Eradication of the New World Screw Worm
*Cochliomyia hominivorax*

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What is a screw worm? A fly that initiates primary obligate myasis

Myasis: the invasion of live vertebrates by fly larvae (maggots)
primary = first attack on host, obligate = must feed on live hosts

New World Screw Worm (Primary Screw worm)
Class: Insecta
Order: Diptera (True flies)
Family: Calliphoridae (Blowflies, bottle flies)
Subfamily: Chrysomyinae
Genus: Cochliomyia (4 species)
Species: *hominivorax* (Primary screw worm)
The Adult Fly
Adult *C. homnivorax* - (powerful flier upto 180mi)
bluish to bluish green,
3 prominent longitudinal black lines on pronotum
reddish brown eyes,
8-10mm long

In general very similar in appearance to other blow flies
The Larva - “The Screw”

Pale white colors tapered cylinders upto 17mm long (2/3 inch) ("Wood Screw shaped")
Breathing spiracles at the wide end
Mouth hooks at the narrow end (b)
Body segments are ringed with spines (c)

Unique to C. homnivorax:
Dark pigmentation of dorsal tracheal trunk in posterior segments (a)
Lifecycle

21+ days (depending on temperature, moisture and soil type.)

Sexually mature 48hrs after ecdysing.
Males aggressively seek out and mate with females.
Females mate once only

Adults fly for 10-14 days
Capable of traveling large distances

Oviposition begins 6 days after ecdysing.
Females lay an average of 4 batches of 200-500 eggs on edge of wound

Eggs hatch in 12-21hrs and enter wound to feed

Eggs cannot survive sustained temperatures below 46°F (8 °C)

Mature larvae (~17mm) leave the wound and burrow into the soil
Larvae feed on living tissue for 5-7 days
Pupate in soil for 7 days-2 months depending on temperature
Pathology

All open wounds, as small as a tick bite, can be targeted. All warm-blooded vertebrates are susceptible to attack.

New wounds contain larvae of a single age. Older wounds may contain larvae of various ages and of other species of flies.

The necrotic tissues of the wound produce a stinking, reddish brown fluid as they leak blood and serum.

Attracting further gravid females and other facultative myiasis producing species (e.g. C. macellaria the secondary screw worm)

Thus the wound can become greatly enlarged due to multiple infestations and, unless treated, usually result in death of the host.
1930’s Knipling developed his Sterile Insect Technique (SIT)

He theorized that screwworm, could be controlled by

1) inundating wild populations with sterile males.

2) Fertile females mate only once - if mate is sterile their eggs do not hatch.

3) Reproduction would drop with each generation, eventually reaching zero if sterile flies continued to be introduced.

1936 Bushland developed an in vivo technique for mass rearing on an artificial diet, thus saving live animals which were the only way to produce screwworms for experiments, an inhumane and costly practice.
late 1930s,
By this time the elements in place for a solution to the screwworm problem were

1) Knowledge that the screwworm was a separate species, with a dependence on live hosts,

2) Bushland's technique for raising large numbers of flies,

3) Knipling's understanding of the species' mating patterns, and theory for controlling the pest by the mass release of sterile males.

Unsolved Problem: how to sterilize mass quantities of screwworm flies

Not solved until 1950

1950
Knipling and Bushland solved the problem of mass sterilization using cobalt-60 gamma ray equipment from Oak Ridge National Laboratory to sterilize masses of screwworm flies.
First Complete Eradication

first successful field trial

1954-1955 Curaçao Island Experiment:
40 miles off the coast of Venezuela.

1954 (Aug) Large scale sterile fly releases
(10s of 1000s)

Within 2 months no fertile eggs were found

1955 (Jan) Screwworms had been eradicated from Curaçao.

Effective eradication - achieved in 10 weeks!
1956-1957 Florida livestock producers, petitioned the State of Florida to set up a full-scale screwworm eradication program.

1957 a test in a 2,000sq mile area east of Orlando produced ~70% eradication.

1957-1958 A severe winter forced overwintering screwworms further south than usual and increased releases (upto 800 sterile males/sq mile) made possible the establishment of a barrier zone across central Florida early in 1958.

1959 by the end of 1959 the barrier had been pushed to the Mississippi River. Screwworms disappeared from the Southeast One year ahead of schedule!

