The New World Screwworm eradication programme in North Africa

An international effort aims to stop the spread of the health-threatening pest

by A.M.V. Van der Vloedt and B. Butt

In the late summer of 1988, during field monitoring of livestock, researchers at the Libyan Arab Jamahiriya's Faculty of Veterinary Medicine at Great Al-Fateh University in Tripoli recovered maggots from wounds in different parts of the bodies of various animals. They were checking for ectoparasites. However, morphological examination of samples by the national scientists, and later by experts from the Natural History Museum, London, revealed that larvae of the New World Screwworm were present. Such larvae result from batches of eggs which female flies deposit around the edges of wounds in the skin of animals and humans. In fact, the scientific name of the fly, *Cochliomyia hominivorax*, literally means "devourer of man" and was applied because the first cases were diagnosed in humans in Cayenne, French Guiana, in 1858 before they were recognized in animals.

Late in 1988, a special mission of the IAEA and the Food and Agriculture Organization (FAO) of the United Nations confirmed the suspected occurrence of screwworm in Libya. In early 1989, recommendations were made for initial national emergency measures and for international emergency assistance to the Libyan Government.

New threat for continent

Until 2 years ago, the screwworm fly had never become established outside of the Americas. It was endemic in the tropical and sub-tropical regions of the New World, primarily in Central America, the Caribbean islands, and South America as far south as Argentina. The screwworm has been eradicated from the United States and Mexico.

The screwworm is thought to have reached North Africa with a shipment of contaminated livestock imported from Central or South America. The parasite's presence in Libya poses a great threat to livestock, wildlife, and the environment in Africa, the Middle East, and the Mediterranean Basin.

The screwworm causes "myiasis" (the presence of larvae in tissues and organs of the living hosts and the tissue destruction and disorders resulting from it) primarily in animals. However, parasitologists from the Faculty of Medicine reported the occurrence of human infestations with this dangerous parasite in the Tripoli area relatively soon after the detection of cases in animals.

The parasite's present restricted distribution in Africa — confined to an area of approximately 20 000 square kilometers, 30 kilometers south of Tripoli and 60 kilometers east of the border with Tunisia — offers the possibility for eradication, if an international emergency action programme can be fully instituted. The programme is a collaborative effort of the Government of Libya and international agencies including FAO, IAEA, International Fund for Agricultural Development (IFAD), and United Nations Development Programme (UNDP).

Infestation in the Western Hemisphere

The screwworm problem in the Western Hemisphere is well documented. Before the eradication programmes in the southeastern and southwestern United States, *Cochliomyia hominivorax* caused serious losses estimated in excess of US $100 million annually, making livestock production difficult and labour-intensive. Moreover, the parasite caused untold losses in wildlife.

Where the New World Screwworm occurred in the southern USA and Mexico, its presence dictated animal

