



**FOOD AND AGRICULTURE
ORGANIZATION OF THE UNITED NATIONS**

**A REVIEW OF THE CURRENT STATUS OF
NEW WORLD SCREWORM IN THE
AMERICAS
2000**

**Santiago, Chile
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PREFACE

During the 1996 World Food Summit held in Rome, world leaders and FAO representatives ratified the following statement: "...animal diseases represent an important limitation to food self-sufficiency and to improving international trade worldwide". On the same occasion, it was recommended that a priority contribution to the alleviation of global poverty was the prevention of key animal diseases and pests and improving the state of readiness to combat them by such measures as their progressive eradication.

Cutaneous myiasis caused by the New World Screwworm fly (NWS) is one of the disease obstacles to self-sufficiency in livestock production, in part because of the severe economic losses it causes. In addition, it causes public health problems and has the character of a transboundary disease. Because epidemics can be readily spread across international borders, co-operation among neighbouring countries is required to maintain food security and to facilitate control and eradication of NWS. For these reasons, livestock producer organizations in North and Central America have, since 1972, made requests to their respective governments for the creation of international programmes for NWS elimination. The goal of such programmes will be achieved in 1999 with the eradication of NWS from all countries of North and Central America, together with the establishment of a biological barrier of sterile NWS flies across the narrowest part of the Isthmus of Panama. The barrier will be established to prevent the northerly migration of wild flies, which would otherwise cause the reintroduction of disease into NWS free territories, and it will be supported by strict epidemiological surveillance and quarantine measures.

The transboundary nature of the disease was acutely demonstrated in 1988 when there was an outbreak of NWS myiasis in Libya, North Africa, the first time the parasite had become established outside of its natural habitat of the Americas. In response to this emergency situation an eradication campaign was implemented, supported both by the international community and by the Libyan Government. The campaign was co-ordinated by FAO and resulted in the successful eradication of NWS from Libya in 1992, so avoiding potentially huge negative impacts to the livestock sector, wildlife and public health of Africa, Europe and the Middle East. In the Americas, FAO has been providing technical assistance for control and eradication of NWS to its member countries, according to the institutional priorities and the magnitude of the problem. Assistance has been directed especially in the Caribbean and particularly to those countries where NWS is endemic, such as Cuba, Jamaica, Haiti and the Dominican Republic.

The report presented here is based on information gathered during FAO missions carried out between 1992 and 1993, as part of the Preventive Phase of the SECNA programme (Screwworm Emergency Centre for North Africa). In addition, up-to-date data is included, generated by the countries covered and by those international institutions involved in NWS control and eradication programmes in the region.

This report is the first involving the Caribbean and South American sub-regions and contains the majority of the existent information on NWS myiasis. Its objective is to contribute to the preparation of programmes for the control and eradication of NWS, through providing information on the epizootiological situation in the region. It includes alternatives at national, sub-regional and

regional levels for the establishment of control and eradication measures and for implementing these programmes, according to local conditions.

FAO acknowledges the contribution of the Veterinary Services of all countries in the Americas, the Mexico – United States Commission for the Eradication of Screwworms and the NWS experts participating in the field missions, as well as the professionals participating in the preparation of the report, Dr Norvan L. Mayer (Former Director of International Veterinary Programmes, APHIS-USDA), Dr Martin J.R. Hall (FAO Collaborating Centre on Myiasis Causing Insects and Their Identification, The Natural History Museum, London, UK), Dr Moises Vargas-Terán (Animal Health Officer, FAO Regional Office for Latin America and the Caribbean), Dr Brian Hursey (Senior Animal Health Officer, FAO Headquarters, Rome) and Helen Gillman (Professional Editor).

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1. INTRODUCTION

The discovery of the New World Screwworm (NWS) in the Libyan Arab Jamahiriya in 1988 focused worldwide attention on the potential for this destructive pest to become established in countries outside its natural range. The presence of screwworms in Libya represented an emergency situation for the entire North African Region and beyond. If left uncontrolled, the pest could have spread to neighbouring countries and eventually into sub-Saharan Africa, the Near East and Mediterranean Europe.

In response to the emergency, the Food and Agriculture Organization of the United Nations (FAO) designed and successfully carried out an eradication programme in Libya, based on the sterile insect technique (SIT). One of the FAO's first actions was to recommend that myiasis caused by NWS, *Cochliomyia hominivorax* (Coquerel) (Diptera: Calliphoridae), be included in the list of international notifiable animal diseases (List B). The recommendation was approved by the general session of the International Office of Epizootiology in Paris on May 12, 1989. This meant that the disease was included in the international reporting systems, occurrence data would be published in the FAO/WHO/OIE Animal Health Yearbook, and that special recommendations for export and import of animals were included in the OIE International Zoosanitary Code (Annex N° 1).

By mid-1992 Libya was officially declared screwworm-free. The FAO then initiated a Preventive Phase Programme, with three main objectives:

- 1) Reduce the risk of future outbreaks of the NWS and other exotic diseases that may threaten livestock in North Africa.
- 2) Improve the technology for NWS eradication.
- 3) Reduce the risk of spread from enzootic areas.

As one element of the third objective, a series of surveillance missions were undertaken by the FAO to investigate the situation regarding NWS in the Caribbean and South America run on.

This report is based on information gathered during these missions, carried out between October 1992 and March 1993. . As well as the 1995 report on the NWS outbreak in Cuba, the Mexico – United States Commission for the Eradication of Screwworms inputs and the FAO, IAEA and USDA recent contributions to NWS eradication efforts in the Region.

Screwworm: A major livestock pest

The two species of insect that cause screwworm infestations are *Cochliomyia hominivorax*, commonly referred to as the New World Screwworm (NWS) and *Chrysomya bezziana*, commonly referred to as the Old World Screwworm (OWS). Apart from the outbreak in Libya, the NWS is confined to the tropical and subtropical Americas. The OWS is widely distributed over the tropical and subtropical parts of Africa and Asia and is not known to exist in the Americas.

Screwworms are obligate parasites of many warm-blooded animals, including humans. Although the name “screwworm” is given to both the larval and adult stages of the insect, the adult fly is harmless. Its reputation as a deadly parasite comes instead from its larvae, which are totally dependent on the living tissues of host animals for development. The adult female screwworm fly is attracted to skin abrasions and wounds, where she deposits eggs. Within 24 hours the eggs hatch into larvae which immediately start feeding on the living tissue, dramatically increasing the size of the wound and causing intense suffering. If left untreated, the infested animal often dies. Hence, the livestock industry can suffer severe economic losses.

NWS distribution

The NWS can live year-round in tropical and subtropical regions of the United States, Mexico, Central America, Panama, Northern and Central South America, and in the Caribbean Islands. Its distribution is largely determined by its inability to survive persistently cold weather, therefore it is usually unable to overwinter in temperate regions. Warm, moist conditions are optimal.

The NWS has been eradicated, using the Sterile Insect Technique (SIT), from the *United States* (1981), *Puerto Rico* (1975), the *US Virgin Islands* (1972), the *British Virgin Islands* (1972) and *Curacao* (1954, 1976). *Mexico*, declared NWS-Free on 25 February 1991, after the aerial release of 250 631 millions NWS sterile flies using 58 000 flight hours. The report and identification of 198 231 larvae samples, with a programme cost of \$EE.UU.413.5 millions, including the participation of 3 000 persons and travel of 224.6 million kilometres by the field forces searching for NWS cases in cars, boats, horseback and walking. *Guatemala*, last NWS case occurred on 22 of May 1994, as result eradication campaign begins in 1988, *Belize*, implemented eradication in 1989 and NWS elimination obtained in 1994. *El Salvador* in 1991 begins a campaign against NWS concluding its eradication in 1995. *Honduras* implemented a zoosanitary programme starting in 1991 and concluding NWS eradication in 1996. *Nicaragua* is the most recent country to be NWS-Free in Central America, after a successful zoosanitary effort begins in 1992 and concluding on 28 November 1998.

Eradication efforts are underway in *Costa Rica* expecting the NWS eradication in 1999, as well as in *Panama*, programmed to be NWS in the year 2000. NWS presently occurs in all countries of Central and South America south of the eradication zone except for Chile mainland, where the last outbreak was recorded in 1959.

The smaller islands of the Caribbean are also apparently screwworm-free, even though their climates are generally favourable to screwworm reproduction. However, several of the larger Caribbean islands are infested, e.g., Cuba, Jamaica, Cuba, Hispaniola, Trinidad and Tobago.

The Sterile Insect Technique

The Sterile Insect Technique (SIT) can most simply be described as a form of birth control. Combined with surveillance, wound treatment, animal movement control and quarantine, the use of SIT has been phenomenally successful, as demonstrated in the Americas and North Africa carry on.

The technique involves the mass rearing of the pest species (in this case the NWS), sexual sterilization by radiation (using caesium 137) and the release of vast numbers of sterile insects into the infested area, at a ratio of sterile to one wild fly. When a wild female mates with a sterile male, she will still lay eggs but these will be infertile approximately ten and thus will not produce offspring. If sufficient numbers of sterile males are released, so that most indigenous females are mated by them the size of the wild population can be rapidly reduced. Continued release of sterile flies over consecutive generations will lead to extinction of the wild population. Unlike many other methods of pest control, the Sterile Insect Technique is environmentally friendly.

ACRONYMS

ARS	Agriculture Research Services
APHIS	Animal and Plant Health Inspection Service
BVI	British Virgin Islands
CIMIAT	International Centre for Tropical Myiasis
EMPRES	Emergency Prevention System for Transboundary animals diseases and plant pest
FAO	Food and Agriculture Organization of the United Nations
GOJ	Government of Jamaica
IMV	Institute of Veterinary Medicine
IAEA	International Atomic Energy Agency
JLA	Jamaican Livestock Association
MUSCES	Mexico – United States Commission for the Eradication of the Screwworms
NWS	New World Screwworm
NWSEF	NWS Eradication Fund
OIE	Office International Epizooties
PR	Puerto Rico
READEO	Regional Emergency Animal Disease Eradication Organization
SIT	Sterile Insect Technique
TCP	Technical Cooperation Project
USDA	United States Department of Agriculture
USVI	United States Virgin Islands
WIU	West Indies University

2.0 SOUTH AMERICA

INTRODUCTION

The NWS is endemic throughout most of the South American continent. All countries are infested except Chile, where the pest was last identified in 1959 (although it is possible that Easter Island, a Chilean territory, remains infested). Although Chile shares borders with countries infested by the NWS, it has been able to maintain its screwworm-free status thanks to the strict controls it imposes on the importation of animals and animal products. These controls are imposed in order to maintain Chile's status as free of Foot-and-mouth disease.

ARGENTINA

Status: Screwworms endemic

Background

Argentina, the second largest country in Latin America, occupies most of the southern portion of the South American continent. It is bordered by Chile, Bolivia, Paraguay, Brazil and Uruguay and has an extensive Atlantic coastline. The country is made up primarily of lowlands, and can be divided into four topographical regions, the Pampas, Patagonia, the Andes and their foothills, and the Northeast.

Myiasis

Screwworms are endemic in northern Argentina. North of the city of La Rioja, NWS is found throughout the year. South of La Rioja, NWS is found only in the hotter months of October through to March. In the far south of the country, temperatures are lower and are not favourable to NWS reproduction. The NWS population is believed to be higher during the rainy season.

Screwworms are not considered to be a major problem, even though more than 50% of the producers visited were able to produce an infested, or recently infested animal. Each livestock owner or cowboy carries medicine to treat infested wounds. Since there is no regular system for reporting infestations, the incidence and geographical distribution can only be roughly estimated.

A few cases of screwworm myiasis in humans have been reported.

BOLIVIA

Background

Bolivia is a landlocked country straddling the central Andes mountain in west central South America. The country shares borders with Brazil to the north and east, Paraguay to the southeast, Argentina to the south, and Chile and Peru to the west. The southwestern quarter of Bolivia is dominated by the Andes mountains. The remaining three-fourths of Bolivia lie east of the Andes and are occupied by the Eastern Lowlands, or llanos, which slope gradually eastward from elevations of about 450 m in the foothills of the eastern Andes to 200 m or less along the borders with Brazil, Paraguay and Argentina.

Myiasis

NWS is commonly called “queresa” or “gusanera” in Bolivia. Official records of screwworm infestation are not maintained, since the pest is considered to be endemic. Therefore, the only way in a brief visit, to determine the incidence and seasonal variation of NWS is through interviews with people such as animal health authorities, livestock producers, veterinarians and entomologists. Results of such interviews suggest that, with the exception of the high Andes, the entire country is infested. There is apparently some seasonal and geographical variation in infestation rates, but this has not been studied, and therefore its importance cannot be evaluated. Heavily infested areas include the departments of Beni and Santa Cruz and Chaco region.

All livestock species are affected to some extent by NWS, but the attack rate is dependent on management practices. For example, dairy cattle in the outskirts of the city of Santa Cruz are checked daily and NWS is therefore rarely a problem even when pigs penned nearby have severe infestations. If found infested they are usually treated within 24 hours.

Since there is no official NWS control programme, control activities are the responsibility of the livestock owner. Sprays, powders, liquids and smears for treatment of infested wounds are readily available.

The only written records of myiasis were found at the Pampa de la Isla slaughterhouse in Santa Cruz. The showed that since 1987, several hundred cattle had been condemned for causes “including myiasis”. The exact number could not be determined, since the records did not specify the reasons for the condemnation of individual carcasses.

An average of two human myiasis cases caused by NWS reach the La Paz Hospital each year. However, the altitude of the city of La Paz prevents the development of screwworms in that area and only very severe human cases are brought in from other areas for treatment. In the yungas region where the climate is hot and humid, there are 10 medical clinics which treat an average of about 10 human cases per year. Human myiasis due to NWS is, therefore, not a significant problem.

BRAZIL

Status: Screwworms endemic

Background

Brazil occupies almost half of South America. It stretches from the foothills of the Andes eastwards to the Atlantic Ocean and borders on every country of the continent except Chile and Ecuador. It is the world's fifth largest country. The land is relatively flat with few high altitude areas. Brazil has a tropical climate, characterized by high rainfall, high relative humidity and high temperatures.

Myiasis

Ranchers can identify NWS infestations and are familiar with methods of treatment. Most farms have supplies of insecticides for treating NWS cases, perhaps as: "Because many ranchers consider NWS as relatively easy pest to treat, some can be careless about animal management and create wounds which are attractive to NWS females".

In Brazil, cows and new-born calves are most affected by screwworm infestation. Although the NWS is not usually a problem in a dairy cattle, which are regularly observed and promptly treated, screwworms can be a serious problem in beef cattle, specially on range land where it is difficult to check animals frequently. Range land occupies nearly 2 million km² of Brazilian territory and supports about 57,425,000 head of Zebu cattle, or 42% of the national herd. The greatest economic losses occur in these cattle.

The NWS is a very common parasite of domestic animals throughout Brazil. Extensive information about the pest was found in a 1983 official report on the geographical distribution of the most important ectoparasites attacking cattle in Brazil. Prepared by veterinarians of the Ministry of Agriculture, the report also gives a wealth of information concerning ticks (*Boophilus microplus*) and warbles (*Dermatobia hominis*), known in Portuguese as "berne". (Ministério da Agricultura. Secretaria Nacional de Defesa Agropecuária. 1983. Carrapato, berne e bicheira do Brasil. 153 pp.).

The report shows that the NWS is present in all Brazilian states. Bovines were the most important hosts and infestation was heavy in 33.1% of the counties and very light in 60.2% of the counties. Sheep were second in importance as hosts, with heavy infestation in 13.0% and very light in 41.7% of the counties. Equines were third in importance with heavy infestation in 4.6% and very light infestation in 49.4% of the counties. Heavy infestations were observed in buffaloes in 0.6% of the counties and low level infestation in 18.7%.

The Ministry of Agriculture's report also provided information on the incidence of NWS myiasis in humans. It recorded human infestations in 6.8% of the counties of Brazil, with 0.9% having heavy infestation and 5.9% light infestation.

Seasonal abundance of the NWS was first studied in the county of Itaguai, Rio de Janeiro, from September 1979 to August 1980, using wind-oriented traps baited with spoiled beef liver. The fly was

found throughout the year, being less abundant during months of November through April when the rainfall is heavier. The greatest concentrations of insects were recorded in areas well covered by trees and bushes and with large numbers of domestic animals. Similar results have been obtained by subsequent studies in various parts of the country.

In Rio Grande do Sul, where bovines and ovines are raised together, about 13 million each, NWS cases are more frequent in sheep because of foot rot. Infested sheep isolate themselves from the rest of the herd, so they are difficult to locate for treatment. Many die from the infestation.

