Myiasis Caused by Old and New World Screwworms

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Importance

New World screwworm (*Cochliomyia hominivorax*) myiasis and Old World screwworm (*Chrysomya bezziana*) myiasis are caused by fly larvae (maggots) that, unlike most maggots, are obligatory parasites that feed on living tissues. Screwworm larvae are usually found in wounds or superficial body cavities such as the nose, and can infest all warm-blooded animals, though they are much rarer in birds than mammals. Old and New World screwworms have adapted to fill the same niche, and their life cycles are nearly identical. Female flies lay their eggs at the edges of wounds or on mucous membranes, where the hatched larvae enter the body, grow and feed, progressively enlarging the wound. Eventually, the larvae drop to the ground, pupate and develop into adult flies. Screwworms can enter wounds as small as a tick bite, and existing infestations often attract additional flies to lay their eggs, resulting in wounds that may sometimes contain hundreds or thousands of larvae, and can be fatal if left untreated. Screwworms have been eradicated from some parts of the world, including the southern United States, Mexico and Central America, but infested animals are occasionally imported into screwworm-free countries. These infestations must be recognized and treated promptly; if the larvae are allowed to leave the wound, they can introduce these parasites into the area.

Etiology

New World screwworm myiasis is caused by the larvae of *Cochliomyia hominivorax*, and Old World screwworm myiasis by the larvae of *Chrysomya bezziana*. Both flies are members of the subfamily Chrysomyinae in the family Calliphoridae (blowflies) and are obligatory parasites of warm-blooded animals (homeotherms), feeding only on living tissues during their larval stage.

Wohlfahrtia magnifica, which is sometimes called the Palearctic screwworm, causes a similar infestation of wounds and body cavities known as wohlfahrtiosis. While this organism is not discussed in this factsheet, it is also an obligatory parasite of homeotherms in its larval stage and feeds on living tissues. *W. magnifica* is a member of the family Sarcophagidae (flesh flies) and, unlike New and Old World screwworms, it deposits a limited number of live larvae rather than large numbers of eggs at lesions. However, its larvae can resemble Old World screwworms on cursory examination (though *W. magnifica* larvae have some anatomical differences and are larger) and the distributions of these two organisms overlap, with *W. magnifica* also being present in parts of North Africa and Asia, as well as in Europe.

Species Affected

All warm-blooded animals can be infested by screwworms, though these organisms are common in mammals and rare in birds.

Zoonotic potential

Humans can be hosts for screwworm larvae.

Geographic Distribution

Screwworms are very susceptible to freezing temperatures or long periods of near–freezing temperatures, and do not survive in regions with cold winters, though they may spread into these areas during the warmer months. The climatic requirements of Old and New World screwworms are similar and, while these flies are currently limited to their respective hemispheres, they could readily become established in the other hemisphere if introduced.

At one time, New World screwworms could be found throughout the tropical and semitropical regions of North, Central and South America and on a number of nearby islands. However, eradication programs in the 20th century eliminated them from North and Central America, Puerto Rico, the Virgin Islands and parts of the Caribbean. They have also been absent from Chile since 1947 and are rarely found above 7,000 feet in South America. A sterile fly release program (see Prevention), maintained at the Darien Gap between Panama and Colombia, usually prevents screwworms from spreading north, but flies or infested animals have sometimes passed this barrier, and occasional

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outbreaks have occurred in Central America, the U.S., or screwworm-free Caribbean islands. New World screwworms were detected in Libya in 1988, but were eradicated.

Old World screwworms can be found in parts of Asia, much of tropical and sub–Saharan Africa and some countries in the Middle East. They have never become permanently established in Europe, Australia, New Zealand or the Western Hemisphere.