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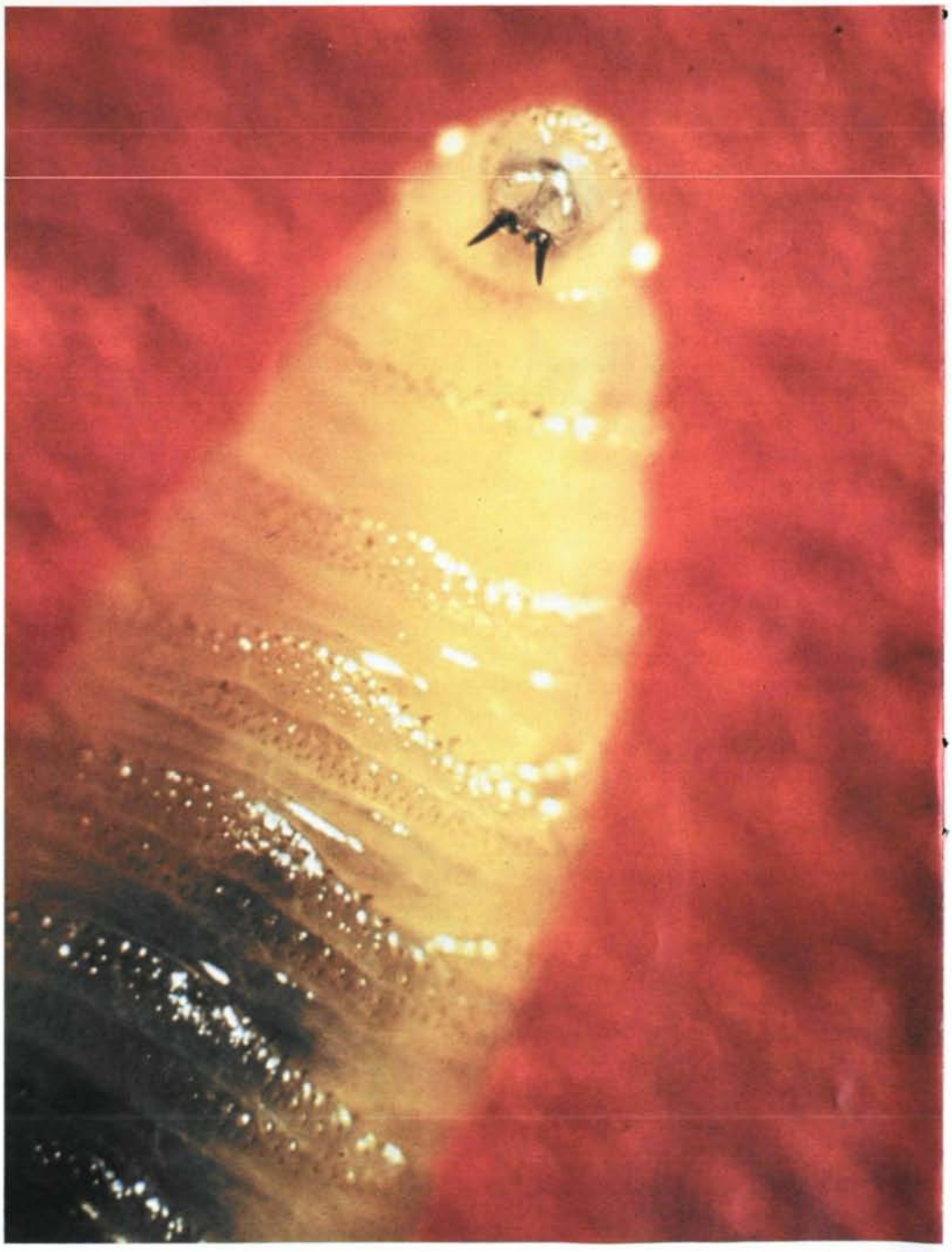
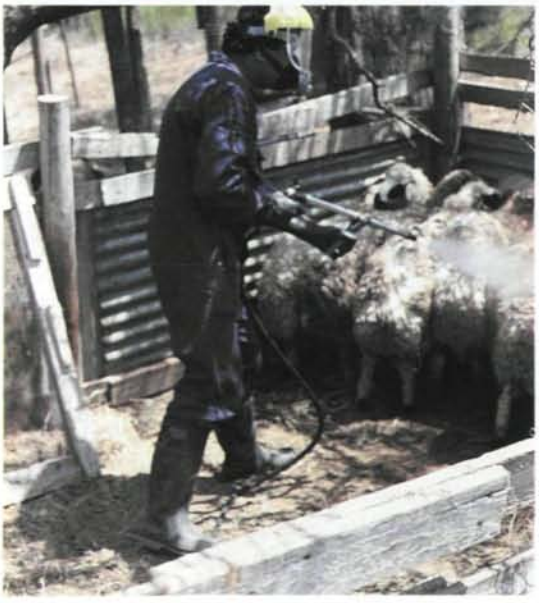
The New World Screwworm lays her eggs around the edge of an animal's wound. The larvae's mouthhooks tear at living tissue, inflaming the wound and attracting other screwworm flies. (Credit: FAO; Van der Vloedt, FAO/IAEA)



husbandry practices. In areas where the screwworm was seasonal in incidence, ranch management and practices such as calving, branding, shearing, castration, and dehorning were scheduled to avoid infestation by the parasite. With the advent of modern insecticides, prophylactic and curative treatment became possible. However, the cost of continuous surveillance of all animals for wounds and the treatment of wounds became prohibitively expensive. Moreover, many infested animals on open ranges were not found or had either fatal or debilitating infestations by the time they were found.