During the past 20 years, many cattle ranches have been established in the Amazon region and there have been reports of screwworm infestations. Tree trunks and branches left after the clearing of the forest often cause wounds on animals. Since it is difficult to inspect livestock under the existing conditions, fatalities often result.

The animal health monthly reports forwarded to Brasilia do not cover screwworm cases. Therefore, interviews were conducted with representatives of the Ministry of Agriculture of eight states: Pará, Amazonas, Maranhão, Mato Grosso, Mato Grosso do Sul, Paraná, Rio de Janeiro and Rio Grande do Sul. It was found that screwworm infestations were very common in each of the states.

International Center for Tropical Myiasis (CIMIAT)

The CIMIAT was established in 1978 by the Universidad Federal Rural do Rio de Janeiro with the following goals:

- systematically study the biology, ecology and integrated control of insects causing tropical myiasis, with special emphasis on *Dermatobia hominis* and *Cochliomyia hominivorax* (NWS).
- stimulate, advise and coordinate research projects on tropical myiasis in different countries of Latin America.
- evaluate the losses caused by tropical myiasis in the cattle industry of Latin America.
- arrange international intensive courses to train Latin American researchers in modern techniques and methods for the study of tropical myiasis.
- organize international seminars on tropical myiasis to comment on and critique the research being carried out in Latin America and to determine the direction of research in the future.
- promote effective communication between Latin American researchers on tropical myiasis, creating a data bank on this important branch of animal health.

In 1979, Brazil's National Council for Scientific and Technological Development financed a project entitled "Preliminary ecological studies on *Cochliomyia hominivorax*, as a requirement to eradicate screwworm from Brazil using sterilized males".

Between 1982 and 1986, five international courses on tropical myiasis were held by the CIMIAT. The First International Seminar on Tropical Myiasis was held in 1986 with the participation of Argentina, Brazil, Colombia, Venezuela, Mexico and the United States. The methodological, scientific and various other problems related to ecological studies of screwworms and berne were evaluated during this event.

There are no specific programmes to control screwworms in wild animals. In the past 15 years, Electronorte, the company responsible for supplying electricity to the Brazilian states, has built three large hydroelectric plants in the Amazon region at Tucurui, Balbina and Samuel. In the process, rivers were dammed and 5700 km² of land were flooded. Thousands of trees were submerged and more than 100,000 mammals were captured and released at the edges of the flooded area.

Scientists who participated in salvage operations at Tucurui advised that there was some myiasis in the animals captured, especially in pacas (*Agouti paca*) and armadillos. At Samuel, a few screwworm infestations were observed in deer, armadillos and anteaters. Wild animals are very well adapted to life in the jungle and they do not become wounded easily, leaving the impression that the few infested animals observed were wounded while trying to avoid being captured. Bovines on farms in the vicinity of these hydroelectric plants have also become infested.

In 1987, an agreement was signed between the Brazilian Government and the World Bank to study animal health for six years, at a cost of US\$108 million. About 20% of the funds have been used. Brazil's National Animal Health Programme is divided into six projects: Foot-and-mouth disease (FMD); Swine diseases (particularly Classical Swine Fever); Rabies; Equine infectious anaemia; poultry diseases; and, animal parasitoses (endoparasites and ectoparasites). There is no specific national programme financed by the Brazilian Government to control or eradicate the NWS.

COLOMBIA

Status: *Screwworms endemic*

Background

Colombia is located in northwestern South America. It has both snowcapped peaks and tropical regions and its topography is dominated by three Andean ranges that cross the country from southwest to northeast and divide Colombia into three major regions, the highland core, the coastal lowlands and the eastern plains.

Myiasis

As a prerequisite to development of a myiasis control strategy, a study was conducted in Northwest Colombia to identify the causes of myiasis in the area. Larvae were collected during routine farm visits by technicians of Colombian Agricultural Institute (ICA)/US Department of Agriculture foot-and-mouth disease control programme. The technicians inspected animals and

collected larvae when possible. The wounds were treated with an organophosphate pesticide, and the specimens were placed in a tube containing a preservative and forwarded to the laboratory for identification. During the study, 785 samples were collected and identified, revealing the presence of four species of parasite, the NWS, *Phaenicia sp.*, *Cochliomyia macellaria* and *Sarcophaga sp.* More than 97% of the specimens were NWS, found in cattle, horses, sheep and swine.

It is estimated that NWS is endemic in about 90% of the country and that the environment in the infested area is suitable for NWS reproduction throughout the year, although the incidence of screwworms probably diminishes during the dry season. These are estimates, since actual case incidence information is not available.

While livestock owners know that losses occur, they have learned to treat infestations and know how to live with NWS. Therefore, producers and animal health authorities may not fully appreciate the cost of living with NWS. It is assumed that the livestock industry sustains considerable economic loss due to NWS, since a substantial percentage of wound become infected and deaths as a result of infestation sometimes occur. There are also costs associated with surveillance and wound treatment.

There is no indication that NWS causes a significant human health problem in Colombia. However, experience in other countries indicates that there the NWS is found in domestic animals and wildlife, it is also an occasional problem in humans, particularly in lower socioeconomic groups.

In Colombia, the zones of intensive livestock production are located in areas with good communication, usually near big cities. A NWS eradication programme for these areas could be designed based on experience gained in eradication programmes in other countries. In areas where range-type livestock production is practiced, eradication would be more difficult. Cattle management is characterized by gathering the cattle twice a year for branding, vaccination, castration and similar operations. Most of these operations are located in areas where farms are not fenced and most of the roads are impassable during the rainy season. Eradication is possible in such areas, but the lack of all-weather roads and the shortage of other communications facilities would make it difficult and more costly than in the intensive livestock zones.

The area of Colombia located within the Amazon basin includes the departments of Amazonas, Guainía and Vaupés, which border Brazil. All, or part of other departments such as Caquetá, Putumayo and Quaviare are also within the Amazon basin. This area constitutes a substantial portion of Colombia's land mass, but it supports only a small percentage of the cattle population. In the Amazon area, where there are almost no roads or telephones, very few people and comparatively small numbers of domestic livestock, an eradication programme would have to deal with conditions and situations never before faced in an NWS eradication effort.

CHILE

Status: Screwworms-free (with the exception of Easter Island)

Background

Chile is on the west coast of South America. It stretches in a ribbon more than 4200 km from Peru to the southern tip of the continent at Cape Horn, including the larger part of Tierra del Fuego, an archipelago separated from the mainland by the Strait of Magellan. The country has an average width of 177 km. Outlying territories include Easter Island, the Juan Fernandez Islands and other islands in the Pacific. The Andes Mountains, rising to more than 6700 m above sea level, separate the country from Argentina and Bolivia. The capital and largest city is Santiago, located in the central part of the country where most of the population is concentrated.

Chile is justly proud of the fact that it is one of the countries in South America that is free of Foot-and-mouth disease. To protect this free status there are very strict controls over movement of livestock into Chile from neighbouring countries. Live animals and many animal products are prohibited from entry into Chile except from FMD-free countries. The quarantine stations on the borders between Chile and its neighbours are well manned and rules are meticulously enforced. These control measures help to prevent re-introduction of NWS.

Myiasis

NWS was last identified on the mainland of Chile in 1959, but there is no evidence that it currently exists anywhere there. It was identified in 1989 on Easter Island and it is assumed that the island remains infested.

There are a number of areas in Northern Chile where the microclimate is suitable for screwworm survival. In the summer, such areas may extend as far south as Puerto Mont and in the winter to Valparaiso City. These microclimates provide moisture, trees and other vegetation, warm climate and a sufficient number of warm-blooded animals for NWS reproduction.

In Santiago, two veterinarians dealing with small animals were interviewed about their experiences with myiasis. One said that he treated three or four cases of myiasis on dogs each year, always in summer. The other said he had not seen a case of myiasis in 20 years of practice. Two practitioners in the city of Arica, in Northern Chile, said they had seen three cases of dogs with myiasis in the past two years. The larvae in each case were reported to be superficial. Livestock owners on farms, dairies and small ranches in the irrigated Yuta Valley were interviewed. The valley's climate would be ideal for screwworm reproduction if the insect were present. Several owners had seen myiasis in animals in the past seven years, although none recently.

There is no information indicating that NWS myiasis exists in humans. In the absence of myiasis in animals it would be virtually impossible for it to exist in humans.

If NWS were found on the mainland of Chile, it could be eradicated in the winter months by treating only the affected microclimates (irrigated valleys). The country has sufficient infrastructure (roads, airports and seaports) to support an eradication campaign if one should become necessary.

ECUADOR

Status: Screwworms endemic

Background

Ecuador is divided into three distinct physical areas, which also differ culturally and politically. About 35% of the country's total population lives in the coastal region, or costa, which centres on the port city of Guayaquil. Most of the country's tropical export products are grown in the region.

Myiasis

NWS exists throughout the country and all species of warm-blooded animals are affected. According to experienced veterinarians it has been found up to 2500 m above sea level. Treatment of wounds is the principal method of control, with curative and preventive wound treatment routinely conducted on farms and ranches which use high-tech or intensive production methods. However, animals are seldom treated at the larger operations that use unfenced range lands. There is not enough case incidence information available to accurately identify the case rate or the geographic distribution of the NWS, nor is there information about the role of wildlife in perpetuating the pest. However, interviews with Ecuadorian livestock producers indicate that there are heavy NWS infestations throughout Ecuador. Most producers are familiar with the pest and know how to both prevent and treat cases of myiasis.

On the island of Santa Cruz, one of the Galapagos group and part of Ecuadorian territory, discussions with five cattlemen who represented the five principal production areas presented no evidence that the NWS is present on the island.

Intensive livestock production in Ecuador is located in areas with good communication, usually near big cities. A NWS eradication programme for such areas can be designed based on experience gained in eradication programs in other countries.

In areas where range-type livestock production is practised, eradication would be more difficult. Cattle management is characterized by gathering the cattle twice a year for branding, vaccination, castration and similar operations. Most of these operations are located in areas where farms are not fenced and most of the roads are impassable during the rainy season. Eradication is possible in such areas, but the lack of all-weather roads and the shortage of other communications facilities would make eradication more difficult and probably more costly.

FRENCH GUIANA

Status: *Screwworms endemic*

Background/Myiasis

French/Guiana is on the north coast of South America. NWS occurs throughout the livestock production area of the country. The remainder of the country is probably infested, but is largely uninhabited and has not been surveyed for NWS. Livestock owners and veterinarians are experienced in handling infested animals, therefore animal deaths from infestation are minimal. The secondary costs of the disease, due to such factors as treatment and weight loss, have not been studied.

GUYANA

Status: *Screwworms endemic*

Background

Guyana is on the northeast coast of South America and most of its population lives in a narrow strip of land along the north coast. Adjacent to the coastal region is an area known as the White Sands Region; it is about 75 km wide, running parallel to the Atlantic Ocean. This area is hilly and covered with sand, and it varies in altitude from 25 m in the east to 100 m in the west.

Small and medium-sized livestock producers are located in the narrow coastal plain between the Essequibo and Courantyne rivers. In addition to dairy and beef herds, there are also intensive swine and poultry production farms. The other principal livestock production areas are the grasslands of the White Sands Region in the northwest and the grasslands of Rupununi in the southwest.

Myiasis

NWS is present throughout Guyana and causes significant losses in domestic livestock and wildlife. The highest incidence occurs during the rainy season and the lowest at the end of the dry season.

There appears to be a high prevalence of infestation -screwworm-infested wounds were found at all farms visited in the Georgetown area and along the coastal strip- and the problem is compounded by a shortage of hard currency to buy insecticides to treat infested wounds. During a

visit to the Moblissa Dairy, a state farm located about 75 km southeast of Georgetown, many untreated and heavily infested wounds were seen. More than 200 larvae were collected and two adult female NWS flies were captured and preserved for later laboratory study.

Losses could be greatly reduced if supplies of wound treatment chemicals were readily available at prices that livestock owners could afford to pay. Government Veterinary Services are also hampered by a lack of resources to secure needed medicines and vaccines. A precise estimate of NWS losses is not possible because information is not collected on the number of NWS cases and deaths, or on the cost of treatment.

Guyana has a high potential for increasing livestock production. The country has extensive pasture lands, as well as byproducts from sugar cane and rice production that can be used for supplementary animal feed. Under present conditions, national production covers 100% of national meat consumption and 80% of the demand for dairy products. Livestock producers have attained these production levels with little more than natural pastures, rice and wheat bran and their own skills. They invest very little in veterinary care. NWS infestation, among other diseases, is a deterrent to further development of the livestock industry.

PARAGUAY

Status: *Screwworms endemic*

Background

Most of Paraguay has a subtropical climate. Weather conditions are also affected by hot, moist winds from the Amazon River basin and cool dry winds from the Argentine Pampas. Animal health programmes are carried out by the National Service for Animal Health (SENASA)

The principal campaigns are Foot-and-mouth disease (FMD), Tuberculosis, Brucellosis, Bovine Rabies, Hog cholera, Newcastle disease, and Equine infectious anaemia. The FMD campaign is given the highest priority.

Myiasis

The NWS is endemic in Paraguay and the entire country is infected. Since the pest is so widespread, records of myiasis are usually not maintained. One exception is the Asunción Zoo, where records of NWS infestation have been maintained since a new administration took over in July 1991.

Ranchers know how to treat animals to reduce losses from infestation and do not consider NWS a serious threat to production. Interviews with animal disease officials and livestock

producers and on site visits indicate heavy infestations throughout the country. For example, during the visit of the FAO team: 1) a larvae sample was collected from a pig farm and four other animals on the same farm had been recently treated there for the NWS; 2) two samples were collected from dairy cattle in Los Altos in the department of Cordillera about 60 km. from Asunción, and another animal had just been treated for NWS; 3) three samples were collected from dogs in the Animal Hospital in San Lorenzo; 4) records showed several cases at the Asunción Zoo. Conversations with veterinarians and cattlemen indicated a high incidence in other parts of both the eastern and western zones.

No information is available on cases of human myiasis.

The entire country is heavily infested, but NWS cases are not reported so there are no records of the number of cases that occur, or the seasonal incidence. There are no people trained in the identification of NWS flies or larvae and there is no campaign to control or eradicate NWS. Control in individual animals is the responsibility of ranchers, who generally use medications containing insecticides to treat infested wounds and to prevent wounds from becoming infested.

More than ten products are available for treatment of NWS in Paraguay and the following are estimates of the amount of screwworm treatment products sold by several companies in Paraguay:

<u>Company</u>	<u>Volume produced or imported and sold</u>
Biotecnia	3000 sprays a month, 5000 assorted products
Cooper	No data
Bayer	2000 kg Negasunt powder per year
Agroveterinaria	1000 kg smears, 12,000 sprays, 1000 litres of liquid per year
Shell	17,000 sprays per year
Vetenac	5000 litres of spray per year

These sales estimates are for products legally imported into the country. Some observers believe that an equal or greater quantity of myiasis control products are brought into the country illegally each year. The legal sales alone probably provide enough product to treat more than 1.5 million animals each year in Paraguay.

Based on case reports and the unexpected heavy demand for treatment products, the NWS population in Paraguay seems to be very heavy. In fact, the frequency of pesticide use in treating wounds is an important indicator of the number of NWS cases when no other information is available. Further studies are needed to define incidence rates and geographical distribution.

PERU

Status: Screwworms endemic

Background

Livestock includes cattle, sheep, goats, pigs and horses, as well as substantial numbers of vicuña (59,000) alpaca (2,703,185) and llama (1,029,339).

Livestock numbers in Peru have been decreasing for several years as people move to the city for economic reasons, and as an aftermath of agrarian reform. The number of dairy cows in the Lima region has dropped from 200,000 a few years ago, to less than 25,000 due to the encroachment of the growing city of Lima on the farmland formerly occupied by dairies. Agrarian reform has also served to decrease the size of livestock production establishments. Peru imports meat from Argentina, milk from New Zealand and leather from Colombia, Bolivia and Chile. The only live animal exports are baby chicks to Chile and Bolivia.

There is illegal movement of livestock into Peru from Ecuador and Bolivia when prices are higher in Peru. Conversely, there is illegal movement from Peru into Bolivia and Ecuador when livestock prices are higher in those countries.

The main animal health campaigns are against Foot-and-mouth disease, Hog cholera, Rabies, Brucellosis and Tuberculosis. Programmes for Brucellosis and Tuberculosis in the country's large dairies are financed by the producers themselves.

