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Irradiation to control the screw-worm fly

by C.J. Thompson

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The screw-worm fly, widespread in tropical areas, could pose a threat to Australia's livestock industry. Ms Chris Thompson, Editorial Assistant with ANSTO, outlines how the CSIRO is testing methods for its erradication.

INTRODUCTION

Insect pests cost the world millions of dollars each year and many methods are used and are being researched in our attempts to control or eradicate them. Some methods employ the pest in its own destruction – genetic or autocidal control. The release of sterile insects, for example, is one that has been particularly successful since it was suggested in 1938 by E.F. Knipling.

The sterile insect technique (SIT) involves the mass-rearing of insects, sterilising them by exposure to gamma radiation and then releasing them into target areas. Matings between sterile insects and the native insect population will not produce offspring and, providing the sterile insects compete effectively, the method is an effective form of birth control.

Though not without problems, to many scientists and environmentalists SIT provides a more acceptable alternative to the use of chemical insecticides and pesticides. Its main advantage is that it highly specific.

Since first proposed a considerable amount of research, testing and application of the technique has been achieved. A recent symposium organised by the IAEA and the Food and Agriculture Organization (Vienna, 16-20 November 1987) reported many successes including the eradication of the tsetse fly in a 3500 square kilometre cattle-rearing area of Burkina Faso and the elimination of the fruit-damaging Mediterranean fruit fly from parts of Guatemala.

The most notable success, however, has been in the eradication of the American screw-worm fly (Cochliomyia hominovorax).

In 1954 SIT was used to eradicate the screw-worm fly from the island of Curacao and, following this success, extended to the southern USA and Mexico. Despite setbacks in the early 1970s these areas are now effectively free of this particular insect pest.

Dr M J Whitten, Chief of the CSIRO's Division of Entomology, also attended the symposium and reported on the work currently being done by Australian scientists on the Old World screw-worm fly (Chrysomya bezziana). This inhabits the tropical areas of South-East Asia, Africa and India. The CSIRO program is aimed at building up the knowledge and facilities to deal with a screw-worm fly outbreak in Australia should it ever occur.

THE SCREW-WORM FLY

The screw-worm fly is a member of the blowfly family. The Old World screw-worm fly and the American screw-worm fly, though distinct species are very similar in their biology.

The female screw-worm fly deposits 150-200 eggs near open wounds or body orifices of livestock. When the maggots hatch (within 8 to 12 hours) they tunnel into the flesh of the animal: hooked mouthparts are used to scrape away at flesh to reach the blood vessels – their food supply.

The mature maggots fall to the ground and pupate within the soil, emerging as adult flies which mate after four or five days and can then infest another host. The whole life-cycle takes about three weeks depending on environmental conditions. A short life but a vicious one.

When infected with the maggots the host animal suffers from loss of tissue and blood, may lose its appetite and hence lose weight and, depending on where the infection occurs, may be maimed or made sterile. It is possible to treat the animals but this involves checking them for infestation every few days and repeating the treatment as new strikes occur.

Untreated infestations, especially where more than one strike has occurred, or when the strike is around the head, may result in the death of the host animal. It is a particular danger for newly-born stock when the navel is used as an egg site.

The fly lives in tropical and sub-tropical areas: as their common names suggest, one species in the Americas, the other in Africa, India and South-East Asia. But its effect is not limited to tropical areas as it can invade cooler latitudes in the summer months, causing considerable damage before dying off in the winter.

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A PROBLEM FOR AUSTRALIA

Australia is the the only country with a tropical zone not infested with the screw-worm fly. But the fly it is not far away. It is found in high densities in parts of Papua New Guinea.

The Torres Strait has provided an effective natural barrier preventing its spread into Australia, but the small islands that dot the Strait could prove effective stepping stones into Queensland or the Northern Territory. This becomes more probable as the number and movement of stock on the islands is increased.

[Below] Female flies laying eggs on the edge of the wound.

Should it reach Australia it is probable that it would infest not only livestock but also native animals and spread rapidly.

A red kangaroo and three wallabies in the Malaysian National Zoo in Kuala Lumpur are known to have suffered screw-worm fly strikes and it appears that it can live on most warm-blooded animals, including domestic pets.

While animals that have been exposed to the fly for centuries seem to have some resistance, this may not be true of Australian animals. If the fly does invade Australia it is estimated that it could cost the livestock industry over $300 million per year.

It is for this reason that Australian effort has been put into finding out more about the insect.

In 1973 the CSIRO Division of Entomology established a Screw-worm Fly Unit at Port Moresby in Papua New Guinea, led by Dr Philip Spradbery. The aim of the group was to study the basic biology of the screw-worm fly, to attempt artificial rearing and to evaluate control methods.

One of their first findings was the alarming rate of dispersal of the fly. Flies labelled with radioactive phosphorus were released and traced. Radioactive egg-masses were found over 50 kilometres from the release point.