Transmission

Although they are members of different genera and not very closely related, New World and Old World screwworms fill the same parasitic niche and have nearly identical life cycles. Screwworm larvae are obligate parasites of live animals. Infestations are transmitted when a female fly lays her eggs on a superficial wound or mucous membrane. Old World screwworms are also known to occasionally lay their eggs on unbroken soft skin, particularly if it has blood or mucous on its surface. Once screwworm larvae hatch, they burrow into the flesh, where they feed on living tissues and fluids. Wounds infested by screwworms often attract other female screwworms, and multiple infestations are common. After feeding through two molts (5- 7 days), the larvae leave the wound and fall to the ground, then burrow into the soil to pupate.

The adults that emerge feed on vegetation (flowers) and wound fluids or decomposing carcasses, with females mating after 3 to 5 days and males as soon as 24 hours. Female flies usually mate only once, but can lay more than one batch of eggs at intervals of a few days. While New World screwworms usually deposit two masses of eggs, they are capable of laying 6-8 batches or more. Female screwworms are attracted to all warm-blooded animals. Although many flies find a host within a few kilometers, they may travel up to 10-25 km, and even longer journeys have been reported. They tend to travel along river valleys and other bodies of water in dry regions. The ideal environmental conditions for their survival and activity are temperatures of 25-30°C (77-86°F) and relative humidity of 30-70%.

The length of the screwworm life cycle varies with the temperature. At the high temperatures in the tropics, it may be completed in less than three weeks, but at low temperatures, maturation can take up to 2-3 months. Freezing or a soil temperature consistently below 8°C (46°F) will destroy the pupae. The lifespan of a male fly is up to 14 days, while 10 days is common for a female; however, some female flies may live up to 30 days or more.

Incubation Period

Screwworm larvae emerge from the eggs in 12 to 24 hours, but they are difficult to detect in wounds for the first day or two.

Clinical Signs

Screwworms can infest a wide variety of wounds, from tick bites to cuts and dehorning or branding wounds. Infestations are very common in the navels of newborns and the vulvar and perineal regions of their dams. If a screwworm deposits its eggs on mucous membranes, the larvae may enter any orifice including the nostrils, sinuses, mouth, ears, genitalia or orbit of the eye.

In the first day or two, screwworm infestations are difficult to detect. Often, all that can be seen is slight motion inside the wound. As the larvae feed, however, the wound gradually enlarges and deepens. Infested wounds often have a serosanguinous discharge and sometimes a distinctive odor. Larvae can usually be observed within the wound by the third day and are oriented with their posterior end toward the surface. There may sometimes be as many as 200 vertically oriented parasites packed deep from a single infestation, and repeated infestations may result in thousands of larvae at various life stages. Large pockets of screwworms with only small openings in the skin are possible. In dogs, larvae have sometimes been reported to tunnel under the skin. Screwworms can also infest tissues near various orifices, and may be particularly difficult to find inside the nasal, anal, preputial and vaginal openings.

Screwworm larvae generally do not crawl on the surface, and tend to burrow deeper instead when disturbed. However, opportunistic flies that feed on dead and decaying tissues may lay their eggs on screwworm-infested wounds, and their larvae may be observed more superficially. Secondary bacterial contamination of the wound is also common. Discomfort, malaise, decreased appetite and lower milk production are frequent consequences of screwworm infestations. Affected animals often separate from the herd and lie down in shady areas, and fawns with screwworms in their navels have been observed standing in water up to their abdomen. Some untreated animals may die from toxicity or secondary infections within a week or two.

Post Mortem Lesions

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At necropsy, screwworms may be detected in any wound, in adjacent tissues or in various body cavities near orifices. They can feed deeply in tissues and can be found even around the bones.

Diagnostic Tests

Screwworms are normally diagnosed by identifying their morphology under the microscope. While larvae from the wound are generally used to diagnose a clinical case, eggs may also be observed, and adults can be caught in traps during outbreak investigations. Screwworm eggs are creamy and white, and are deposited in a shingle-like array on or near the edges of superficial wounds. This array helps distinguish them from the eggs of other species of flies, which are usually not well organized. Any eggs on the edge of the wound can be collected by carefully removing them with a scalpel.