Peru is located on the west coast of South America. There are two diagnostic laboratories, one in Cajamarca and one in Arequipa. Both laboratories would need equipment and staff training in order to serve as NWS identification centres. Peru's quarantine system is being reorganized and is therefore inactive. The new organization will be called "Defensa Pecuaria". Animal health activities are covered by the Animal Health Police Law (4638 of March 23, 1923). This law guides sanitary control by establishing measures for defense against the risks of exotic diseases and measures for the control of endemic animal diseases. The law also provides general provisions for the import and export of animals and animal products and a guide for the control of animal movement.

Myiasis

NWS myiasis is found throughout the year in Peru. All species of domestic animal are affected, most frequently cattle. Information was gathered from livestock producers, the Ministry of Agriculture and the Fund for Livestock Raising (FUNGAL) in the Department of Piura.

The highest incidence of myiasis is in the Amazon basin, according to representatives of the Fund for Raising Dairy Cattle. Among the most heavily infested areas are the departments of Loreto, San Martin, Madre de Dios and Ucayali, in jungle area near the Brazilian border. A study conducted in 1975-77 of the incidence of myiasis in Pucallpa, Ucayali, showed that more than 75% of cases occurred in baby calves. The study covered myiasis cases for the three-year period in a

herd of 465 (\pm 59 during the three-year period) Nellore cattle. The herd was 51.6% adult, 32.8% middle sized and 15.6% calves. It was located in the Pucallpa zone, where the annual rainfall is about 1600 mm and the average temperature 25.2° C with less than 1° C difference between the dry and rainy seasons. The basic purpose of the test was to determine: myiasis prevalence; location of the lesions; severity of the lesions produced, and; number of treatments required.

The lesions produced were classified in accordance with the number of larvae found in the wound, with 12.3% classed as light (< 5 larvae), 78.4% were classed as medium (5 - 40 larvae), and 9.3% were classified as heavy (> 40 larvae). There was a significant difference each year in the prevalence of infestation, with 32.7% of the animals in the herd infested in 1975, 12.4% in 1976, and 31.3% in 1977. The first treatment was all that was needed for recuperation in 76.3% of the cases, while 18.6% required a second treatment and 5.1% required more than two treatments. There were a total of 333 cases of NWS in the herd during the three-year period, with 41% in adult animals, 38% in middle-sized cattle, and 25.4% in baby calves. Since more than 75% of the cases occurred in calves, an effective programme to control infestation in that age group would greatly reduce NWS myiasis in cattle.

NWS is a persistent problem in zoo animals. For example, in 1991, a Corriedale ram had a chronic wound on its sternum which became infested. The infestation was cured with a local product called “matabicheras” (which translates as screwworm killer). Unfortunately, whenever the animal laid down it knocked the scab from the wound and it became reinfested. The animal became reinfested several times during the year until it was put down. In order to better understand the extent of the problem in zoo animals, zoo managers need to keep track of myiasis cases and report them to animal health authorities for tabulation.

According to the Director of the Department of Transmissible Diseases of the Ministry of Health, NWS myiasis in humans is a problem but it receives little attention and case records are not maintained. Between 1952 and 1954, eight humans were treated for NWS myiasis in Lima. The cases were successfully treated using fresh Albaca leaves (*Ocinum basilicum*) or by irrigation of the nasal sinus using a 125 solution of boiled leaves from the same plant.

The NWS is found in Peru throughout the year. It is endemic in the coastal area and in Andean valleys below 2500 m, and the Amazon region is reported to be heavily infested.

NWS cases are not reported so there is no information available concerning the number of cases, or their seasonal incidence. However, the frequency of pesticide use in treating wounds is an important indicator of case incidence when no other information is available. Further studies are needed to define incidence rates and geographical distribution.

There is no campaign to control or eradicate the NWS, nor are there people trained in the identification of NWS flies or larvae. Control in individual animals is the responsibility of the ranchers, who generally use medications containing insecticides to treat infested wounds and to prevent wounds from becoming infested.

SURINAM

Status: Screwworms endemic

Background

The country has a rainy tropical climate, with an average temperature of 27° C. Surinam has a developing mixed economy, in which both the public and private sectors participate. Bauxite mining, aluminum production, public services and agriculture are the largest sectors of the economy.

Cattle numbers have doubled in the past 10 years, but milk production has not kept pace and is now quite low. The dairy plant in Paramaribo uses imported powdered milk to produce 7.8 million litres of milk as compared to 3.4 million litres from local production. With the exception of milk and milk products, domestic demand for livestock products is met by domestic production.

Swine production has been on the increase since 1987, but, as with poultry producers, swine producers must depend heavily on imports for production supplies such as feed and drugs. Shortage of the hard currency needed for such imports is slowing the growth of the entire livestock industry.

Beef cattle are mostly zebu crosses, dairy cattle are mostly Holstein crosses, sheep and goats are African breeds improved in Barbados, and swine and poultry, in the industrial type production units, are the modern high production breeds.

The legislation governing animal health was initiated during Dutch rule of the country and has been subsequently updated as necessary. Legislation governing meat inspection follows FAO guidelines.

Brucellosis was introduced into Surinam in the 1970s during massive importation of zebu cattle from Central America, but has been virtually eliminated by a well-implemented eradication plan. Parasitic diseases such as Anaplasmosis and Trypanosomiasis are endemic throughout the livestock industry.

The NWS is present throughout Surinam, located on the north central coast of South America, although its presence in the forested part of the country is not proven. Losses in domestic livestock and wildlife are significant partially because of the heavy rate of infestation, but also because of a shortage of hard currency needed to purchase insecticides to treat infested wounds. The incidence of NWS is thought to be increasing due to the lack of suitable drugs for treatment. As long as livestock producers lack the resources to prevent and treat infestations, the presence of NWS will reduce livestock productivity in Surinam. Losses could be significantly reduced if supplies of wound treatment chemicals were available at prices producers could afford. Information such as the number of deaths resulting from NWS infestations, and the cost of treating cases, is not collected. Therefore, a precise estimate of losses due to the NWS is not available.

URUGUAY

Status: Screwworms endemic

Background

Uruguay is the smallest country in South America and forms a wedge between Argentina to the west and Brazil to the north and east. To the south is the Atlantic Ocean and the Rio de la Plata estuary. The country is shaped like a huge valley, which is well drained by rivers. Its highest point is 300 m above sea level.

Livestock production is more important than other agricultural activities. The livestock population, estimated at 37,750,000 is large when compared to the human population of about 3 million

Uruguay has a very large sheep population that produces about 100 million kilograms of wool per year. About 90% of that amount is exported, principally to Europe. Sheep ranches vary in size with the largest having up to 60,000 head of sheep and usually a few cattle.

The dairy industry is located mainly around Montevideo. Sheep and beef cattle are concentrated in the centre and northern part of the country.

The principal animal disease problems, apart from NWS myiasis are: Fascioliasis (caused by the liver fluke *Fasciola hepatica*) in sheep, Anaplasmosis, Babesiosis, lice and the horn fly. Foot-and-mouth disease, often considered the most important animal disease in South America, has not been found in Uruguay for more than 30 months. A compulsory FMD vaccination programme remains in effect.

Imported animals are held in quarantine in authorized ranches, under the supervision of veterinarians who are accredited by the Animal Health Department of the Ministry of Agriculture, Livestock and Fish.

Since 1980, Uruguay has exported live animals to Japan and the Arab countries. Dairy animals are exported, mostly to Brazil and Paraguay.

Importation from Argentina is rigidly controlled at four bridges across the Rio Uruguay. Imports from Brazil are more difficult to control since there is a 700 km border and only three authorized ports of entry. Livestock has a tendency to move across the border toward the side with the highest price. Livestock inspection is also carried out at seaports and airports.

Myiasis

NWS is present in high numbers throughout the country in summer, with infestation being most frequent between November and April. A veterinarian in private practice in Montevideo reported that he treated from 100 to 150 cases of myiasis in small animals each year.

A five month survey in 1991 of 382 livestock producers conducted by scientists from the Parasitological Institute of the Veterinary Faculty in Montevideo, confirmed that skin myiasis was a factor of major economic importance in Uruguay. Myiasis was found in all of the establishments surveyed. The general prevalence rate in the animals included in the sample was 4.5% in bovines and 6.2% in sheep. Of the infected animals, the death rate was 6.5% in bovines and 18.5% in sheep. For cattle, prevalence was greatest in the Southern zone. The data collected were also evaluated according to the various zones of Uruguay. The prevalence of infection in sheep was greatest in the Central and Southern zones.

In cattle, screwworm infestations are most often found in the navel and in sheep the feet are the most common site, usually as a complication following foot rot.

The survey revealed that the NWS is present in very high numbers throughout the summer. In winter, temperatures drop to as low as 0° C in much of the country, preventing screwworms from completing their life cycle during normal years. Therefore, the insect is rarely found in winter. However, additional studies are needed to determine with more precision how far south the insect survives in a normal winter.

The survey included a sampling of producers from each region of the country. A detailed report of this study can be found in the Uruguayan publication *Veterinaria*, Volume 288, N° 114, October-December 1991.

NWS infestations are most frequent in November and are almost never found during the months of April, May and June.

There is no information which suggests that human myiasis is a big problem in Uruguay, but cases presumably occur.

There are about 150 veterinary clinics in Montevideo. Each year these clinics sell an estimated US\$ 900,000 worth of medicines for treating myiasis in animals

The NWS outbreak in Libya may have originated in sheep imported from Uruguay. Because of the outbreak, Uruguay lost its market for live sheep in the Arab countries. This incident serves to remind Uruguayan officials and producers, of the advantage of eradicating NWS. Animal health officials and livestock producers alike expressed a desire to participate in a regional eradication programme. Government officials and livestock owners were interested in and pledged their support for a regional screwworm eradication programme. However, the greatest concern expressed was “who would pay?”

The terrain and climate of Uruguay do not present any obvious technical problems toward eradication. The topography of Uruguay is like a vally without hills around it. Therefore, the aerial

dispersion of sterile flies can be accomplished with great efficiency. The winter months will aid in eradication, reducing the length of time needed for sterile fly release and, therefore, the cost.

VENEZUELA

Status: *Screwworms endemic*

Background

The most northerly South American nation, Venezuela has coastlines on the Caribbean Sea and the Atlantic Ocean. There are six major geographical regions in Venezuela:

1. An area incorporating a narrow coastal strip, the continental shelf and more than 300 islands and keys;
2. The densely populated northern coastal mountain range, where Caracas and the Federal District are located;
3. The Western transitional zone between the coastal mountain range and the Andes, with its semiarid valleys and plains and Coro's unusual sand dunes;
4. The densely populated Andean mountain region bordering Colombia and site of Venezuela's highest peak, Pico Bolivar (5 007 m);
5. The flat, tropical savanna, or llanos, that lies between the coastal range and the Orinoco river; and,
6. A tropical savanna and jungle known as Guayana, south of the Orinoco River, which comprises 45% of the national territory and is home to Venezuela's small indigenous population.

The climate varies from region to region. Most of the country is tropical or subtropical but temperatures give tem range in °C between the Andean heights and the coastal areas. The period from December to April (summer) is relatively dry in the northern half of the country, with more frequent rainfall between April and November (winter). In the far south, heavy rain falls throughout the year, while in the desert-like region around Coro there is very little rain.

There is considerable loss among imported European breeds due to parasites and the heat, therefore, most cattle are crossbreeds which are more resistant to both these factors, but which still retain some of the higher production characteristics of the European breeds.

Venezuela has animal health programmes for Tuberculosis, Brucellosis, Venezuelan Equine encephalitis, Equine infectious anaemia and Classical Swine Fever. The progress of these

programmes has been slowed due to internal restructuring of the Department of Agriculture and the country's economic crisis.

There is no health inspection of livestock during transportation from one state to another or to slaughtering establishments. Venezuela has two quarantine stations, but they are used primarily for screening import livestock.

Myiasis

The NWS exists year-round throughout Venezuela. Although the presence of the insect has been confirmed by the identification of recently collected field samples, a countrywide sampling has not been conducted, nor has the seasonal occurrence been evaluated. Nonetheless, producers believe that screwworms are most abundant at the end of the rainy period, just before the dry season.

On farms which use intensive production techniques, wounds are routinely treated with repellents. The treatment regimen is the same during each season, wet or dry. On the larger ranches, where livestock are seen infrequently, the treatment of wounds and of the umbilicus of newborn animals is more sporadic.

The NWS has a definite impact on livestock in Venezuela. Umbilical cords, dehorning wounds and hot brand wounds become infested and, if not promptly treated, animals lose weight or die. Producers spend a significant amount of time inspecting livestock and treating wounds. There are also significant expenditures for wound treatment drugs but these losses and costs have not been quantified. At least two NWS studies have been conducted in Venezuela. The first was in 1968 and the second in 1991. At the time of the FAO mission to Venezuela there were no NWS investigations in process.

The prevalence and geographic distribution of NWS could not be determined. However, it has been established that NWS exists in the north of the country. Similar studies have not been conducted in the southeast and the seasonal occurrence of NWS is not monitored. Those associated with livestock production have lived with NWS all their lives and therefore do not consider it to be of major importance.

Animal health officials and livestock producers expressed great interest in using the Sterile Insect Technique (SIT) to eradicate NWS from Venezuela.

There is no information indicating that NWS causes a significant human health problem in Venezuela. However, experience in other countries indicates that where the NWS is found in domestic animals and wildlife, it is also an occasional problem in humans, particularly in the lower socioeconomic class. Venezuela's Department of Zoonosis does not recognize NWS myiasis as a threat to human health.

Personal observations suggest that the entire country is heavily infested with the NWS, although this needs to be verified through surveys in the various livestock production areas. The pest causes considerable losses to livestock producers. However, the cost of losses from factors

such as animal deaths, weight loss, meat and milk are not produced, and calves that die a few days after birth are not documented. In order to establish the economic feasibility of eradication, a countrywide NWS survey is needed. The survey should be designed to enable a calculation of the true cost of living with the NWS.

3.0 THE CARIBBEAN

INTRODUCTION

The NWS is endemic in the Dominican Republic, Haiti, Jamaica and Trinidad and Tobago. In October 1995, the International Office of Epizootics was notified for the first time of a NWS outbreak in Cuba.

The Director General of Cuba's Institute of Veterinary Medicine (IVM) informed the OIE that the outbreak had occurred in March 1995 and all provinces of the country were affected, except Juventud Island.

CUBA

Status: Screwworm endemic

Background

Following official confirmation to OIE (5.10.95) of the presence of NWS in Cuba and based on a request from the Government. FAO-EMPRES (Emergency Prevention System for Transboundary animals diseases and plant pest) mission was sent to Cuba to assess the epidemiological situation and to investigate the local control and containment measures, the training needs and requirements for contingency plans to prevent further spread to unaffected areas and to advise on the attitude of the countries in the region, particularly Cuba and U.S.A. The finding of the mission were that a total of six provinces in the central, eastern and western part of the country were visited and interviews were held in the district veterinary services by the mission, confirming and finding 31 more NWS cases in addition to the 230 originally reported. There is evidence of infestation on all Cuban territory with the exception of Juventud Island. The disease pattern is the same as that which occurred on the continent; no human cases have been recorded yet, and myiasis cases are cured with a product made by the Veterinary Medicine Institute (Lindane, vaseline, and essence of tremeintine) and with home remedies. Due to the special economic period in the country, there are no funds to purchase the ingredients for the better larvicide product. Misunderstandings were also found in the myiasis agent identification. This has created an epizootic situation at national level and has increased the parasite population increasing the possibility of human's cases. The Cuban Government will prepare a request to FAO for a Technical Cooperation Project (TCP) which will focus on early Reaction (containment, control, geographical distribution, seasonal abundance, zoonosis elements, and public awareness). The Cuban authorities state that in the future NWS sterile flies produced by the Joint Mexico-U.S.A. Commission will be required. The Government will be in agreement if the supply of NWS flies falls under the technical recommendation and intervention of FAO.

The Cuban Government asks FAO for a TCP and FAO approves a two years project beginning in 1996. It provided the services of international experts and marked the IMV as the

Cuban Government Agency responsible for the project. The objectives was to strengthening of the food self-sufficiency with an emphasis in animal production and public health improvement through the characterization of the infestation and establishing surveillance, prevention and control systems and providing for their continuity, including NWS impact determination on the economy and production.

