

powdered sugar, and 2 percent of an organic phosphorus insecticide. Such baits, ready for use, are available commercially.

Dry baits should be applied with a shaker-type dispenser wherever flies are congregating and feeding. The flies are attracted to and feed on the dry bait, and some of them begin dying in a few minutes, so that a high degree of control is usually apparent within an hour after application. About one-fourth pound of dry sugar bait or 1 pound of granular bait is enough to control a fly population of average size in a barn or poultry house having 2,500-5,000 square feet of floor area. Heavier applications may be required for control outdoors or when large numbers of flies are in barns.

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Screwworms That Attack Livestock

GAINES W. EDDY AND R. C. BUSHLAND

THE SCREWORM, *Callitroga hominivorax*, is an obligatory parasite of warm-blooded animals. Animals infested with it usually die unless they are treated promptly. It can be controlled by good management and prompt treatment with an insecticide.

The screwworm fly is bluish or bluish green and is about twice the size of the housefly. It lays its eggs on all kinds of wounds but prefers fresh abrasions—wire cuts, nail scratches, boils, brand marks, shear cuts, and sores caused by tick bites, by needle grass on the legs and face of sheep and goats, and by prickly pear in the mouths and other parts of the body. The navel of newborn animals is especially vulnerable.

The screwworm fly lays shiny white eggs in masses that contain about 200 eggs. The eggs are glued to each other

and are placed on the edge of the wound, usually on a dry part of the skin. The masses of white eggs, arranged in neat rows, are unlike the eggs of other blowflies, which are yellowish and laid at random in uneven masses. Eggs of screwworms hatch in 12 to 24 hours, and the tiny maggots feed as a colony in the living flesh.

They feed with their heads down. The tail, or blunt end, usually is exposed for breathing. During development they have a pinkish color, which is very noticeable by the fourth day. The pigmented air tubes, or tracheal trunks, which open at the blunt end of the body, are also noticeable then.

These show as two almost straight black lines. They and the pinkish color identify them from larvae of other blowflies. Wounds infested with screwworms smell bad. There is considerable

drainage of brownish-red fluid, which stains the hair below the wound.

Larvae complete their growth in 5 to 7 days and drop to the ground, where they burrow into the soil and pupate. The pupal stage lasts 7 to 10 days in warm weather but may last several weeks when the weather is cool. Flies emerge from the puparia in the soil, work their way to the surface, where they crawl up on vegetation, and expand their wings within a few minutes.

For the first few days of adult life, the flies visit animals to feed on wound fluids. They also take water, nectar, and plant juices. The insects mate when they are 2 days old. The females, when they are 5 or 6 days old, seek out wounded animals on which to lay their eggs. The eggs usually are deposited in one mass. The average life span probably is only about 3 weeks but may be as long as 65 days.

The distribution of the screwworm fly in the United States in winter is confined normally to the southern part of California, Arizona, New Mexico, and Texas, and most of Florida. The flies breed the year around in tropical and subtropical North America and South America. The fly occurs only in the Western Hemisphere.

The flies migrate in spring and summer at a rate of about 5 miles a day. The limits of winter survival determine the areas or States infested one year or another. The southeastern areas usually infested by fall include all of Florida, the southern tip of South Carolina, the southern half of Georgia, and the southeastern part of Alabama. Occasionally the flies move into Mississippi and northward into Kentucky and Virginia. Outbreaks have occurred in New Jersey. In the Southwest, the flies migrate out of Texas into Oklahoma, Kansas, Missouri, Arkansas, and occasionally Mississippi.

The infestations in California, Arizona, and New Mexico are usually local and cover only the southern parts. Severe outbreaks have occurred in many of the Northern States; they

usually are costly, because many stockmen in those areas are not familiar with screwworms and by the time expert advice is available the flies have spread over a large area.

Because many animals, especially cattle, move across the country today by rail and truck, outbreaks are likely unless all animals from infested areas are checked closely. Many of the outbreaks in the Northern States have been traced to the shipment of infested animals.

SCREWWORMS cost the livestock industry an estimated 20 million dollars a year in deaths of cattle, permanent injury, and poor weight gains.

Another loss lies in the constant watch necessary to find and treat infested animals. Animals with screwworms tend to stray from the herd or flock and hide in underbrush to escape the flies. Sheep and goats hide under old buildings or in caves. Stockmen may spend the equivalent of several months each year looking for screwworm cases and treating them.

In some years the loss of game animals, especially deer in Florida and Texas, is great. When the fly season comes early and the fawn season is late, a heavy toll of the fawns and their mothers can be expected. Deer are one of the favorite hosts of certain ticks in Florida and Texas, and the sores the ticks cause are also favorite spots for screwworms to lay their eggs.

CONTROL OF SCREWWORMS consists of good ranch practices and the use of an approved remedy.

Corrals, fences, and gates should be kept in good repair so that livestock do not suffer snags and cuts from them.

Dogs used in working stock should not be allowed to bite animals.

Necessary surgery, branding, ear-marking, and birth of young should be scheduled for the winter months, when screwworm activity is at its lowest.