The sterile insect technique (SIT) opened new prospects. After many years of research and development, particularly on mass-rearing of screwworm flies, methods of sterilizing them, and testing their competitiveness under field conditions with fertile native males, the SIT was put into large-scale operational use. Eradication of the pest began on the island of Curaçao in 1954 followed by the campaign in the southeastern United States in 1957. The parasite has been eliminated from Puerto Rico, the Virgin Islands, the continental United States, and Mexico. This was accomplished by diligently



In Libya, efforts to control the screwworm include inspecting livestock for signs of screwworm infestation and spraying insecticides. (Credit: Van der Vloedt, FAO/IAEA)

treating the wounds of infested animals with the recommended insecticide, by strict control of animal movement, and by releasing billions of factory-reared adult screwworm flies that had been exposed to a sexually sterilizing dose of gamma rays. No endemic screwworms have been observed in the USA since August 1982. In Mexico, the area north of the Isthmus of Tehuantepec has been essentially screwworm-free since 1985 and completely free since May 1990.

There are no longer any screwworms in the United States except for research colonies closely confined in cages at the Bioscience Research Laboratory of the US Department of Agriculture (USDA) in Fargo, North Dakota. At this unique reference quarantine laboratory, research emphasizes New World Screwworm genetics and bioassays related to the chemical basis for fly behaviour.

The screwworm production facility in Chiapa de Corzo, Chiapas, Mexico — dedicated in 1976 and operated by the Mexican-American Commission for the Eradication of the Screwworm — is still the only source of sterile screwworms.

Projection of North African infestation

According to the FAO, so far no cases of New World Screwworm have been reported outside the previously known area of infestation in Libya. However, it is anticipated that favourable climate and vegetation, and an abundance of hosts (livestock and wild animals) will assure that the parasite continues its spread throughout North Africa and in due course invades Africa south of the Sahel, the Middle East, and southern Europe.

Spread will be facilitated especially by uncontrolled movement of infested animals. Costs of control and losses to livestock owners will be extensive and may exceed US $1000 million per year.

If the New World Screwworm invades sub-Saharan Africa and the Middle East, it will cause immense losses to livestock producers in countries where animal production is the most important activity of the majority of people. The foreign exchange costs of insecticides to adequately control established infestations will additionally contribute to the burden on national economies. Since the human populations are not familiar with the parasite, suffering will be considerable. Not only sickness but mortality can be expected since people there frequently live far from any medical services.

The already endangered wildlife of these areas will now have another major threat. National economies and people reliant on wildlife for livelihood or income will suffer. The mortality rate in newborn animals may approach 80%, based on pre-screwworm eradication data for deer herds in south Texas. The potential impact on wildlife in Africa is a grave concern to wildlife conservationists and enlightened people throughout the world.

Each year populations of New World Screwworms will build up and spread northward into Europe to cause livestock and wildlife losses until winter stops the life cycle. Since the parasite can continue to develop wherever soil temperatures remain above 10 degrees Celsius, the screwworm could very well find areas in which it will survive winter. Surveillance and treatment would be required, in addition to animal movement control and quarantines.

The Middle East imports many millions of live animals annually from Africa. The most significant cause of long-range movement of the screwworm is by commercial transport of infested animals. Even if prohibition were placed on importation of live animals from Africa, screwworm infestation would arrive in the area by uncontrollable illegal animal movement, imports of infested pets, and gradual migration of fertile flies.

Action taken by the international community

After the screwworm occurrence in Libya was confirmed by its experts, the FAO mounted an emergency assistance programme in early 1989. The programme was launched to assist Libyan Veterinary Services in the control of the parasite and prevention of its spread, to define the limits of infestation by surveillance measures, and to advise immediate risk countries on prevention strategies. The FAO/IAEA also provided assistance in the form of training courses in July 1989 and February 1990, which were attended by veterinarians and parasitologists from Libya, Algeria, Tunisia, Morocco, Chad, Niger, Egypt, Sudan, Somalia, Mauritania, Mali, Senegal, Cameroon, Burkina Faso, and Nigeria.

FAO, UNDP, and IFAD have made significant funds available to initiate and sustain activities in Libya and other North African countries to combat the New World Screwworm. The Libyan Government has made available more than US $7.5 million towards the initial phase of surveillance and control work at the national level. In addition to financial support, the IAEA has made available members of its staff to assist in the programme and is co-operating fully with the FAO.

Eradication programme

Despite all the activities being undertaken in the infested area and the vast resources committed for the control programme, it is feared that the great risk to the African region may still be underestimated if the pest is not eradicated soon. The only rational strategy to solve the problem in North Africa is to eradicate the New World Screwworm in the present limited area of infestation before the extent of the infestation increases substantially. Otherwise the infestation is likely to proliferate beyond the technical feasibility to eradicate at any cost. The situation can be described as virtually "now or never". The enormity of projected losses to the producers and consumers of countries where the parasite will spread must be compared to the more manageable cost of the eradication programme.