Myiasis

At the end of the project NWS was found in all provinces, year round, in all animal species, more frequently in cattle, sheep and pigs. Seasonal variations are not consistent and could easily obey more to fieldwork level than to natural variations. During 1995 a total of 394 NWS cases were reported, in 1996 increase to 1 102 cases and in 1997 a total of 4 407 NWS cases were diagnosticaed. Even that in 1997 are four times of those found in 1996 they are considered low compared with the natural NWS population. Because of lack of vehicles, fuel and spare parts which also affect public transport by road which is practically non-existent, this affects sampling specially in areas far from the diagnostic laboratories where personnel that collects a sample has to go to the lab and back, by their own means, while leaving their normal obligations unattended, which causes that a lot of myiasis are not reported. Delay on sample tube and insecticide distribution due to the present difficulties in Cuban foreign commerce also caused some underreporting. To alleviate the situation an epidemiological network was created under the responsibility of the IMV using adequate computers and Epi info software, for collection and analysis NWS data, as well as the vehicle pool was improved, to support sampling reporting.

Adult tramping activities take place using two traps, in a rural location 30 kilometres south to the Havana City, during November 1997 capturing 2 215 NWS flies and 17,969 of other diptera. Which indicates a very high population even do there is need to place more traps more, for a longer period of time to have statistically representative results.

A total of 26 pens were set up each with one sentinel sheep working the first 10 days of the month for five months (Oct 97 – Feb 98) Collecting 77 NWS egg masses. While overall the collect was low it was done almost immediately in several areas giving strength to the theory of a high NWS population.

The professional and technicians were trained on the problem by means of a course given to train trainers on NWS control and eradication. Which was replicated later in all Cuba. Also a communications campaign was done and is the first done in Cuba, involving mass media and printed materials. Also a course on NWS artificial rearing was done and the first Caribbean high security laboratory for NWS rearing was constructed, with the porpouse to rear enough biologic material to prepare a sexual compatibility and competitiveness test, between the Cuban NWS strain and the one reared in Tuxtla Gutierrez, plant.

NWS is of little importance to Cuba's public health because of cultural factors and free medical services that treat almost all wounds immediately. Till February 1998 only three human NWS cases were reported.

An economic study on NWS losses was prepared; it is the most complete survey done in the Caribbean. It evaluated costs of specific and unspecific (secondary infections) myiasis treatments, men/hours of veterinarians or technicians for treatment, deaths and humanitarian slaughter, production losses (direct costs) and national surveillance and farm surveillance costs (indirect costs). Total annual losses were calculated at 14,229,000 Cuban pesos at national prices and US\$33,688,000 at international prices.

Benefit-Cost conservative assumptions were made as to when the benefits might accrue: one-third after the first year, two-thirds after the second year and the full benefits after the third year. Benefits were simulated over 10 years and 20 years; a standard discount rate of 10% was used. The analysis was carried out only in terms of international prices (US\$), for comparability with other studies and because most of the funding for its eradication is expected to come from external sources.

The eradication programme is clearly justified economically, as well as being a necessary part of the wider regional programme. Sensitivity analysis shows that on-farm labour costs would have to be less than 10% of those estimated before the investment would be unprofitable.

An eradication plan was prepared during the project, using Chilled Fly System and working from Ciego de Avila's airport, as a main distribution centre. Covering Cuba by halves, beginning on the oriental half of the country, Eradication time is set at four years and an estimated cost between US\$ 26 to 30 million. A Preparatory Phase, previous to the national programme is contemplated. Focussing in the NWS eradication from the Juventud Island, with the boxed NWS sterile flies use. This Phase will eliminate the need to fly over the Caribbean with a high tech aeroplane from Ciego de Avila to the Juventud Island, eliminating a high flight cost, train Cuban personnel on eradication methods and show the factivity of the NWS eradication to the Caribbean Sub-region. The programme will be supported by a strong animal movement control at the Sancti Spiritus province, due to most animal movement goes from east to west thus diminishing the risk of reinfestation of a free zone in the oriental half.

THE DOMINICAN REPUBLIC

Status: Screwworm endemic

Hispaniola is part of the Greater Antilles group of islands in the Caribbean. It is the second largest island in the group, after its neighbour, Cuba. The Dominican Republic makes up about two-thirds of the Island of Hispaniola and covers an area of 48,734 km². The Republic of Haiti occupies the rest of the island.

The Dominican Republic has a quarantine law, but lacks the infrastructure for enforcement activities. Brucellosis and tuberculosis, eradication campaigns are carried out primarily in dairy herds.

Myiasis

There are several types of flies that cause myiasis in the Dominican Republic. These include, *Macellaria sp.*, *Lucilia sp.*, and *Musca domestica*, but the myiasis are reported to be light, economic losses are probably heavy. There is no central programme for reporting, control or eradication of NWS and there are no records to show the true extent of screwworm myiasis and the losses it causes.

According to livestock producers, screwworm cases occur in all parts of the country and without seasonal variation. Most neglected wounds and untreated umbilical cords on newborn animals soon become infected. For example, a producer dehorned three animals and did not treat the wounds. On the third day, each animal was visibly infested with larvae and on the fourth day, third instar NWS larvae were removed from the wounds.

The most common site for screwworm myiasis in the Dominican Republic is the umbilicus on newborn animals. Secondary infections are often observed in untreated infested wounds. NWS myiasis is estimated to cause 4% mortality among cattle. The annual cost of living with NWS is estimated at US\$ 18 to US\$ 25 million. This includes larvicides, antibiotics to treat secondary wound infections, the cost of inspection and treatment, weight loss and deaths. In addition, considerable losses occur in the wildlife population of the island.

Identification of NWS larvae and flies is carried out at the Parasitology Department of the Government's Central Veterinary Laboratory.

Unofficial reports indicate that human myiasis is a common occurrence. Three recent cases reported from the area of Monte plata included one in a baby girl, one in a chronic wound on a man's foot and one in an adult with an untreated cut. In the Province of San Cristóbal, on November 22, 1984, an infestation was found in the umbilicus of a two-day-old infant. Fourteen larvae were taken from the wound. These were individual cases reported to FAO consultants. There are no long-term statistics which would enable a judgement on the relative importance of NWS myiasis in humans as compared with other diseases.

NWS is present throughout the country and causes significant losses in domestic livestock. The secondary costs, for items such as medicines and veterinary care, have not been studied, but are apparently significant.

The climate and terrain are similar to other countries where the sterile insect technique (SIT), has been successfully used in eradication programmes. Eradication of NWS is feasible from a technical point of view and logical from an economic point of view. The NWS can be eradicated from the Dominican Republic using SIT, along with other eradication tools, in a well-managed eradication programme.

HAITI

Status: *Screwworms endemic*

Haiti covers a land area of approximately 27,400 Km² on the island of Hispaniola in the Grand Antilles group. The country consists of two mountainous peninsulas that enclose the Gulf of Conave. The ranges are separated by valleys and plains, however, about 80% of the land area of Haiti consists of mountain ranges and high plateaus. The Massif du Nord, one of Haiti's great mountain regions, is a continuation of Hispaniola's Cordillera Central and has a number of peaks in the 1000 to 1500 m range. The mountains of the southern peninsula reach a maximum altitude of about 2680 meters at Pic La Selle near the border with the Dominican Republic. The Artibonite, Haiti's most important river, originates in the northern peninsula and flows to the Gulf of Gonave. Haiti's territory incorporates two large inhabited islands, Tortuga off the north coast and Gonave in the gulf.

The country's climate is tropical, with little seasonal variation. The annual average temperature is 27° C. Annual rainfall varies from 510 mm on the coast to 2540 mm in the mountains.

Because of heavy losses during the past two years, the size of the livestock population is difficult to estimate.

Haiti's severe economic and political crisis worsened during the 1994 embargo. There are almost no funds for animal health programmes. Livestock have not been vaccinated against endemic diseases such as rabies and anthrax for more than two years. Tick infestation is at a very high level because the needed pesticides are not available. Brucellosis and tuberculosis are widespread and there are no resources to conduct control programmes.

The critical lack of resources has brought animal health and quarantine activities in Haiti to a standstill.

Myiasis

Screwworm incidence is high throughout Haiti and causes considerable losses in domestic livestock. However, other diseases such as Tuberculosis, Brucellosis, anthrax and blackleg, as well as tick infestation, are considered to be more serious problems. Veterinarians associated with the livestock industry are aware of the NWS problem and know that the country is heavily infested. The secondary costs, for items such as medicines and veterinary care, have not been studied but are significant.

NWS is also a problem for the human population, affecting people of all ages. These cases serve to stress the desperate situation faced by the Haitian people, many of whom suffer from malnutrition and lack medical services.

Haiti's climate and terrain are similar to other countries where the sterile insect technique (SIT) has been successfully used in eradication programmes. The use of the SIT, along with the other eradication tools, in a well-managed eradication programme would result in the eradication of

NWS from Haiti. Government officials are very receptive to the idea of NWS control, or future eradication programme, but are hampered by the lack of resources.

JAMAICA

Status: Screwworms endemic

Background

Jamaica is part of the Greater Antilles group of islands in the Caribbean. The island's principal rivers include the Great River in the northwest, the Grande River in the northeast and the Yallahs River in the south-central part of the island.

Jamaica has a tropical climate and is well known for its trade winds, which blow almost constantly. The island is frequently affected by hurricanes. Temperatures range between 20 and 33° C over most of the island.

Myiasis

Since 1970 both the Government of Jamaica (GOJ) and the Jamaican Livestock Association (JLA) have been trying to eradicate NWS from the country in an effort to improve the public health problem and to stop the livestock economic losses amounting to US\$ 3.5 million per year in Jamaica (data from 1982).

During a FAO NWS mission on March 1993, its find that screwworm was a serious and costly problem for the Jamaican livestock industry. There are heavy infestations of screwworms throughout the island, with 100% of untreated wounds becoming infested, with no seasonal variation. The chief of the diagnostic laboratory in Kingston stated that screwworm infestations account for 25% of all cases seen by Jamaican veterinarians. Jamaican animal health authorities, livestock producers, and animal health researchers have long recognized the NWS as a major livestock pest. The JLA pledged its strong support for any effort to eradicate the pest. While there are some organized screwworm control activities, it is unlikely that Jamaica can provide all of the resources necessary for an eradication campaign.

The importance of human screwworm myiasis cannot be quantified, since no records are maintained. However, experience in other countries indicates that where there are many cases in animals, there will also be cases in humans. A Jamaican sanitary law governs the importation of livestock. Most importations come from the United Kingdom, Canada, and the United States. A quarantine facility, called Palizada, is located on the Peninsula near Norman Manley International Airport.

There are no regulations governing local movement of cattle. However, cattle are sometimes moved with a veterinary certificate which verifies their health and authorizes their movement. If necessary, the region or ranch involved may be placed under quarantine. While there are no inspections along the roads, good sanitary control exists.

During December 1995, as an answer to the NWS outbreak occurrence in Cuba, The Jamaican National Committee for the NWS Control & Eradication was created and integrated by GOJ, JLA, FAO, the West Indies University (WIU) in order to organize, implement and operate an NWS control/eradication campaign in Jamaica. As well as, a Jamaica, NWS Eradication Fund (NWSEF) was implemented by the GOJ and JLA, in order to support part of the local cost of the eradication campaign and to show to the international community its interest to eliminate the disease from the national territory. The NWSEF will be constituted by US\$ 2.7 (JAM\$100) for each animal slaughtered animal in the country, the daily slaughtered animal average in Jamaica is estimated between 300 to 500.

On April 1996, the NWS National Committee of Jamaica organized the first “NWS Research meeting” with the participation of all the institutions forming the Committee and the Agriculture Research Services (ARS) of the United States Department of Agriculture (USDA). The objectives were: to interchange scientific experience between institution leaders in NWS research, in mainland and Jamaica; to begin in a coordinate manner the activities on the scientific information collection data, to be used in the future to evaluate control methods for applicability to local condition and identify the best cost/benefit alternative for control and eradication strategies; to study how to validate in Jamaica the entomological scientific methods related with the NWS fly surveillance, monitoring and control developed, in North and Central American territories.

During August 1997, a National Training Course on NWS control and eradication, with emphasis in SIT, was organized by the GOJ, FAO and the International Atomic Energy Agency (IAEA), which was held in Kingston, Jamaica. Parallel to the event, a Project Document for NWS eradication from Jamaica was prepared, to be used as a main document possible donors identification to implement the NWS eradication programme in Jamaica.

On July 1998, the GOJ begins with a NWS eradication programme supported with USDA loan and with the cooperation of international agencies in particular IAEA and FAO. The cost of an eradication programme for Jamaica is about US\$ 9 million and will require 3 years for completion. A plan for the eradication has been developed and the funds for the Jamaica programme have been obtained from both national and international sources. Sterile flies will provided from the NWS flies rearing factory located in Tuxtla Gutierrez, Mexico, property of the Mexico- U.S. Commission for the Eradication of Screwworms (MUSCES). Twenty million pupae will be delivered, by air, once a week to Kingston, Jamaica. The pupae will emerge in 2 large, heated chambers and will be attracted (fly) into a lighted, cold chamber (10° C). The inactive flies will then be collected and released as chilled adults over Jamaica. The procedures and methods used will be identical to those used in the eradication programmes now underway in Central America

TRINIDAD AND TOBAGO

Status: Screwworms endemic

Background

Trinidad has a tropical climate with high humidity. The coolest months are January and February, when the average minimum temperature is 20° C. The warmest months are April, May and October, which have an average maximum temperature of 32° C. There is a significant difference between day and night-time average temperatures. A major dry season occurs from January to May and a short dry season from September to October. The prevailing winds are the northeastern trade winds. The islands are outside the main hurricane zone. Rainfall varies widely across the islands, with some parts of the rainforest receiving in excess of 2500 mm per year.

Agriculture accounts for about two per cent of Gross National Product (GNP) and provides employment for about 10% of the labor force. Pasture land occupies about two per cent of the national territory.

The importation of livestock from South America is prohibited. Most of the replacement breeding stock is imported from the USA or the United Kingdom.

Myiasis

NWS is endemic on Trinidad and Tobago. Cases are found throughout the year, but may be slightly higher in number in the drier months from December to May. Wounds left untreated usually become infested. Many livestock producers see their stock every day and treat wounds regularly. Interviews with a random sample of livestock producers and animal health personnel on the island of Trinidad revealed that 82% have found at least one case of myiasis in livestock and that 65% examined their livestock daily for wounds and screwworm infestation. The estimated annual cost of surveillance and medication is US\$ 25.70 per animal.

Studies by scientist and graduate students of the occurrence of NWS on Trinidad and Tobago have shown that NWS infestations are regularly found on most species of domestic livestock. It was also found that treatment of NWS- infested animals takes up a significant amount of government veterinarians' time. Private veterinarians also apparently spend a lot of time treating screwworms, but statistical information to confirm this was not available.

No information is available on the incidence of human myiasis.

ANTIGUA AND BARBUDA

Status: Screworm-free

Background/Myiasis

Aruba is a small island from the Netherlands Antilles on 1 January 1986, becoming an autonomous member of the kingdom of The Netherlands, the same status as the whole of the Netherlands Antilles.

The island's climate is dry-tropical and the temperature is mild throughout the year. Cactus and other desert plants are prevalent throughout the island.

Although there is some livestock production on the island, tourism is the major industry. Livestock production must be supplemented by importation in order to supply local demand for meat. Sheep and goats are imported from Venezuela and Colombia for slaughter at the municipal slaughterhouse. Breeding swine and horses are also imported.

There was an outbreak of NWS on the island from December 1985 to June 1986, probably caused by importation of slaughter cattle from South America. Veterinarians reported treating hundreds of cases of screwworm myiasis in various species of animals. Many infested animals had large wounds, up to the size of a man's fist. Since that time the island has remained NWS-free, but live animals continue to be imported from South America, making the reintroduction of NWS likely, even with current system of inspection and other safeguards before shipment.

There is no indication that human myiasis has ever been a problem.

BONAIRE

Status: Screworm free

Background/Myiasis

Bonaire is located in the Caribbean off the coast of Venezuela, 48 km east of Curacao. It is prohibited to import livestock from South America. The last importation was from Venezuela in October, 1991. The island has only one veterinarian.

Bonaire has never recorded a case of screwworm and local officials report that it is rare to find myiasis from any cause. Livestock owners normally see their animals daily and there is no indication of a myiasis problem. The arid climate may be a contributing factor. Under the present circumstances the risk of infestation is low.

However, Bonaire would be a prime target for a screwworm outbreak, due to its favourable climate and proximity to NWS-infested South America.

There are no records of human myiasis.

THE BAHAMIAN ISLANDS

Status: Screwworm-free

Background

The Bahamas are located about 97 km east of the south Florida coast of the US and extend southwest to within 80 km of Cuba.

The islands have a dry tropical climate. Rainfall is normally highest during the summer season from June to September. The average yearly rainfall is 1168 mm, but there is considerable variation throughout the islands. The average summer temperature is 28° C and the average winter temperature is 21° C.