Livestock need special watching during the fly season. Because animals are killed so quickly by screwworms, every

animal should be seen at least once a week. In brushy country, cowboys need to ride the pastures early in the morning and late in the afternoon to find wormy animals grazing and watering when flies are least annoying.

In places where sheep and goats are pastured, brush should be controlled so that infested animals can be found easily.

Several chemicals can be used to kill the maggots.

Chloroform is an old remedy. It kills maggots quickly, but it irritates the wounds. Benzol is less damaging to tissues, but deep wounds must be plugged with cotton, soaked with benzol, to assure kill of the larvae. Since neither benzol nor chloroform protects wounds against reinfestation, pine oil was used as a repellent dressing. However, such treatments are no longer recommended.

Much better than those treatments is Smear 62, which was developed in 1941. Smear 62 contains 35 percent of benzol, which kills the larvae; 35 percent of diphenylamine, which protects wounds; 10 percent of turkey red oil, a wetting agent; and 20 percent of lampblack, a thickening agent.

EQ-335 was recommended in 1950. The figure "335" stand for the concentrations of the two main active ingredients, lindane (3 percent) and pine oil (35 percent). The formula contains lindane, 3 percent by weight; pine oil, 35 percent; mineral oil, 40-44 percent; emulsifier, 8-12 percent; and silica aerogel, 8-12 percent. The mineral oil is used mostly as a filler and the silica aerogel as a thickening agent. The emulsifier makes the compound mix more easily with wound fluids and with water.

EQ-335 is better than Smear 62 in that it does not stain, it is not highly volatile, it is more effective against fleeceworms and other blowflies, and it is considerably more toxic to the screwworm fly. This last point is important, because the flies may visit wounds to feed even before they are old enough to lay eggs.

In treating screwworm cases, the main idea is to get plenty of material in the wound and a good dressing around the outer edges.

Deep pockets need special attention, because larvae in them often escape being killed. As the flies lay their eggs around or on the outer edges of the wound, a good coating of material will protect the wound against reinfestation and kill many of the flies that visit the wound to feed or to lay eggs.

In sheep and goats, the area below the infestation, which is usually covered with exudate, should be given a light application as a preventive against attack by fleeceworms.

EQ-335 is best applied with a 1-inch varnish brush. The wounds should be treated at 7-day intervals or so until they are completely healed. Large, bleeding wounds, especially in cattle, may require two treatments during the first week, although one or two treatments may be enough to protect the wound until it is healed.

A NEW METHOD of screwworm control—that of releasing laboratory-reared sterilized flies—has been studied in the hope that it might eradicate screwworms from the Southeastern States, where screwworms were introduced in a shipment of infested cattle in 1933 and where infestation normally is isolated from the midwestern screwflies, which overwinter in Texas. If the screwworms that overwinter in Florida could be eradicated, the Southeast would again be free of screwworms. Proper inspection should prevent re-introduction through shipment of infested animals.

Keeping flies from breeding in domestic animals alone is not enough to eradicate screwworms because too many flies breed in wild animals. Therefore, Dr. E. F. Knippling, of the Department of Agriculture, proposed that research be conducted to determine the feasibility of control through the release of sterilized insects.

Screwworms are easily reared in the laboratory on a medium containing

blood, water, ground meat, and a little formaldehyde. The laboratory-reared flies can be made incapable of reproducing by exposing the pupae to gamma rays from radioactive cobalt.

Laboratory experiments at Kerrville, Tex., field tests in Florida during 1950-1953, and an eradication experiment on the Island of Curaçao in 1954 were successful. Sterile males competed with the normal males for mates. Wild females, once mated to a sterile male, do not mate a second time and so cannot reproduce.

Curaçao was heavily infested with screwworms until sterile flies were released there. Each week 400 sterile males and 400 sterile females to a square mile were released. The screwworms were eradicated within a few months.

Research began in 1955 to adapt procedures that worked on Curaçao to conditions over the area of 50,000 square miles in Florida where screwworms ordinarily survive the winter.

The eradication procedure seems limited to the Southeast. It would not be worthwhile to try to eradicate screwworms from the Southwest, be-

cause they would be replaced soon by flies migrating north from Mexico.

Although the control of screwworms through the release of sterilized insects has received considerable attention, research also has been conducted on the feasibility of other methods. Research on materials that attract the flies has shown a great deal of promise.

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Fleeceworms

GAINES W. EDDY AND R. C. BUSHLAND

SEVERAL kinds of maggots may attack the fleece of sheep and goats, infest old wounds, or be primary invaders of fresh wounds of animals.

The black blowfly (*Phormia regina*), the secondary screwworm fly (*Callitroga macellaria*), and the green-bottle fly (*Phaenicia sericata*) are the main species. They usually breed in large numbers in carrion.

The black blowfly is blackish green and about the size of the screwworm

fly. It lays 50 to 100 or more yellowish eggs in a heap, quite different from the neat, white mass deposited by the screwworm.

The egg masses of all three blowflies look much alike. In infestations on sheep and goats they usually are deposited on soiled fleece. The larvae are creamy white. The larvae do not usually feed as a colony, but may do so, especially in wounds of dehorned cattle. The life cycle takes about 2 weeks.