Facts about the New World Screwworm

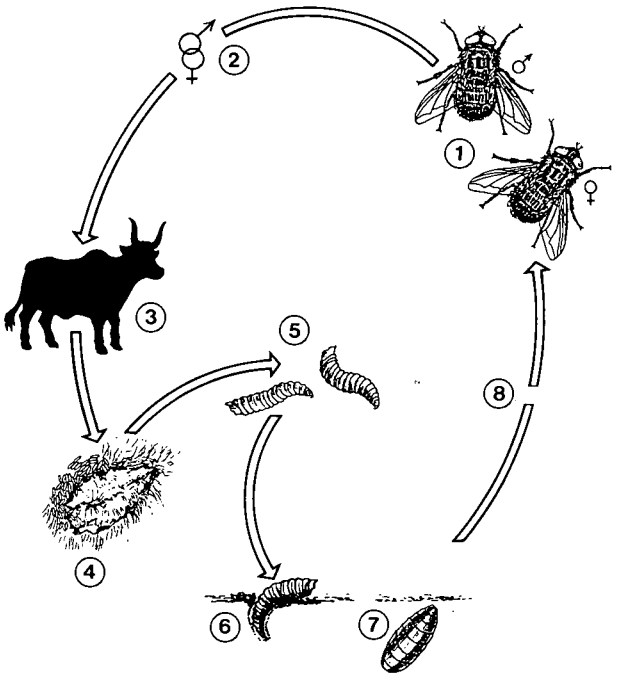
Until its introduction into North Africa, the screwworm was found only in the tropical and subtropical regions of the Western Hemisphere.

The adult fly is approximately twice as large as the common housefly. It is a dark blue-green insect with orange-reddish eyes and three dark stripes on its back. It resembles the bluebottle flies that lay eggs on carcasses and decaying meat, but it attacks living animals and its larvae are obligate parasites of mammalian wounds.

Almost all warm-blooded animals may be attacked. Cattle, horses, donkeys, sheep, goats, pigs, and dogs are frequently reported as hosts. In North Africa the camel has become a host. Humans are particularly at risk from infestation when living in conditions of poor hygiene and in close proximity to infested livestock.

The screwworm's life cycle. Male screwworm flies are sexually mature within 24 hours after eclosion and are polygamous, mating 5 to 6 times. The female fly is monogamous, mating only once during her lifetime. ① ② The gravid female fly is attracted to open wounds and lays its eggs in batches of up to 400 on the edge of them. ③ ④ Among the favourite sites for infestations are the navels of newly born animals and wounds resulting from castrating, shearing (sheep), branding, tick bites, scratches from thorns, and wounds from barbed wire fences. The most dangerous infestation sites in people are the nose and ears and other exposed body cavities.

One female may lay 1000 eggs during her lifetime. These eggs hatch into small larvae in about 12 hours and invade the wound. ⑤ With their mouthhooks the larvae tear at the wound and as they feed exudates are produced that promote secondary bacterial infections and prevent healing. The growing worms increase the size of the original wound which discharge pus and blood; it has a characteristically foul odour which in turn attracts more female screwworm flies. These multiple infestations lead to sickness and frequently death of the host animal if left untreated. Mortality rates of 20% or more of infested animals have been reported in the Americas. Up to 80% of newborn calves or lambs are killed by this pest if appropriate control measures are not taken.



Infestation in humans causes enormous pain. Death occurs in approximately 10% of the people infested, unless rapid action is taken to remove the larvae and to treat secondary microbial infections.

After 5 to 7 days of feeding, the larvae, characterized by their spiracles and the pigmented dorsal respiratory trunks at the posterior end of the body, are fully developed. They drop from the wound, burrow into the soil, and form brown puparia (cocoons) which protect the developing flies. ⑥ ⑦ ⑧ The pupal stage lasts from 7 days (in warm weather) to 65 days (in cold weather).

The screwworm life cycle averages about 3 weeks under optimum conditions.

The international programme to eradicate the screwworm centres on the use of the sterile insect technique. Larvae are produced by the millions at a mass-rearing facility in Mexico. After irradiation, screwworm pupae are put in special boxes for long-distance transport. (Credit: ARS-USDA)

If eradication is achieved before much additional spread occurs, savings will be very great indeed.