Livestock production is not a major industry, although there are government and private efforts to increase production. The main constraint is the inability to produce sufficient livestock feed locally, which means feed must be imported, primarily from the United States. As a result of the high cost of imported feed, locally-produced meat cannot compete in price with imported meat.

Myiasis

The veterinary service in the Bahamas is performed by government veterinarians, who have intimate knowledge of the animal disease situation on the islands. Veterinary staff are convinced that the NWS does not exist on the islands – none have seen nor heard of signs or symptoms consistent with NWS infestation.

The islands which best represent the livestock industry of the country were surveyed: Providence, Inagua, Eleuthera, Long Island, Abaco and Gran Bahamas. Interviews were conducted with governmental officials, veterinarians, medical doctors, public health officials, farmers, extension officers, conservation officers and hunters. Facilities visited included the largest swine production facility in the Bahamas, a government livestock production farm and a wildlife sanctuary.

Although there is little surveillance of wildlife, it is very unlikely that NWS could be present in feral animals and nonexistent in the domestic livestock and human population. The evidence indicates that NWS does not exist in the Bahamas.

A small animal practitioner reported that he had occasionally observed myiasis in animal wounds. However, larval samples which he submitted were not NWS. There were several other

reports of larvae-infested wounds, but it was concluded that these were cases of long neglected wounds that became infested by one of the common blow flies. Most importantly, producers who routinely produced fresh wounds through animal surgery such as castration, reported no evidence of NWS infestations.

The Director of Public Health had not received any reports of human myiasis in the Bahamas.

THE CAYMAN ISLANDS

Status: Screwworm-free

Background

There are three islands in the Caymans: Grand Cayman, where the capital, Georgetown, is located, Little Cayman and Cayman Brac. These islands are located in the Greater Antilles about 160 km south of Cuba and 290 km northwest of Jamaica.

The climate is tropical and the average temperature is 27° C, with a range of 13 to 35° C. The average yearly rainfall is about 1420 mm and the heaviest rains occur in September and October.

On Grand Cayman there is an estimated 1500 head of livestock, 300 head on Cayman Brac, and there only dogs and cats on Little Cayman.

Myiasis

Government veterinary officers do most of the medical treatment of animals on the islands. The principal animal health problems are ticks and liver flukes in domestic animals and heartworm in dogs. Both the chief veterinary officer, who has served in that capacity for 12 years, and his assistant, who is in contact with livestock almost daily, are convinced that the NWS does not occur in the Caymans. As part of a large mosquito research project on Grand Cayman, extensive insect trapping has been carried out. A review of the literature on the project revealed no reference to NWS.

A veterinary practitioner dealing primarily with small animals reported that he had occasionally seen myiasis in tick and flea skin irritations on dogs and cats. He said that the wounds were generally old, neglected and suppurative, with surface maggot infestations unidentified.

The Public Health Director for the Caymans reported that he had not received any reports of myiasis in humans.

THE TURK AND CAICOS ISLANDS

Status: Screwworm-free

Background

These islands are generally flat with only a few low hills and their climate is similar to that of the Bahamas.

There are cattle, donkeys, horses, pigs and goats on the islands, but no official census is kept. The animals are not feral, but in most cases they are not confined. There are also dogs and cats.

Myiasis

Interviews were conducted with government officials, public health officers, a veterinarian and farmers. Four islands were visited: Grand Turk, South Caicos, North Caicos and Providenciales (where there are domestic pets, but no livestock).

On Grand Turk, the chief environmental officer and the sanitation officer see many of the animals and confer regularly with livestock owners. Neither were aware of any cases of myiasis on the island.

A veterinarian on Providenciales reported that he had seen no evidence of the NWS on any of the islands. He is convinced that it doesn't exist in the island.

On South Caicos, the health officer and his assistant, who see the animals and talk to the animal owners about their problems had not seen or heard of any animals with larvae infested wounds.

On North Caicos, the health officer and the vector control officer, who have contact with all of the animals on the island, have not seen or heard of any larvae infested wounds.

None of the 14 people interviewed has seen animals or humans with larvae infested wounds. All are convinced that screwworms do not exist in the Turk and Caicos islands. There are feral animals on some of the islands that were not surveyed; however, it is highly unlikely that a NWS infestation could exist in feral animals without spreading to domestic animals and humans. There is ample evidence that the NWS does not exist in the Turk and Caicos Islands.

DOMINICA

Status: Screwworm-free

Background/Myiasis

There is no historical record of the NWS on Dominica. None of the animals examined showed any signs of infestation with the NWS or any other myiasis and it is concluded that the NWS does not exist on Dominica.

ST. KITTS (St. Christopher) AND NEVIS

Status: Screwworm-free

Background/Myiasis

There is no record of NWS infestation on these islands. None of the animals examined showed signs of the NWS infestation. The wild donkeys on Nevis are being eliminated by shooting. There has been no evidence of NWS infestation on any of the 65 donkeys killed to date. It is concluded that the NWS does not exist on St. Kitts or Nevis.

ST. LUCIA

Status: Screwworm-free

Background/Myiasis

There is no record of the NWS infestation on St. Lucia. None of the animals examined showed any signs of NWS infestation. There have been unconfirmed reports of secondary screwworm infestation in the past but, since no records were kept no further information was available. It is concluded that the NWS does not exist on St. Lucia.

ST. VINCENT AND GRENADINES

Status: Screwworm-free

Background/Myiasis

During a survey for *Amblyomma variegatum* ticks on St. Vincent during June 1992, NWS was not found. None of the animals examined on the islands of St. Vincent and the Grenadines showed signs of NWS infestation and there are no records of previous infestation. Discussions with animal health officials and livestock owners and reviews of records of animal health problems produced no evidence of NWS infestation. It is concluded that the NWS does not exist on these islands.

As part of the planning for a regional programme for the eradication of the tick *Amblyomma variegatum*, a proposed package of the necessary legislation was developed. The legislation provides for regulation of animal movement, quarantine when needed, and mandatory treatment of diseased or tick-infested animals. These same legislative powers would be useful if an outbreak of screwworm should occur in the region.

PUERTO RICO, THE BRITISH VIRGIN ISLANDS AND THE UNITED STATES VIRGIN ISLANDS

Status: Screwworm-free

Background to previous SIT campaigns in the region

The New World Screwworm (NWS) was eradicated from these islands between 1971 and 1975 and they remain screwworm-free. However, it is vital that an awareness be maintained among veterinarians, public health officials and livestock owners of the ever present threat of NWS reintroduction. The climate on the islands is ideal for NWS reproduction and they lie within the area in which NWS is historically endemic and could easily become reestablished.

Although records from Mayagüez and Guánica show that the NWS existed in Puerto Rico as early as 1935, the first U.S. Department of Agriculture record of the disease on the island was made on August 6, 1963. The NWS was first discovered on Vieques (PR) on June 22, 1967, St. Thomas (USVI) on July 11, 1969, St. John (USVI) on July 17, 1969, Tortola (BVI) on December 31, 1969, and Culebra (PR) on January 19, 1970. The outbreak apparent spread of the NWS could be attributed to strong winds. Sufficiently strong westerly winds had been blowing on dates that match the spread.

In the early 1970s, following a successful programme for the eradication of screwworm from mainland USA, the only areas under U.S. jurisdiction where the NWS remained a problem were Puerto Rico and the US Virgin Islands. It is estimated that the NWS losses in Puerto Rico were about US\$ 2.5 million per year and there were occasional cases in humans (Fox & Galindo 1962; Fox et al 1965). For these reasons, and to experiment with the development of the sterile insect technique (SIT) in a tropical environment, a cooperative effort to eradicate the NWS was initiated. The agencies involved included the Government of the Commonwealth of Puerto Rico, the US Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) and the US Air Force. The NWS was also found in the British Virgin Islands. Since the screwworm could fly between the Virgin Islands, it was necessary to include the BVI in the eradication campaign.

The programme to eradicate the NWS from Puerto Rico and the USVI was initiated in July 1971, using sterile flies produced at Mission, Texas. Between July 1971 and September 1972, 2.5 million sterile pupae were shipped each week to Puerto Rico. During that period, the insects were eradicated from the BVI, the USVI and the island of Culebra, 32 km east of Puerto Rico. The shipment rate was increased to 5 million sterile pupae per week in September 1972 and to 14.5 million per week in February 1973.

The disease was eradicated from the island of Vieques, 14 km east of Puerto Rico and south of Culebra, by July 1973. It was also eradicated from Mona Island, 72 km due east of Puerto Rico, at the same time. The last case of NWS myiasis was reported on November 5, 1974. Sterile fly releases were continued until May 3, 1975. A total of about 1.8 billion sterile flies were released during the campaign.

There were two major problems during the early part of the campaign: poor fly quality and inadequate ground support activities. The fly quality problem was addressed by improving the shipping of the flies from Texas and by improving pupae handling to avoid excessive heat build up. Ground support was improved by an intensified public information campaign, mainly to stimulate owner participation in activities such as treating wounds and spraying infested and adjacent herds. The success of the SIT was dependent on ground support activities, which are the mainstay of conventional methods of animal disease eradication.

Despite the eradication of NWS from the Virgin Islands, vigorous screwworm surveillance was needed to avoid the strong possibility of reinfestation. The disease was, in fact, reintroduced in 1989 – not by wind-borne flies, but by importation of an infested horse. Emergency action prevented the NWS from becoming re-established (see under Puerto Rico in this chapter).

BRITISH VIRGIN ISLANDS (BVD)

Background

The BVI, as well as Puerto Rico, and all of the USVI except St. Croix, rest on a common platform that rose from the ocean floor just over 100 million years ago.

There are more than 40 islands in the BVI, with a total land area of about 150 km² and a population of 11,000 (1980 census). The main islands are Tortola (54.4 km²; population 9,200), Virgin Gorda (38.9 km²; population 1,500), Anegada (21.4 km²; population 250) and Jost Van Dyke (9.1 km²; population 150). All of the islands in the group, except Anegada, are of volcanic origin and very hilly, rising steeply from the sea to one or more peaks or a mountain spine along the island length. The highest peaks are Mount Stage (527 m, Tortola), Virgin Gorda Peak (414 m, Virgin Gorda), Mount Bell Vue (385 m, Tortola), and Jost (321 m, Jost van Dyke). In contrast with the other islands, Anegada is a flat coral island composed entirely of limestone, its highest point being only nine metres above sea level.

There are no freshwater lakes on the islands, but there are a number of saltwater ponds, which dry up in the drier months. The two largest of these are on Tortola: Belmont Pond near the town of West End and Josiah's Bay Pond towards the East End. Streams and rivers flow only at certain times of the year. Even after heavy rains, rivers rapidly turn back into little more than a trickle, called a "Ghut".

Located between the Atlantic Ocean and the Caribbean Sea, the British Virgin Islands are within the trade winds belt and enjoy a pleasant and healthy subtropical climate. The annual rainfall averages about 1270 mm, and the average temperatures are in the range of 25-32° C from March to September, and 22-28° C from November to February.

Although there is some livestock production on the islands it has only a minor impact on the BVI economy, contributing about 2% of the Gross National Product. Most agricultural holdings are small, 0.4-0.8 hectares, and most farmers are aged over 50 years and work part-time. Most of the pastures are on steep slopes, have an inadequate water supply and are, therefore, difficult to manage (Percival 1988).

The majority of cattle are kept for beef, in herds which average 12 head. There is no dairy industry.

Sheep are kept for mutton and there is no wool industry. On Tortola, most sheep are kept on well-established pastures, but on the smaller islands they are mostly free-ranging. Goats are kept for meat and are mostly free-ranging, with little management input. There is one small goat dairy on Tortola. All other dairy products are imported, primarily from the USVI, United Kingdom, New Zealand and Trinidad.

Swine are kept for meat and mostly confined to backyards, but a number of farms have specially constructed pig pens.

Myiasis

NWS was first detected on the BVI in 1969. Cattle were particularly affected with navel infestations, which were treated with EQ335. The problem was most severe in 1971. The NWS was eradicated from the BVI in 1972, during a campaign that also resulted in eradication of the fly

from Puerto Rico and the USVI (see earlier in this chapter). Screwworms have not been reported in the BVI since that time, either in livestock or domestic pets.

There is no information indicating that human myiasis has ever been a problem.

PUERTO RICO

Background

Puerto Rico is the eastern most and smallest of the four main islands that constitute the Greater Antilles. The other islands are Cuba, Hispaniola and Jamaica. Two small islands 10 km to the east of Puerto Rico, Culebra (33 km², population 8,000) and Vieques (138 km², population 2,000), as well as the uninhabited Mona island 80 km to the west (56.1 km²) come under the jurisdiction of Puerto Rico. Culebra is a National Wildlife Reserve, while about 70% of Vieques is kept in reserve by the US Navy. Isla Caja de Muertos is a small island 15 km south of Puerto Rico.

The highest mountain peak is Cerro de Punta (1338 m) about midway along the Cordillera Central mountain spine which traverses the southern half of Puerto Rico from east to west for about 100 km. The Cordillera is located about 15 km from the south coast and 40 km from the north coast. There are two other mountain ranges, the Luquillo Mountains, rising to 1074 m in the northeast of the island, and the Cayey Mountains, rising to 900 m in the southwestern part. The extent of the mountain ranges is reflected by the fact that 45% of the land surface is above 150 m and half of that area has slopes greater than 45%. The mountain ranges are surrounded by foothills merging into coastal lowlands.

The climate in Puerto Rico is tropical, with an average daytime temperature between 24 and 29° C, which drops by only about 5° C at night. Frequent short rainfalls, heaviest in May and August to October, lightest from mid-December to the end of March, give the island an average of 1800 mm per year.

Due to the rugged terrain, there are marked geographical variations in rainfall. The forested, mountain areas receive in excess of 2500 mm per year. Coastal areas receive from 750 mm per year in the southwest to 1500-2000 mm in the northeast, east and southeast, where the prevailing winds strike first. The easterly trade winds are one of the most constant wind regimes, generally blowing from the east northeast through east southeast.

Livestock are distributed over all the island, but there are regional variations. Dairy herds tend to be found in the wetter areas, with about 70% in the North Coastal and Northern Slope zones; the remaining 30% are in the southeast. Beef herds tend to be concentrated in the cooler Eastern Interior and Western Interior zones, and sheep and goats are concentrated in the drier, southwest areas of the South Coastal zone.

Most imported livestock come via the United States and so do not require quarantine. Quarantine is needed only for those animals coming directly from non-USA ports. Race horses are the exception; they are often imported directly into Puerto Rico and placed under quarantine on arrival. There are no other normal livestock import routes which pose a threat for NWS reintroduction.

Ticks were eradicated from Puerto Rico in 1954. However, due to the reappearance of the cattle fever tick, *Boophilus microplus*, a new Tick Eradication Program was started in 1978. It is far the largest ongoing animal health campaign in Puerto Rico.

Myiasis

The NWS was present on Puerto Rico for a considerable period before the eradication campaign of the early 1970s. The pest was eradicated using the sterile insect technique (SIT), reinforced by ground support activities. The last recorded case of NWS myiasis was November 5, 1974, and sterile fly release was discontinued on May 3, 1975. No populations of NWS have since become established on Puerto Rico. However, an isolated introduction of the NWS occurred in September 1989 (see under Preventing re-establishment of the NWS).

There is an ever present risk that the NWS could be reintroduced and all cases of myiasis are required to be reported to the Veterinary Services for identification. Between September 1989 and April 1992, eight cases of myiasis in domestic animals and pets were reported: five in horses, two in dogs and one in cattle. Larvae specimens from each of these cases received tentative identification in Puerto Rico, and were then forwarded to the National Veterinary Services Laboratory at Ames, Iowa, for confirmation. The average lapse from collection of larvae to confirmation of identification was five days, with a range of one to 12 days.

Although there is no ongoing zoosanitary programme to control the NWS in Puerto Rico, due to its eradication in 1975, and there is no specific NWS surveillance programme, there is a high level of awareness of the NWS and the dangers its reintroduction would pose for the livestock industry of Puerto Rico. The US Department of Agriculture has established a Regional Emergency Animal Disease Eradication Organization (READEO) in each of its regions, to respond rapidly to any exotic disease threat to the US livestock and poultry industries, including the NWS.

Since the NWS has been completely eradicated from Puerto Rico, the NWS is not a factor in human health. There were occasional cases in humans before eradication (Fox & Galindo, 1962; Fox *et al.*, 1965), but there is not sufficient statistical information available on which to base an assessment of the importance of those cases.