The Southeast was kept screwworm free by:
- livestock inspection and quarantine, 24hrs/day as of May 1958
- targeted fly releases in areas accidentally reinfested by livestock from other areas.

Inspecting ground beef and blood for growing media

"Removing Eggs from Oviposition Vat"

Inspecting larval rearing trays

Pupa inspection

Boxes ready for release

Irradiation Room

Filling boxes with irradiated Pupa

A box of flies
Releasing Sterile flies
Eradication Time Line
Screwworm situation in January 1961

Overwintering area
- Average
- Maximum

Seasonal spread
Eradication area
Inspection stations
Eradication Time Line

Eradication in the Southwest 1958-1969

1958 (Sept) with success in Florida livestock producers in the Southwest began to press for an eradication program.

Knipling stated that Texas and the other southwestern states would never be free from screwworms until Mexico was also free of the pest.

1962 Eradication began in the southwest.
Ranchers alone raised over $3.0 million for the construction of sterile fly-production facilities at.
The plant near Mission, Texas was producing >50 million sterile flies/wk by July 1962.

1966 The eradication barrier was pushed to the US-Mexican border.
USDA declared the U.S. free of indigenous screwworms as early as July 1966.

Produced up to 200 million sterile males/week
Released 96 trillion by 1975
Although the barrier zone was large and difficult to maintain, screwworm damage in 1967 was less than it had been 5 years previously.

In 1962, at the beginning of the program, Texas alone had reported 1000s cases/wk. In 1967, Texas 835 cases. Arizona 23 cases, California 14, and New Mexico recorded none.
Eradication Time Line

1970s Setbacks

1971 Heavy rainfall and warm temperatures late summer and fall followed by the mild winter of 1971-1972, allowed the screwworm population to move farther north and survive the winter.

Heavy screwworm activity in northern Mexico resulted in a large influx of screwworm flies migrating across the U. S. border and overwhelming eradication efforts in the Southwest.

1972 A severe screwworm outbreak in the United States – the worst since 1966. All SW states reported screwworm-infested livestock.

Texas alone confirmed 90,000 cases, after reporting 444 in 1971.

The Screwworm Eradication Program Agreement between the United States and Mexico was signed August 28, 1972, establishing a joint Mexico-United States Screwworm Eradication Commission.
The agreement called for screwworm eradication in a much larger portion of Mexico than previously planned. It moved the barrier zone from the United States-Mexican border, (~2000 miles long), to the narrowest point (140 miles) in Mexico—the Isthmus of Tehuantepec at the 93rd meridian.

1974, work began on a new facility near Tuxtla Gutierrez, Chiapas, Mexico
1976 New plant opened producing 500 million sterile flies/wk
**Eradication Time Line**

1980, Northern Mexico free of self-sustaining screwworms

1982 (Feb) Mexican government officially declared the north Mexican states of Sonora, Baja California Norte, and Baja California Sur free of screwworms. Texas reported zero cases of infestation. Only a handful of imported cases have been reported in the US since 1982.

1984 a permanent barrier zone at the Isthmus of Tehuantepec was achieved, 1986 no outbreaks were reported north of the barrier zone.

1986, the Mexico-United States Commission extended the eradication program to the adjoining Central American states.

1993 Mexico completely free of NWS

It was clear by the mid-1980s that an eradication plan extending to the Darien Gap, Panama and east to the Columbian border was necessary.

1991 Projected cost of maintaining the barrier at Isthmus of Tehuantepec = US $235.2 million/yr cf. at Darien Gap = US$181.8 million/yr
### Eradication Time Line

#### Screwworm Eradication in Central America

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<thead>
<tr>
<th>Country</th>
<th>Program Initiated</th>
<th>Screwworm Eradicated</th>
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<tbody>
<tr>
<td>Mexico</td>
<td>1972</td>
<td>1993</td>
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<tr>
<td>Guatemala</td>
<td>1987</td>
<td>1994</td>
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<td>Belize</td>
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<td>Aruba</td>
<td>Mar 2004</td>
<td>2005</td>
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<td>Panama</td>
<td>2003</td>
<td>2006?</td>
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<tr>
<td>Jamaica</td>
<td>1999? 2007 (SIT failures)</td>
<td>(05/21/2012) ~$15m/yr for govt eradication program 2012/2013</td>
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<tr>
<td>Cuba</td>
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Questions?