The sterile insect technique, in conjunction with surveillance, preventive, and curative treatment of animal wounds, is the only available technique for eradicating the New World Screwworm. The sterile insect technique requires the releases of huge numbers of factory-reared, sexually sterile insects. Sexual sterility is induced by exposing the late pupal stage to gamma rays. When these sterile insects mate with native females, the eggs laid on open wounds fail to hatch and no progeny are produced. By sustained releases and maintaining a ratio of 10 or more sterile insects to each native insect over several generations, eradication is achieved in a relatively short period of time.

As pointed out earlier, only one functioning rearing plant for the screwworm now exists. It is located in southern Mexico and operated by the Mexican/American Commission for the Eradication of the Screwworm. This large facility employs several hundred people and operates 24 hours a day, 7 days a week, with a capacity to produce up to 500 million flies a week.

The eradication technology developed in the USA and the sterile flies produced in Mexico are available for transfer to Libya. In March 1990 the United States Congress amended the Animal Disease Control Act of 1947 to authorize the Secretary of Agriculture "to produce and sell sterile screwworms to the government of any country of the world or to any international organizations or associations".

The IAEA's role

The FAO is in charge of the execution of the programme with a significant supporting role being played by the IAEA. The IAEA is directly involved in the sterile insect technique portion of the programme because of its expertise in the Joint FAO/IAEA Division, and the research capacity of the Agency's Laboratories at Seibersdorf, Austria.

A consultant group, consisting of Dr J.E. Novy from the USA, Drs L.F. Liera and J.W. Mackley from Mexico, and FAO and IAEA staff, met in January 1990 and developed a detailed programme for the eradication of the New World Screwworm from North Africa. Before programme formulation was done, batches of screwworm puparia were taken from Tripoli to the Bioscience Research Laboratory in Fargo, North Dakota, USA, to investigate if sterile flies produced in the Mexico plant are able to mate with the screwworm strain from North Africa. The strain from Libya was collected as egg masses from experimentally wounded sheep exposed in the zone of infestation and then reared through the pupal stage at the Laboratory of the Veterinary Services in Tripoli before transfer to Fargo.

Compatibility studies conducted by Drs D.B. Taylor, L. Hammack, and R. Roehrdanz from the Fargo team revealed that reproductive barriers should not impede the eradication programme in North Africa by means of sexually sterile screwworms from the Mexican production facility.

To meet the North African emergency, transport planes must deliver millions of factory-reared flies weekly from Mexico to the infested area. At the destination, specially constructed cardboard boxes containing up to 1500 flies each would be loaded onto light aircraft, which will make flights along a grid pattern covering the entire infested area twice a week.

The effects of air shipment on the quality of the factory-reared flies are being evaluated at the Seibersdorf Laboratories. The IAEA, through a technical co-operation project sponsored by the Swedish International Development Authority (SIDA), is also assisting the programme with the procurement and shipment of equipment and supplies to North Africa. Agency experts are participating in the FAO/IFAD preparatory phase pilot project aimed at developing infrastructures and initiating releases of sterile flies in Libya.

Dr D.A. Lindquist, Head of the Joint FAO/IAEA Division's Insect and Pest Control Section, has taken a 1-year leave of absence from the Joint Division to head the eradication programme in Libya, and Mr M. Taher of the Seibersdorf Laboratories has been assigned to Libya for 6 months.

In July 1990, a donors' meeting was held in Rome. Sufficient commitments were made to initiate the eradication programme.

The budget for the eradication programme during its 2 years of operation is estimated at approximately US $85 million, based on requirements of between 40 to 100 million sterile insects per week and sustained control activities, including restricted animal movement, prophylactic and curative insecticide treatment of wounds, and surveillance. This is in addition to contributions from participating North African governments.

This expense is only a small fraction of the losses that a widespread infestation would cause. If it is not eradicated from Libya, the estimated cost of controlling the screwworm in the five countries of North Africa alone would exceed US $250 million a year. Costs of any further spread of the screwworm are incalculable.

The aerial release of sterile screwworm flies in North Africa began in December 1990.

Model for international action

The presence of screwworm in Libya is a regional problem and prompt eradication action is needed to prevent the spread of infestation to other countries.

The eradication programme represents the first time that so many partners in the international community, many with diverse agendas and, sometimes, conflicting political leanings, have come together under a common mandate to combat this imminent threat to agriculture, public health, and the environment. This co-operation may serve as a model for action in future international emergencies.