Preventing re-establishment of the NWS

On August 27, 1989, three horses were shipped from San Juan, Puerto Rico, to Caracas, Venezuela, to take part in a jumping competition sponsored by the Venezuelan Equestrian Sport

Federation. During transit to Caracas, a tail wrap was applied too tightly to one of the horses, causing local edema and irritation. The lesion was treated by the owner until September 2, 1989.

On the evening of September 5, 1989, the horses were flown back to San Juan, disembarking at Luis Muñoz Marín International Airport. All three horses were examined to establish their identity and general health, then their hooves were cleaned and disinfected with a 4% solution of sodium carbonate, and they were given a sponge bath with vinegar. The aircraft, loading area, shipping stalls, and quarantine delivery vehicle were cleaned and disinfected with a 0.125% solution of permethrin (Atraban) and sodium carbonate. The hay and manure were also treated with these solutions, then sealed in plastic bags and burned.

The quarantine delivery vehicle then took the horses to the USDA-approved quarantine facility at El Nuevo Comandante Racetrack in Canovanas, about 13.7 km from the airport. On arrival, the horses, the delivery vehicle and the grounds were treated with a permethrin spray, and all manure deposited in the vehicle in transit was treated, bagged and buried.

The next morning, September 6, the three horses were examined again in more detail, temperatures were taken, and blood samples collected. At that time a putrid odor was detected coming from the caudal area of one horse. Hair was sloughing and four wounds less than 2.5 cm diameter were observed on the lateral and ventral sides of the base of the tail, each draining a yellow, serous exudate. Several larvae, suspected screwworms, were removed. They were examined on September 8 at the local USDA laboratory, resulting in a tentative diagnosis of NWS. The samples were then sent by courier to the National Veterinary Services Laboratory in Ames, Iowa where the diagnosis was confirmed on September 8.

On September 7 the wounds of the affected horse were irrigated with a 6% Coumaphos solution (CoRal), and 42% e.c. coumaphos with petroleum jelly was applied on the outside of the wounds. The wounds were flushed on September 8 with Nolvasan solution, then further treated with a screwworm dip containing lindane. In all, some 50 second and third stage larvae were collected from the wounds.

On September 8, the vehicle used to deliver the horses from the airport to the quarantine facility was re-treated with a 0.5% solution of chlorpyrifos solution. All horses that had travelled in the truck after the infested horse, were examined for the NWS.

Since the possibility of larvae escaping from the horse before its infestation was discovered could not be ruled out, it was decided to initiate a six-week programme of sterile fly release. The area covered included the airport, the quarantine stables, and the route taken by the truck travelling between them. The total area covered was about 16 x 32 km.

Sterile pupae were imported twice weekly from the sterile insect production facility of the Mexico-US Commission for the Eradication of Screwworms, located near Tuxtla Gutiérrez, Chiapas in Mexico. Received in bulk, they were packed in Puerto Rico into standard dispersal boxes (18.5 x 10.5 x 14.5 cm), 2000 pupae per box. After the pupae emerged as flies, they were ground dispersed from 116 predetermined release sites and, in addition, from each location visited by the quarantine delivery vehicle on September 6 and 7. A total of just over 7 million flies were dispersed between

September 12 and October 19, 1989. Sterile flies were not dispersed during the period of September 18-24 because of the disruption caused by Hurricane Hugo.

In addition to the fly releases, the screwworm programme included a major publicity effort with a press conference, radio announcements and screwworm alert notices. All members of the Puerto Rico Veterinary Medical Association were notified and sent information packs and specimen collection tubes. Tubes were also distributed by state and federal workers. Within three weeks of the initial identification of the NWS, approximately 1000 collection tubes were dispersed throughout the island.

No further cases of screwworms were detected. The cost of operating the Puerto Rico emergency screwworm eradication program was approximately US\$ 46,600, including salaries, travel and all other related expenses. The cost of producing the sterile flies and the salary and other expenses incurred by the Commonwealth of Puerto Rico are not included in this estimate.

UNITED STATES VIRGIN ISLANDS (USVI)

Background

There are three main islands in the USVI and about 50 smaller islands, with a total land area of approximately 355 km². The largest island, St. Croix (218 km², population 49,880), is set apart from the others, about 60 km to the south in the Caribbean Sea. The other main islands are St. Thomas (83 km², population 53,626) and St. John (52 km², population 3,500). The capital, Charlotte Amalie, is located on St. Thomas. The main towns of St. Croix are Christiansted (island capital), on the northeast shore, and Fredericksted, on the west coast. With a population of about 103,200 (1988 estimate), the USVI are much more densely populated than the BVI.

The USVI are similar to the BVI in topography. The highest point on St. Thomas is Crown Mountain (470 m) and on St. John is Bordeaux Mountain (387 m). There are no substantial water bodies on the islands and no rivers that run year round.

The United States Virgin Islands are within the trade winds belt and enjoy a pleasant and healthy subtropical climate. On St. Thomas the annual rainfall for the period 1941-70 was 1074 mm and the average temperature was 26.4° C. Most rain falls during September and October with a smaller increase in May. The driest months are January to April, but no month is sure to be free of rain.

Livestock production does not have a substantial impact on the national economy. Several major problems face the industry. The most important problem, particularly on St. Thomas, is a severe shortage of available land due to competition from the tourist industry. There is also overgrazing of what land is available for pasture. Secondly, there is a problem attracting workers to the agriculture sector, which offers lower wages than those available in the tourist industry. Thirdly, the cost of importing animal feeds is high, a problem shared with the BVI and Puerto Rico.

Another important problem – also shared with Puerto Rico and the BVI – is the importation of meat products from the USA, which constitutes a direct competition to the local livestock industry. There is also a shortage of government funds for agricultural programmes.

The islands do not produce enough meat or dairy product to supply local needs. One estimate indicates that only 20% to 50% of the beef consumed is produced locally.

All livestock imported from outside the USA or Puerto Rico is always transited through quarantine in the USA, usually in Miami. The possibility of constructing a quarantine facility on St. Croix is being considered to enable race horses from the BVI to compete in the USVI.

Myiasis

The NWS was first detected in the USVI in July 1969 (Nellis 1977) and spread to St. Thomas and St. John, but not St. Croix. The fly was eradicated from the USVI during the campaign to eradicate NWS from Puerto Rico and the Virgin Islands and it has not been reintroduced.

No information is available on human screwworm myiasis.

CURACAO

Status: Screwworm-free

Background/Myiasis

Curacao is located in the Caribbean, 56 km north of Venezuela.

The prevailing trade wind is from the northeast. Natural vegetation includes such drought-resistant plants as agaves, aloes and cacti.

In the past, farmland on Curacao was used primarily for livestock production. Today, small-scale agricultural ventures are more common. For example the production of aloes for pharmaceutical products and oranges for Curacao liqueur are common shall farm activities. Agriculture, including livestock production, plays a minor role in the economy.

The NWS was eradicated from Curacao in 1954 using the sterile insect technique (SIT). The island became reinfested after several years and a second eradication campaign using SIT was carried out. Since then, cases have been found in live cattle imports from Venezuela. The last known case on the island occurred in March, 1991 in a dog.

Precautions are being taken to prevent the entry of screwworms from South America. Curacao could become reinfested, due to its close proximity to NWS-infested Venezuela and because its climate is favourable to year-round screwworm infestation. However, under the present circumstances the risk of infestation is low.

There is no information available on human cases of myiasis.

SCREWWORMS AND PUBLIC HEALTH

Despite the danger posed to humans by the screwworm in endemic areas, it is primarily a pest of domestic and wild animals. For instance, while many thousands of animal cases were reported in the southern part of United States in 1935, less than 100 human cases were recorded. But, while humans are not the primary host for screwworms, an outbreak of the parasite in animals will almost certainly be accompanied by human infestations. Historically, cases of myiasis in humans have been directly proportional to the level of infestation in animals and the public's knowledge of the danger. Control or eradication of the pest from domestic and wild animal populations brings control or eradication in the human population.

It is not difficult to protect humans from the NWS. Simple precautions, such as covering wounds, will usually be sufficient. Generally, infestations in humans occur in debilitated or mentally unstable people who are unable to care for themselves and are, not able to ward off the "attacks" of screwworm flies. The exceptions are people with wounds who may be unaware of the danger and "take a nap" in the open at a time of day when gravid female NWS are active.

The medical profession needs to be aware of the danger in all screwworm endemic areas and particularly in areas threatened for the first time by an epidemic. When there is an outbreak in a previously free area, the human population should be alerted and advised how to protect themselves. As the medical profession becomes more aware of the danger, public education usually follows and people protect themselves from flies.

In countries at risk of screwworm infestation (all tropical and subtropical countries not presently infested), public health officials should consider adding human myiasis to their list of reportable diseases. A sampling procedure should be established to ensure that larvae are quickly and correctly identified. It is most important to include public health officials in any discussions of screwworm control activities.

There is a little information in the literature concerning myiasis in humans. This doesn't mean that human myiasis is not an important disease, but rather indicates that the number of cases is not great. It also needs to be noted that the disease is not prevalent in lower socioeconomic groups, among people with the least access to medical care and treatment who are therefore less likely to be included in statistical data concerning human diseases.

The following information concerning myiasis in humans is taken from a paper by Dr. Raphael Valderrama, a parasitology professor at the University of Antioquia, in Medellin, Colombia. The complete text of Dr. Valderrama's paper can be found in the Colombian document "IATREA/VOL.4 No. 2/July/1991". A number of the citations listed under the General References at the end of this report are also from Dr. Valderrama's paper.

The term myiasis was coined and first used by Hope in 1840. Since that time the term has been applied to infestations by the larvae of various species of flies, which invade tissues of live animals, including humans. These larvae feed, at least for a time, on the tissues, living or dead, of the host and on nutritive body fluids. However, not all of the cases of myiasis are caused by

parasitism. The larvae which feed on dead tissue (necrotic material from snake bites, infected wounds, leishmaniasis, leprosy, etc.) or which consume fecal material in the rectum, are not really acting as parasites. The invasion of tissue can be asymptomatic, it may cause only benign symptoms or on some occasions, severe symptoms and may even cause death.

Humans can accidentally ingest diptera larvae with food. We are accustomed to eating fruit which can be affected by flies whose larvae develop in the fruit and pass on to man who ingests them. The same can occur when other foods are eaten in which fly larvae have developed. Some of these larvae, whose cuticle is very resistant to digestive juices, are able to pass through the digestive tract and emerge alive from the anus. This type of infestation in which the larvae do not develop in the intestine is called pseudomyiasis because the incriminated larvae do not develop within the host. In practice it is difficult to distinguish between pseudomyiasis and facultative intestinal myiasis in which the larvae develop in the digestive tract. To make such a distinction it is necessary to identify the larvae, at least down to the family category.

It is very difficult to express the amount of damage and impact on human health caused by human myiasis. There is little statistical information available concerning the incidence and prevalence and no required registration of new cases. The costs are unknown and the risk factors have not been determined. Quantitatively the damage caused by these parasites varies from very light infestations of the skin with few larvae, to massive infestations with a large number of larvae. In the first case the diagnosis and treatment are simple and there are no sequela. In the later case the damage is severe, diagnosis may be difficult because of the location of the larvae in areas of the body that are difficult to observe, sequela are likely and in some cases death may result.

There may also be severe demoralization of affected persons who are deformed, specially in the face (nose, eyes, ears, etc.) by deep wounds. Damage may also occur to the urogenital system and the digestive system. The sensation of being “filled with worms” can cause psychological and comportment changes. Affected persons may turn their backs, hide their faces and try to isolate and hide themselves.

For more than thousands of years there have been reports of human myiasis but only recently has information been compiled concerning myiasis caused by specific parasites.

In 1935, an epidemic of myiasis caused by *Cochliomyia hominivorax* (NWS) was reported in Texas. More than 1.2 million live animals were affected. Fifty five human cases were reported, but the real number could have been more than 200. An epidemic of 81 human cases was documented in 5 provinces of Chile in 1945-46. During the epidemic of 1975-76 in Curacao, after the reinfestation of the Island with NWS, 25 human cases were reported. The epidemic generated panic and hysteria which resulted in the implementation of control measures. As part of a review of 10 years of experience in handling nasal myiasis, Sharma and collaborators reported 252 cases in India in 1989. In Colombia there are reports of cases of various types of myiasis in various organs of the body, but only study which analyzes experience with a specific type of myiasis (otic and nasopharyngeal) over a period of 8 years.

Myiasis can be found in people of both sexes and all ages but is most often found in persons of middle and advanced age.

The fatality of myiasis is less than 10% and usually associated with brain lesions or lesions in other parts of the nervous system. In an epidemic which occurred in Mendoza, Argentina, data from 197 cases showed that the fatality was approximately 3% in nasal myiasis because of deep invasion of parasites to the base of the brain. The percentage of lethality was 5% of 44 cases in Salta, Argentina, because of cerebral invasion from nasal, otic and ophthalmic myiasis. In a report Schreiber estimated the lethality of 8.0% in the United States.

From the point of view of veterinary medicine, the losses caused by myiasis are considerable. In a 1977 estimate in Colombia, the losses were estimated at 960 million pesos per year as a result of the infestation of cattle with *Dermatobia hominis*.

The losses caused by *Cochliomyia hominivorax* (NWS), are very high. Taking into account three other species of flies (*Oestrus ovis*, *Hypoderma lineatum*, and *Chrysomya bezziana*) that affect animals and humans, one can see that the worldwide impact and importance of myiasis is very great.

None the less before the advent of the sulfa drugs and antibiotics, larvae that feed on dead and necrotic tissue were sometimes raised under sanitary conditions and used to clean out deep wounds. In addition some larvae seem to stimulate phagocytosis (natural cleansing of wounds by normal body processes) creating an alkaline medium through the presence of calcium carbonate in the salivary and digestive secretions. It has also been found that the secretions of larvae of *Lucilia sericata* and of *Protophormia terraenovae* have a bactericidal and bacteriostatic effect.

There are several parameters with which to refer differentiate myiasis because of the variety, form of presentation, and diverse location of lesions. Never-the-less if we analyze myiasis from the point of view of the evolution of parasitism, using the habits of the present species of insects, we can better understand their evolution and can more adequately differentiate between the various insects and better understand the terminology used in describing insects which cause myiasis.

In 1965, Zumpt presented a logical and convincing theory concerning the origin of myiasis. He theorized that the evolution of this parasites has two branches, one being saprophytic and the other sanguinivorous. The first pertains to larvae which have general eating habits, with capacity to live on a wide variety of decomposing organic material. This may sometimes include dead vertebrate tissue associated with infected wounds, all the way up to living tissue. Such parasites are often found in foul smelling or diseased tissues and they usually cause no ill effect and sometimes are beneficial because they remove diseased and dead tissue from wounds of living animals. The second evolutionary branch is the parasite which is malignant and obligatory in that it requires healthy tissue to complete its life cycle. Such larvae cannot complete their life cycle in cadavers nor in any other type of organic material which is in the process of decomposing but rather develop on tissue from lesions on vertebrates. The NWS (*Cochliomyia hominivorax*) and the OWS (*Chrysomya bezziana*) are examples this later class of malignant and obligatory parasites.

To recommend an adequate method of handling and treating human myiasis one must take into account the type, location and current condition of the lesions, how long the lesion has been present, whether the wound is otherwise infected, and the general state of health of the patient.

Even without knowing the species of parasite, the treatment of advanced myiasis is relatively simple. The larvae must be immobilized by treatment with substances such as chloroform or ether and then removed from the wound. Care should be taken to prevent rupturing the larvae during the removal process. Depending on the size of the wound and its location it should then be treated symptomatically to prevent bacterial infection and to promote healing.

Based on feeding habits, most authors accept three groups of myiasis:

1. Specific myiasis: (obligate or primary) in which the larvae live exclusively as obligate parasites in the living tissue of the host and cannot complete their cycle outside of that environment. In Neotropical America the principal species in this group include: *Cochliomyia hominivorax*, *Dermatobia hominis* and *Oestrus ovis*.
2. Secondary myiasis: (secondary or facultative) in which the larvae normally live in decomposing organic material, but can invade diseased or ulcerating tissues. The principal species in this group are part of the following genera: *Sarcophaga*, *Lucilia*, *Calliphora*, *Musca*, *Muscina* and *Fannia*.
3. Accidentall myiasis: which includes larvae introduced into a host fortuitously, usually associated with ingestion of food and therefore are generally found in the digestive tract, but on rare occasions are found in the bladder, urethra, lungs or other organs. Included in this group are species that infest fruit and other foods (*Musca domestica*, *Drosophila spp.*, *Piophila casei*, *Anastrepha spp.*)

Screwworm myiasis can only occur if there is a wound available on which the adult female screwworm fly can lay her eggs. Therefore if wounds are protected from exposure to egg laying adult flies, myiasis cannot occur. Protection can be provided by covering wounds with repellent materials or by bandaging in a way that will deny the adult female fly access to the wound. Also important is the use of protective screening in doors and windows of homes to reduce the

In Colombia, and other neotropical countries, myiasis is regularly observed, but the shortage of records and bibliography does not permit evaluation of the real impact of myiasis in humans.