If one generation can travel this distance then CSIRO scientists believe, if they reach mainland Australia, stock movements would rapidly disperse the fly and establish the disease in the tropical area as far south as Townsville within one year. From there, in a summer, the infestation could infect livestock in Victoria.

Treatment of diseased animals would be particularly difficult in Australia as livestock are grazed over huge areas, and rarely checked between musterings. Also the high incidence of infestations from the sheep blowfly could invite secondary infestations from the screw-worm fly.

As a result of the Unit's initial findings it was decided to adopt the sterile insect technique as a method of control and to look at the problems of mass-rearing, sterilising and releasing the flies. It was a program to test the methods, not an eradication program.

THE PROGRAM

In its program the research team were able to draw upon the work done in the USA, but dealing with a new species meant that each aspect had to be thoroughly tested.

Breeding

The first flies collected took several generations to adapt to laboratory life – from 6 to 12 months. Experiments with diet, longevity and competitiveness indicate that crossing wild males with domesticated females produces offspring suited to laboratory conditions.

Providing new genetic material is added each year it is possible to maintain a small number of fertile, laboratory-adapted females as a nucleus from which large quantities of

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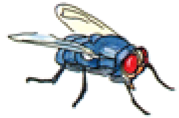

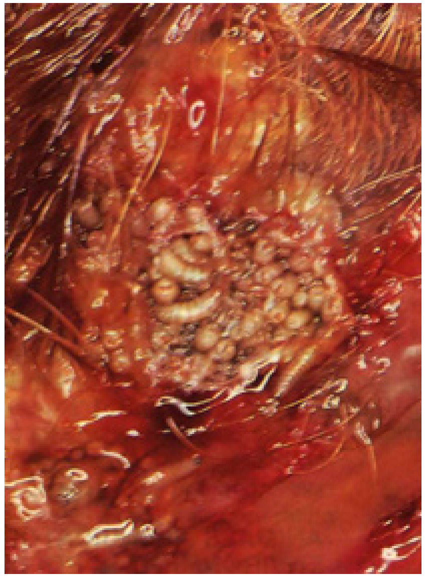

[Above] Maggots burrowing into the flesh.

[Far right] Any animal could bring the screw-worm into Australia.

flies can be reared very quickly. This speed of production would be particularly important should the fly ever invade Australia.

Irradiation

Tests on radiation effects on sterility began in 1982 using a caesium-137 gamma ray source. The aim was to find the optimal dose: too high a dose of radiation would have a detrimental effect on the fly; too small a dose would not cause long-lasting sterility.

The scientists exposed batches of pupae of different ages to various levels of radiation, comparing the number of flies that emerged, their longevity, the insemination levels of the males and the egg production of the females with control batches which had not been subject to radiation. Where sterility occurred they ascertained how long it was maintained.

The best time for irradiation is during the late stages of the pupal development, one or two days before the fly emerges. If done before this either the pupa or emerging fly dies or at best the male fly is unable to successfully inseminate a female.

A radiation dose of 4 kilorads (0.04 kilogray) proved to be the most successful, rendering both male and female flies permanently sterile. At this level of radiation lethal mutations make the sperm in the male fly non-viable and the ovaries of the females fail to develop.

A concern was that although the sterile male flies performed well in the laboratory they might be less able to compete with their native counterparts. To test this a number of sterile flies were released. After one month 25 per cent of the egg masses in that trial area proved to be sterile, sufficient to indicate that the laboratory-reared flies were working well.

Although the female flies are also sterilised, their impact after release is small as they normally only mate once in their lifetime.

Release

The third aspect to be tested was the efficacy of release methods. The best results were obtained by dropping chilled flies from aircraft. This was done over a trial area of 750 square kilometres in the Musa valley of northern Papua Guinea. Results were good and compared very favourably with those in the US screw-worm eradication program.

Mass-rearing

Having found the optimum conditions for breeding, irradiating and releasing the flies it was necessary to demonstrate that sterile flies could be reared in large numbers. This program was begun in 1980 when the Papua New Guinea Department of Primary Industries gave permission for the Unit to move into larger premises at Laloki, outside Port Moresby.

An additional building was funded by the Australian Bureau of Animal Health. By November 1987 the program had reached the stage when 28 to 30 million flies could be produced each week. The irradiation facilities can sterilise 3 to 4 million pupae per day.

TODAY

The aim of the Unit has been to demonstrate and test the methods, not to undertake an eradication program. Having succeeded in this the Unit, under the current direction of Dr Geoff Clarke, will continue to refine the techniques. A nucleus colony of laboratory-adapted flies will be maintained, so that the facility can go into full production if required.

The financing of the facility has recently been taken over by the Bureau of Rural Science of the Commonwealth Department of Primary Industries and Energy.

Should the screw-worm fly reach Australia an 'emergence-facility' would be located at an appropriate airfield. This facility would be used to rear and harvest adults from sterile pupae produced in Papua New Guinea. Sterile flies could then be released to keep Australia free of the screw-worm fly disease. ■

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