despite the success in transferring the expertise to a developing country, some needs were still apparent. A genetic sexing mechanism so that only male flies are released would have reduced the cost of rearing and releasing insects by 50%. Sterilizing, shipping and

The drums, or tumblers, for separating larvae/pupae from the larval medium.

release systems with containers suitable to either ground or aerial release would have eliminated the present release systems which, although functional, were not designed for medfly releases and could be improved. Sterility induction still needs refinement, and training courses, aids and manuals were lacking for programmes of this magnitude. These are now among the principal research and implementation considerations by the Agency's laboratory staff.

What Moscamed achieved

Throughout the preparation, implementation and action phases of the Moscamed project, meetings and seminars were frequently held in Mexico to work out the best ways of using the scientific and technical, economic and political, resources available. This information exchange, operating at all levels, resolved problems before they got too serious and helped the project's integrated approach to control of the medfly.

Once the trained technical staff, materials, equipment and facilities were available, the eradication programme was started. As a result, the northward migration of the fly has been halted and the pest that had infested over 3 million hectares has been eradicated from Mexico as from January 1981. Subsequent light infestations were considered migrations of flies from Guatemala or importations by human action. At present, a quarantine barrier produced by sterile-fly releases is being created over a wide swath along the border between Guatemala and Mexico. As Dr P. Patton of the Secretaría de Agricultura y Ganadería of Mexico and the Director of the Moscamed project says, "Our next objective is the eradication of the insect from Guatemala".

Aerial view of the Moscamed facility in Tapachula (southern Mexico), now producing over 500 million medflies a week.