THE SCREWWORM THREAT TO THE WESTERN HEMISPHERE

There are two ways in which either the NWS or OWS could invade countries in the Western Hemisphere which have tropical or subtropical areas capable of sustaining the parasite. Changes in weather patterns or other environmental factors could enable adult flies to migrate in sufficient numbers to establish a colony in a country which is now free of the parasite. Or, due to lack of sufficient quarantine safeguards, they could be brought into free countries with infested live animals or humans imported from endemic countries. The only sure protection from the first threat is to eradicate the parasite from all infested areas. The second threat can be managed with proper application of preventive measures, particularly import controls.

Nations of the Western Hemisphere which want to develop a screwworm control or eradication programme, or which want to import livestock from a country where screwworms are endemic, should consider appointing a committee to evaluate the screwworm threat and propose methods for dealing with it (see Box 1).

BOX 1

THE SCREWWORM CONTROL/RADICATION COMMITTEE WOULD:

STUDY SCREWWORMS IN ORDER TO FULLY UNDERSTAND THE CHALLENGES THE NATION FACES IN A SCREWWORM CONTROL OR ERADICATION PROGRAMME;

DETERMINE THE CAPACITY OF THE COUNTRY TO TACKLE AN EXISTING OR FUTURE SCREWWORM PROBLEM;

REVIEW THE COUNTRIES EXISTING EXPORT AND IMPORT LAWS AND REGULATIONS AND FORMULATE NEW ONES AS NECESSARY TO MEET THE NEEDS OF THE COUNTRY (SEE ANNEX 1).

DEVELOP PLANS FOR IMPLEMENTING SCREWWORM CONTROL AND ERADICATION ACTIVITIES;

PERIODICALLY REVIEW THE SCREWWORM ACTIVITIES UNDERTAKEN.

The committee should comprise representatives from the various industries involved in livestock production. For example, livestock producers, the veterinary profession, government human and animal health authorities, those involved in marketing and transportation and other related industries should all be considered for committee membership. It is important that the committee generate the widest possible grassroots-level support for programmes to control and eradicate the screwworm. For example, a livestock producer may be more willing to take action that

will cost money or temporarily decrease his profit, if he is convinced that, in the long term, his profits will increase. The appointment of influential livestock producers and representatives of livestock associations to the committee is therefore particularly important to its success.

The committee should seek expert assistance in organizing its activities from scientists in organizations such as FAO, the Mexican and Central American Departments of Agriculture and the United States Department of Agriculture, who have in-depth knowledge of screwworms and how to set up control and eradication activities. With the assistance of these experts, specific goals for the committee can be established.

The committee needs to become familiar with in order to make relevant recommendations, the committee needs to gather as much information as possible on the existing or potential screwworm situation throughout the country:

- the screwworm situation in its country;
- what livestock producers know about screwworms; and,
- the livestock industry's view on the screwworm problem.

The information gained will then assist in answering a number of important questions relevant to screwworm control/eradication programmes, such as:

- Are screwworms a major limiting factor on livestock production?
- Do screwworms cause as great a loss as other livestock diseases?
- Are screwworms a human health problem?
- How is human myiasis handled?
- Will wildlife be a significant factor in NWS control and /or eradication?

After gathering preliminary information, the committee can develop a plan for control or eradication (as appropriate) and an analysis of the cost/benefit of control or eradication.

The next step for the committee would be to present the plan to the government and the livestock industry. The first priority should be to recommend actions that can be initiated quickly (see Box 2).

BOX 2

POSSIBLE COMMITTEE ACTIONS FOR SCREWORM CONTROL/ERADICATION

DEVELOP OR REVISE LIVESTOCK IMPORT AND EXPORT LAWS AND REGULATIONS;

RECOMMEND METHODS TO CONTROL THE SPREAD OF SCREWORM FROM INFESTED AREAS TO FREE AREAS WITHIN THE COUNTRY;

RECOMMEND METHODS TO REDUCE WILD FLY POPULATIONS EXISTING IN THE COUNTRY;

OUTLINE AN APPROACH FOR SCREWORM CONTROL AND/OR ERADICATION

The committee needs to advise government and industry officials on the best and most feasible way to accomplish each of the actions recommended, keeping in mind not only animal health needs, but also current political and economic realities.

Export laws and regulations

The health of domestic animals should be the primary consideration of committee members when reviewing the export laws and regulations. Recommendations for changes in existing laws and regulations, or for new laws should be designed to help the nation's livestock industry, import and export livestock in the safest possible manner, with the least possible interference in normal trade between countries (see Annex 1).

Import and export laws and regulations are essential to protect importing countries from animal diseases. The screwworm eradication programme in North Africa (1988-1992), carried out after the parasite was discovered in Libya, cost well over US\$ 100 million, and expense that could have been prevented by adequate safeguards. Screwworm-free countries that normally import from screwworm-infested countries need to make sure that adequate safeguards are in place.

Every effort should be made to prevent the shipment of animals that would endanger the health status of livestock in the receiving country. Animal health officials in exporting countries should do everything possible to assure full compliance with the animal health requirements of the importing country. Few things will adversely affect a country's export market more quickly than a report that it has exported diseased animals, or is likely to do so.

Included in the regulations should be a list of the diseases and parasites which would disqualify an animal from being exported. Screwworm should be prominent on such a list.

The regulations should also define the measures to be taken to qualify animals for export and identify who is qualified to certify animals as "fit" for export. Animals selected for export should be tested to ensure they are free from communicable diseases and parasites. Health certificates issued by an authorized agent should confirm the condition of each animal.

After arrival at the destination, the imported animals should be kept under surveillance for long enough to ensure that an unidentified infection or infestation did not slip through the system. In addition to government controls, the livestock owner should be prepared to monitor the health status of new imports in order to protect his own herd, as well as those of his neighbours.

Import laws and regulations

Screwworm-free countries should formulate import laws and regulations that prevent importation of the pest. The law should identify both NWS and OWS as dangerous pests worthy of specific consideration and should specify that all animals be treated in order to qualify for importation.

The reinfestations of Curacao and Mexico after eradication and the infestation of Libya, should alert the world to the danger of importing animals from screwworm-infested countries. Countries without strong enforceable regulations controlling the importation of animals, are in danger of becoming infested with NWS.

Reasonable, but effective import restrictions on animal imports must spell out in detail the requirements that must be met before livestock may be imported. They should establish the policies to be followed in negotiating and arranging importations and should clearly define who will make the final decision concerning eligibility for importation.

The larval stage of the screwworm fly is dependent on live animals and cannot survive for any length of time in dead tissue or animal products. Therefore, screwworm prevention restrictions on animal products are not considered necessary. Live animals can be imported from screwworm-infested countries, if proper precautions are taken. Import procedures designed to protect against the importation of screwworms, without preventing trade of live animals, are contained in the international animal health code (see Annex 1). The proposed code for screwworms provides a framework to which animal health officials can add other requirements in order to meet the needs of their country.

Quarantine requirements

Quarantine can take several forms. A screwworm-infested animal may be placed in an isolated location to protect other animals. Animals being exported are often placed in isolation before shipment in order to test for diseases, apply necessary treatments and to protect the quarantined animals from the general livestock population. Quarantine lines are also used to prevent the movement of possibly screwworm-infested animals from infested areas to free areas, specially when the areas are adjacent to each other. Establishing an effective quarantine needs careful study to ensure that it can accomplish its goals.

The participation of both government officials and livestock industry leaders is desirable in establishing a policy concerning the use of quarantines. Government officials need to understand the needs and concerns of the livestock industry and, likewise, industry support is often crucial to the success of quarantine. Government officials and livestock producers who are considering the establishment of a quarantine system to prevent the spread of NWS, might find it useful to study the quarantine procedures used in the successful NWS eradication programmes in Mexico, the United States and in North Africa. Understanding which quarantine procedures have worked elsewhere, should help in the development of an effective quarantine system.

In order to ensure the success of a quarantine line, it is important to clearly understand the reason for the quarantine, who will be affected, how it will be operated and how long it is likely to be in effect. Therefore, before a quarantine line is established, an information and education programme should be implemented to inform the public.

Countries engaged in protecting screwworm-free areas within their borders from endemic populations of screwworms in other areas, can use quarantines or quarantine lines to prevent, or at least delay, screwworm movement into the free areas. However, the adult screwworm fly is able to migrate substantial distances on its own power. Quarantine lines can stop livestock movements, but not the natural migration of flies.

When an area is placed under a quarantine for screwworm, provisions should be made for inspection of animals moving out of, or through, the quarantined area. Inspection and treatment of livestock on transportation vehicles is not adequate. There is often a failure to detect infested animals and treatment of exposed or infested animals is often inadequate. Therefore, facilities must be provided to unload, inspect and treat all livestock leaving the quarantined area. Facilities should be constructed so that animals can be handled safely and humanely.

Unloading docks should be designed to encourage the animals to leave the transportation vehicle voluntarily, slowly and at ease. The passageways should be open, allowing the animals to feel free of pressure. Changes in direction should be gentle curves and designed so that the animal does not feel trapped in a corner. Entrance to any inspection chute should be open, allowing the animal to feel that free passage is ahead. At points where the animals are going to require restraint, generally the best construction is a circular pen with moveable gates hinged in the centre of the circle. After the animals enter the pen, the gate is slowly rotated toward the entrance to the restraint chute, allowing the animals to gradually enter the chute.

Animals under restraint in a chute should be handled gently and as rapidly as careful inspection allows. Gates should be constructed along the chute to allow removal of wounded and/or screwworm-infested animals for special treatment. Exit from the inspection chute should be into another circular pen which will direct the animals into a treatment area or dipping vat, if they are to be treated.

It is possible to adequately treat livestock with spraying equipment. However, experience has shown that if more than a few animals are to be treated, immersion in a dipping vat provides better coverage of the animal's body with pesticide and is much faster.

Therefore a dipping vat is preferred for most application, especially if cattle are to be treated.

The size of the vat will depend on the number of animals to be treated. The vat should be long enough to ensure thorough coverage of the animal before it has reached the end of the vat and the vat should also be narrow enough to prevent animals from turning. Walkways should be provided on each side of the vat to allow inspectors to observe each animal as it passes through the vat. Inspectors should be equipped with poles, hooks or other devices. So that animals having difficulty moving through the vat can be assisted and so that any animal about to leave the vat with a dry head, can be forced to submerge its head for a brief moment.

The animals leaving the dipping vat should be confined temporarily in a drainage pen that collects liquid run-off from the dipped animals and directs it back into the vat. After draining, the animals should be directed to reloading chutes through alleyways constructed to allow smooth passage. In a confined environment animals will usually keep moving forward in the desired direction if they perceive open areas ahead signifying an escape route.

The facilities should also provide for the handling of animals requiring special treatment, such as dairy animals and those too young to enter a dipping vat. Alleyways, gates, chutes and holding pens will be required so that such animals can be moved around the dipping vat and then inspected and individually treated. Carefully handled high pressure hand sprayers are preferred. Spray machines designed to soak animals in a closed environment are available, but they require highly trained operators and extensive maintenance to ensure proper operation.

Before animals are reloaded, the transport vehicle should be thoroughly cleaned and treated with an effective larvicide and pesticide to destroy any larvae that may have been missed during inspection and to destroy flies that may be riding in the vehicle. An official health certificate should be issued to identify the animals treated, certify their freedom from screwworms and to outline any treatment administered.

Additional precautions are needed if an animal is found with an infested wound at the inspection station. Any larvae which leaves a wound could pupate and emerge as a fly and migrate to a screwworm-free area. Isolation facilities are needed to confine infested animals for regular reinspection and treatment until the infestation has been cleared and the wound has healed.

Animals leaving a screwworm-infested area may arrive at a quarantine inspection station accompanied by a health certificate showing that screwworm inspection and treatment were performed at the source. Each animal in the shipment should be listed on the certificate to prevent switches. If the animals in the shipment tally with the certificate, then a determination should be made as to whether the elapsed time since the previous treatment is within the period of residual effectiveness of the pesticide or if retreatment is appropriate.

A penalty may be considered for anyone presenting infested or wounded animals at a quarantine station. Such animals are potential screwworm dissemination and should be avoided if at all possible. The only exception should be an animal that has a fresh wound which obviously came as the result of an accident while in the transport vehicle.

Where appropriate, provisions may be made for a follow-up inspection at the receiving location.

Public information

Public information is a key factor in obtaining support from the livestock industry for a screwworm control programme. Public ignorance about screwworm can contribute to worsening the problem by leading to apathy and even active opposition to control efforts. An informed producer is

more likely to be cooperative and often can be encouraged to actively participate in eradication efforts. The public, including the livestock producer, needs to be informed about the basic aspects of screwworm infestation and what can be done to eliminate screwworm losses (see Box 3).

BOX 3

WHAT THE PUBLIC NEED TO KNOW ABOUT SCREWWORMS

WHAT SCREWWORMS ARE AND HOW THEY AFFECT HUMANS AND ANIMALS;

HOW THE NWS CAN INJURED AND KILL LIVESTOCK IF LEFT UNDISTURBED?

HOW MUCH INFESTED ANIMALS SUFFER IF LEFT UNTREATED;

THAT HUMANS ARE ALSO SUSCEPTIBLE TO INFESTATION AND CAN SUFFER GREATLY OR EVEN DIE AS A RESULT OF SCREWWORM INFESTATION;

NEED TO KNOW THAT MOVING INFESTED ANIMALS MAY RESULT IN THE SPREAD OF SCREWWORMS AND THAT THEY CAN TREAT WOUNDS TO PREVENT INFESTATIONS AND HENCE THE SPREAD OF THE PEST;

NEED TO BE INFORMED ABOUT THE BEST TREATMENT MATERIALS AND THE PROPER WAY TO APPLY THEM;

NEED TO UNDERSTAND WHY THEIR ANIMALS SHOULD BE INSPECTED REGULARLY FOR WOUNDS AND INFESTATIONS; AND

NEED TO BE PROVIDED INFORMATION ON SCHEDULING ACTIVITIES SUCH AS SURGERY AND LIVESTOCK TRANSPORTATION, SO THAT THE DANGER FROM SCREWWORM INFESTATIONIS MINIMIZED.

Information programs should be just that –informative. Don't assume that the basic facts about screwworms and screwworm infestations are common knowledge. New bulletins can provide producers and the general public basic facts about screwworms as well as running account of what is occurring in the control effort and why.

Information programs can also be used as propaganda instruments, not in a negative sense but as a stimulus to keep enthusiasm and support at a high level. Meetings, public forums, posters,

newsletters, pamphlets and other handout material, radio and television announcements and movies are all good ways of keeping the public aware. The material must be fresh and interesting or people will become apathetic and cease to pay attention to the information provided.

In some countries or areas, convincing livestock producers of the value of reducing screwworm populations may be a difficult task. Livestock producers who live with endemic populations of screwworms, have adapted their management practices to deal with the effects of the parasite through continuing treatment programs. They may not consider the screwworm to be of primary importance because they have learned to live with infestation without suffering extensive losses.

Moreover, some producers look unfavorably on the further control of their animals necessitated by screwworm eradication activities. An educational programme may help win producer support by helping them understand the real cost of living with screwworms by reminding them of the cost of products used to treat infested animals, the value of the time invested in treatment and prevention activities, and the value of the weight loss in infested animals.

RECOMMENDATIONS

The following is a list of actions recommended in preparation for possible NWS control and eradication activities in the South American and Caribbean regions.

Concerning the NWS Endemic countries

1.0 Ecological and epidemiological studies

1.1 Study the distribution and seasonal abundance of NWS in greater detail in all countries, with emphasis on the Amazon region.

1.2 Determine the screwworm infestation index of domestic animals, wildlife and humans.

1.3 Determine the population density and movement of adult screwworms.

1.4 Study the effects of humidity, temperature, rainfall, soil type and vegetation on the population of screwworm larvae.

1.5 Identify screwworm parasites and predators which could have implications on the biological control of NWS.

2.0 Studies of the types of wounds most commonly associated with screwworm infestations.

2.1 The warbles/screwworm complex

2.2 The tick/screwworm complex

2.3 The bat/screwworm complex

2.4 The horn fly/screwworm complex

3.0 Study the genetic diversity of NWS occurring in the different regions of Brazil.

4.0 Identify other diptera which could cause cutaneous myiasis in wounds on cattle.

5.0 Study mass-rearing of screwworms, using diets containing South American or Caribbean ingredients.

6.0 Study the effect of gamma radiation on the fertility, sexual vigor and longevity of South American and Caribbean strains of the NWS.