Larvae should be taken from the deepest parts of the wound, as more superficial larvae may be the opportunistic larvae of other flies. The second and third instar larvae of screwworms resemble a wood screw. They are cylindrical, with one pointed end and one blunt end, and have complete rings of dark brown spines around the body. Younger larvae are creamy white, while fully mature third-stage larvae may have a reddish-pink tinge. The presence of dark tracheal tubes on the dorsum of the posterior end aids identification of third-stage *C. hominivorax* larvae; however, pigmentation of the dorsal tracheal trunks is less extensive and not as distinctive in *C. bezziana*. First-stage screwworm larvae are difficult to identify.

Definitive field identification of screwworm larvae can be difficult for non-experts, even with a microscope or magnifying glass, and a suspicion of screwworms can be confirmed by submitting specimens for expert diagnosis. Larvae and eggs sent to laboratories can be preserved by various methods; however, many preservatives cause the larvae to darken and contract. Immersing them in boiling water for 15–30 seconds, then storing them in 80% ethanol helps preserve their morphology.

Adult screwworms are uncommonly seen, and are difficult to distinguish from other flies. Female screwworm flies, which sometimes visit wounds to feed, are larger than houseflies. The thorax of a New World screwworm fly is usually metallic dark blue to blue-green (though it can range from light blue to green) and the head is reddish-orange. On the back of the thorax, there are three longitudinal dark stripes. The Old World screwworm fly is metallic blue, bluish-purple or blue-green, with two transverse stripes on the thorax.

Other techniques used to identify screwworms, mainly in research laboratories, include cuticular hydrocarbon analysis, analysis of mitochondrial DNA, and random amplified polymorphic DNA polymerase chain reaction (RAPD-PCR) assays.

Treatment

Treatment of infested animals is generally allowed even in non-endemic regions, though the larvae must be prevented from entering the environment or accessing another host. Until treatment is complete, such animals are quarantined in a location (e.g., on a cement floor) where any larvae that leave the wound can be readily found and destroyed.

While some infested wounds on livestock may be surgically excised or have the larvae removed manually, most are treated with a suitable larvicide (e.g., coumaphos, dichlofenthion, fenchlorphos, spinosad, ivermectin, doramectin) and allowed to heal without closure. Treatment may need to be repeated at intervals. One study that examined various treatments in sheep found that the efficacy of some agents may depend on the route of administration: while topical ivermectin, chlorfenvinphos/cypermethrin and spinosad were all highly effective on 2-4 day old larvae, injectable ivermectin had significantly lower efficacy, particularly on older screwworm larvae. Wound treatment, debridement of necrotic tissue and antibiotics may also be necessary.

In small animals, screwworm larvae are often removed manually from wounds, often under anesthesia or deep sedation. This is sometimes combined with antiparasitic agents such as macrocyclic lactones (e.g., ivermectin, doramectin, abamectin) to help expel and/or kill the larvae. Recent reports in cats and dogs describe the use of other agents such as isoxazolines (e.g., lotilaner, afoxolaner, sarolaner), nitenpyram, spinosad or oral spinosad/milbemycin, either as adjunct treatments to manual wound removal, or combined with wound treatment and saline flushing alone. While the efficacy of the various agents sometimes differed, some appeared to kill and/or expel all of the larvae within 24 hours, though a percentage of dead larvae were sometimes retained within the wound.

Treatment of wildlife is impractical in many situations, but oral doramectin was used to help reduce mortality in endangered Key deer, which have become habituated to people and readily accept food treats, during an outbreak in the Florida Keys.

Control

Disease reporting

Veterinarians who encounter or suspect screwworms should follow their national and/or local guidelines for disease reporting. In the U.S., screwworm infestations should be reported to state or federal authorities immediately upon diagnosis or suspicion of the disease.