7.0 Chemical control.

- 7.1 Study toxicity and residual effects of insecticides used against screwworm larvae
 - 7.2 Study the effects of various domestic animal treatments using natural and synthetic ectoparasiticides in the control of the NWS.
 - 7.3 Study the use of adult suppression system in different ecosystems of South America and the Caribbean.
- 8.0 Organize a series of meetings between veterinary officials of the subregion to exchange information concerning the NWS, as well as animal health in general.
- 9.0 It is further recommended that international seminars on screwworms be organized for the purpose of training Caribbean and other Latin American researchers on screwworm problems. The seminars should include the participation of researchers from the Mexico-US Screwworm Eradication Program, Central American-US. Eradication Programmes, CIMIAT of Brazil and FAO. Its focus should be on teaching new techniques and methods for control and eradication of screwworms.
- 10.0 In Peru is interesting to note that Peruvian physicians sometimes use a plant called “albahaca” to cure myiasis, the reported scientific name of the plant is *Ocimum basilucus*; this plant should be further investigated, since it may have insecticidal or other properties useful in treatment of myiasis.

The scope of this report does not permit the preparation or inclusion of detailed eradication plans. The information and ideas presented aim to provide “food for thought” for interested government officials, private organizations and individuals. However, before starting a screwworm eradication campaign in South America, the following basic actions are recommended:

- 11.0 Develop a NWS information programme directed at animal health authorities, livestock producers and the general public.
- 12.0 Develop and collect base line data on case incidence in humans, domestic animals and wildlife. This data should be analysed by the appropriate authorities, who will probably need the guidance and assistance of experts.
- 13.0 Determine the economic impact of the NWS in each country and in the region as a whole.
- 14.0 Calculate the cost breakdown of the proposed programme and establish a cost/benefit ratio.
- 15.0 Once costing and cost/benefit ratio information is available, consider funding possibilities.
- 16.0 Consider the direct and indirect environmental impact of eradication.
- 17.0 Develop an eradication strategy which takes into account pertinent factors such as:
 - 17.1 organization and coordination;

- 17.2 the sequence of activities;
 - 17.3 the location and capacity of fly production facilities;
 - 17.4 the time frame of the operations; and,
 - 17.5 natural boundaries to reinvasion by the NWS.
- 18.0 Conduct a regional eradication programme in South America which covers all of the NWS-infested countries.
- 19.0 If the Sterile Insect Technique is used for a regional eradication programme in South America, more than one screwworm production facility will be required. One plant should be located far enough south in Argentina so that cold weather would assist in fly security. The location of an additional plant or plants should be carefully selected to take advantage of a cooler climate or higher altitude to reduce air-conditioning costs and a central location to reduce the cost of pupae transportation. Location near a large airport, or seaport and near an adequate labor supply are also important considerations.
- 20.0 A “South American NWS Eradication Programme” will require substantial external financing, however the countries involved should provide services such as: free entry of all goods imported for use in the eradication programme, radio frequencies, quarantine stations, government aircraft for transport and dispersal of sterile flies, field personnel /by reassignment of duties), and use of airports and of other facilities. The governments of each country need to be made aware at an early stage of what will be required of them if eradication is undertaken.
- 21.0 Initiate as soon as possible, research and field studies to more accurately define factors such as incidence of screwworms, seasonal variations, wound sites and cost/benefit ratio. This type of information should be available before serious planning for an eradication programme is undertaken.
- 22.0 There is considerable traffic in pet animals between the countries of South America and from South America to other parts of the world. Countries receiving such animals should be aware of the potential for these animals to carry screwworms.
- In the Caribbean, regarding with the NWS endemic countries: Cuba, Dominican Republic, Haiti, Jamaica, Trinidad and Tobago, the following is recommended:
- 23.0 The above countries are heavily infested with NWS and most wounded animals become infected if left untreated, due to this the initiation of a national NWS control programme against NWS myiasis in domesticated animals is urgently needed, including pets.
- 24.0 Give the NWS control programme the same priority as the programmes for other important diseases.
- 25.0 The islands have similar climate and terrain to Southern Mexico and Belize, where the NWS has been eradicated, so there should not be any unusual eradication problems for the NWS elimination.

26.0 Trinidad is only 13 km from screwworm-infested Venezuela and could easily become reinfested subsequent to NWS eradication. It is recommended that a study be conducted in Trinidad and Tobago using marked NWS flies released in Venezuela with fly traps set at the closest point of Trinidad to Venezuela. Such a test should help to determine the migratory habits and capability of the insect at that location.

Concerning the NWS Free countries:

27.0 It is vital that an awareness of the threat of reintroduction of the pest be maintained among livestock owners, veterinarians and public health officials, since they are located within the area in which NWS is historically endemic. The reintroduction of the NWS to Curacao is a reminder of the high cost of such a disaster.

28.0 To minimize the risk of screwworm reintroduction to the free islands maintain vigorous quarantine systems to intercept infested animals at the point of importation and early detection systems so that if the pest is reintroduced, steps to eradicate it can be taken before the NWS becomes re-established. These essential systems have been responsible for keeping the islands free of NWS. A rapid and effective response to a NWS reintroduction into Puerto Rico in 1989 to date demonstrated that early detection and quick action can prevent re-establishment of this terrible parasite. Since several islands in the vicinity are NWS infested and since most of South America is infested, continued freedom from NWS will require a high state of awareness of the dangers of NWS reintroduction.

29.0 Undertake thorough veterinary examinations of livestock imported directly into free islands from NWS endemic areas. These should be carried out in a quarantine facility at the port of entry before release to inland quarantine points.

30.0 Issue annual reminders to veterinarians on the NWS situation in the Caribbean and of the need for submission of samples of larvae from cases of wound myiasis. Samples should be forwarded to National Veterinary Services Diagnostic Laboratory or to FAO collaborating Centre for Identification of Myiasis.

31.0 Examine dogs and other pets imported from NWS endemic countries for NWS infestation and give appropriate treatment before release.

32.0 All appropriate staff of the Veterinary Services Diagnostic Laboratory, should be able to identify samples of larvae from cases of myiasis as positive or negative for NWS.

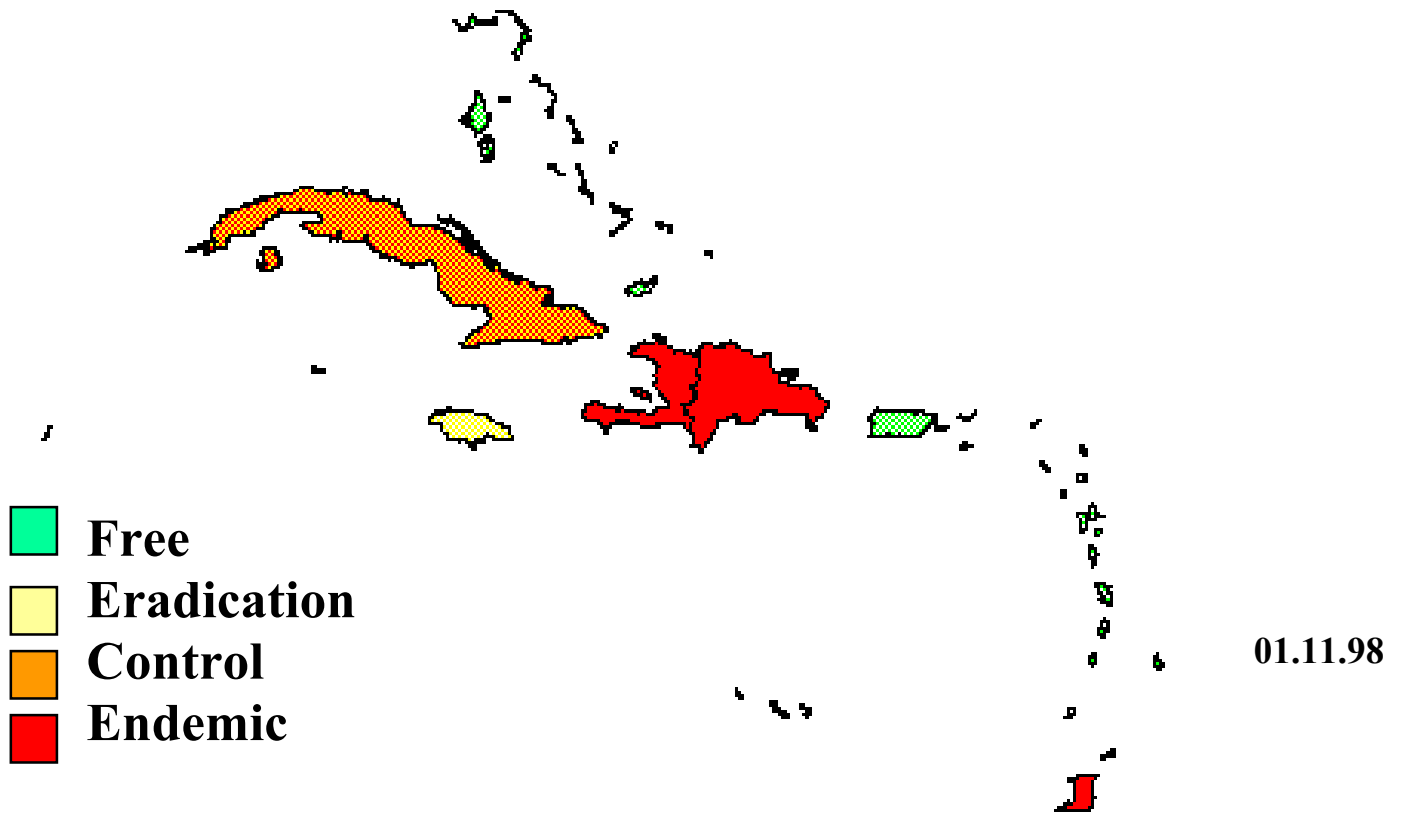
33.0 Develop a plan for a study to determine if NWS is present in the wildlife population, for immediate use if needed.

34.0 Preparation of detailed national emergency plan in case of NWS reintroduction, that includes civil and military sectors participations, field operations involvements and SIT use for treatment and to prevent the spread of parasite into NWS-free territories.

**Map No. 1 Distribution Coeliomiasis *Ch. hominivorax*
Latin America, 1998**



**Map No. 2 Distribution *Cocliomiasis Ch. Hominivorax*,
Caribbean 1998**



ANNEX 1

OIE, INTERNATIONAL ANIMAL HEALTH CODE OFFICE INTERNATIONAL DES EPIZOOTIES

OIE INTERNATIONAL ANIMAL HEALTH CODE
Mammals, birds and bees/section concerning screwworms 1992

Appendix VI

CHAPTER 3.1.8

SCREWWORM (*Cochliomyia hominivorax*)

Article 3.1.8.1.

When importing from countries considered infested with screwworm, Veterinary Administrations should require:

for domestic and wild mammals

the presentation of an *international animal health certificate* attesting that:

1) on the farm of origin:

- the animals to be exported have been inspected, by an *Official Veterinarian*, for wounds with eggs masses or larvae of screwworms and any infested animal has been rejected for export;

2) prior to entering the quarantine pens in the exporting country:

- each animal has been thoroughly examined for infested wounds, under the direct supervision of an *Official Veterinarian*, and that no infestation has been found in any animal; and
- any wounds have been treated prophylactically with an officially approved oily larvicide at the recommended dose; and
- immediately after inspection all animals have been dipped, sprayed, or otherwise treated with a product, officially approved by the importing and exporting countries for the control of screwworm, under the supervision of an *Official Veterinarian*;

3) immediately prior to loading for export:

- all animals have been re-examined for the presence of infestation and all animals have been found free of infestation;

- all wounds have been prophylactically treated with an approved oily larvicide under the supervision of an Official Veterinarian;
- all animals have been prophylactically treated by dipping or spraying; and
- that the cargo area containing the animals during transport has been sealed by an Official Veterinarian;

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Appendix VI (contd)

Article 3.1.8.2.

Quarantine and transportation recommendations

The floor of the quarantine area and the transportation unit must be thoroughly sprayed with an officially approved larvicide before and after each use.

The transit route must be the most direct, with no stopover of more than 24 hours. If the duration of the journey exceeds ten days and involves stopovers in infested countries then all animals must be prophylactically dipped, sprayed, or otherwise treated immediately prior to landing at intermediate port (s), using an officially approved product. Animals should be kept confined on the transportation vehicles during the stopover and not allowed to disembark.

Article 3.1.8.3.

Recommendations to importing countries

- 1) On arrival at the importation point, all animals must be thoroughly inspected for wounds and possible screwworm infestation under the supervision of an *Official Veterinarian*;
- 2) the bedding material of the transportation vehicle and the quarantine area should immediately be gathered and burned follow each consignment.

Article 3.1.8.4.

Import/export of animals products

The larval stage of the screwworm fly is dependent on live animals and cannot survive for any length of time in dead tissue or animal products, therefore, restrictions on these are not considered necessary.

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ANNEX 2

SCREWWORM SURVEILLANCE MISSIONS AND LIST OF FAO CONSULTANTS

The consultants were required to:

- Obtain up-to-date information on the presence of NWS, its geographical distribution and seasonal abundance, as well as its impact on livestock activities, and the status of zoosanitary and quarantine activities in the selected countries.
- Contact officials of the Ministry of Agriculture, heads of cattlemen associations, public health authorities, government officials responsible for wildlife, and private organizations and scientists involved in research on the NWS.
- Initiate a campaign to monitor the incidence of the NWS, obtaining the support and collaboration of government officials, promoting the use of the FAO Reference Laboratory for NWS and other Animal Myiasis.
- Train technical personnel in NWS identification techniques, adult fly trapping, record keeping, control measures and the Sterile Insect Technique.
- Collect and preserve in liquid nitrogen a number of NWS larvae from the countries visited, to enable DNA laboratory identification.
- Present a final report on activities, discussions, conclusions and recommendations including the possibilities for eradication.

The following is a list of the consultants and the countries they visited.

1. **Argentina, Chile and Uruguay**

Dr. Edgar Lee Judy, US

Former Field Operations Director, Mexico-US Commission

Dr. Salvador Cajero Avelar, Mexico

Former Director General, Mexico – US Commission.

2. **Brazil**

Dr. Gonzalo Efrain Moya Borja, Ecuador

Principal Entomologist Research, Rural University of Rio Janeiro.

3. **Bolivia, Paraguay and Peru**

Dr. Luis F. Liera Gutierrez, Mexico

Former Principal Epidemiologist, Mexico – US Commission

Former Chief Epidemiologist of NWS North Africa Eradication Programme.

Dr. Williams Sudlow, US

Former NWS Plant Production Director, Mexico – US Commission.

4. **French Guinea, Guyana and Suriname**

Dr. Manuel Bellver-Gallant, Spain

Former FAO/AGAH, Animal Health

- Dr. Sergio Martinez-Guzman, Mexico*
Former Advisor Entomologist, Mexico – US Commission.
5. **Colombia, Ecuador and Venezuela**
Dr. Guillermo Mateus Valles, Colombia
ICA Senior Entomologist, Colombia
Dr. Mario Licon Quintero, Mexico
Former General Subdirector, Mexico – US Commission.
6. **Antigua & Barbuda, Dominica, St. Kitts and Nevis, St. Lucia and St. Vincent and The Grenadines**
Dr. Glen I. Garris, US
Senior Entomologist, USDA.
7. **Bahamian Islands, Cayman Islands, Turk and Caicos Islands**
Dr. Floyd Smith, US
Former General Subdirector, Mexico – US Commission
8. **Dominican Republic, Haiti and Jamaica**
Dr. Nazario Pineda, Mexico
Former Director General, Mexico – US Commission
Technical Leader, External Revision Team NWS North Africa Eradication Programme.
Dr. Frederic Poudevigne, France
Former Officer, NWS North Africa Eradication Programme
9. **Aruba, Netherlands Antilles, Trinidad and Tobago**
Dr. Edgar Lee Judy, US
Former Field Operations Director, Mexico-US Commission
Dr. Eduardo Rios-Salas, Mexico
Former NWS Plant Production Director, Mexico – US Commission
former NWS distribution Centre Chief, NWS North Africa Eradication Programme.
10. **British Virgin Islands, Puerto Rico and US Virgin Islands**
Dr. Martin J.R. Hall, UK
Senior Entomologist of the National History Museum, London, England
Officer Responsible of the FAO, World Reference Laboratory for NWS and other Animal Myiasis

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