Prevention

Screwworms can enter non-endemic areas in infested animals (and people) or as adult flies. Vehicles can be sprayed with insecticides, while imported animals, including pets, are inspected for infestations, and treated if necessary, before they are allowed to enter. As a precaution, an insecticide may also be applied to wounds that are not obviously infested, and some apparently unaffected animals may be sprayed or dipped. Any infestations that become apparent after an animal enters the country must be treated promptly. If an outbreak occurs, infested carcasses may need to be decontaminated to destroy any third stage larvae that could leave the wound and pupate, for instance by freezing the carcass before disposal.

In endemic regions, inspecting animals for screwworms every few days can help detect infestations in the early stages. Livestock can also be protected by regular spraying or dipping with insecticides, though acaricide resistance can be an issue, or with various antiparasitic drugs. One study found that, in sheep, subcutaneous injections of macrocyclic lactones (ivermectin, doramectin or abamectin) provided only short-term protection, but oral ivermectin capsules were effective for up to 3 months. Insect growth regulators have

also shown good results in some studies. The effectiveness of flea and tick agents such as spinosad/milbemycin or afoxolaner against screwworms in dogs and cats is currently unknown; however, their efficacy in treating infested animals suggests they might be helpful. Additional preventive measures in livestock and pets can include treating wounds with larvicidal agents until they heal, and where practical, scheduling breeding and routine medical procedures (e.g., castration, dehorning) to avoid births and wounds during screwworm season.

New World screwworms can be eradicated from a region by repeatedly releasing sterile male flies that mate with wild female screwworms to produce unfertilized eggs. This technique leads to a reduction in screwworm numbers and can eventually result in complete elimination in a well-designed program. Similar programs are also expected to be effective for Old World screwworms, but sterile insect breeding facilities would need to be established first for this fly, in order for such programs to be feasible.

Morbidity and Mortality

Screwworm infestations occur year-round in some regions but are seasonal in others, spreading into cold-climate areas during the warmer months. In some parts of the Middle East with low winter temperatures and/or hot, dry summers, Old World screwworms persist only in localized foci, but major flare-ups may occur when environmental conditions are more conducive to their survival.

Morbidity from screwworms in domestic animals varies, but it can be very high when the ecological conditions are favorable. In some areas, screwworms may infest the navel of nearly every newborn animal. A single deposition of eggs, or a treated infestation, is not usually fatal, though deaths may occur in smaller animals or from secondary infections and other complications. However, untreated wounds often develop multiple infestations, which are more likely to kill the animal. In the 1950s, when screwworms were still endemic in south Texas, the annual mortality rate in fawns on one ranch ranged from 20% to 80%. The effects of screwworms on free-living wildlife are poorly understood.

Public Health

People can be affected similarly to animals, though the number of cases seems to be only a fraction of those reported in animals during outbreaks. People who are debilitated and unable to keep screwworm flies away from wounds may be disproportionately affected, but infestations also occur in those who are healthy. Clinical signs reported in humans include pain, pruritus and discomfort, in addition to wound discharge, bleeding and the observation of larvae or larval movement. Screwworm myiasis can quickly become debilitating, destructive or fatal if it affects the eyes, mouth, nasal or frontal sinuses, ears or critical sites such as the tissues around tracheostomy or pharyngostomy tubes.

Human cases are generally treated by manual removal of the larvae, sometimes under local or general anesthesia, followed by local wound treatment, with antibiotics and debridement as necessary. Larvicidal agents such as hydrogen peroxide, isopropyl alcohol or chloroform in oil are sometimes used to aid removal and reduce the risk that larval fragments will be left in the wound, which can result in increased inflammation. Various suffocating agents, such as mineral oil, liquid paraffin, petroleum jelly, beeswax or adhesive tape, have also been used to help kill the larvae or encourage them to leave the wound, and anthelminthic drugs such as ivermectin have been employed successfully in some reported cases, including oral myiasis. Keeping wounds covered and clear of blood or exudates that can attract flies is an important preventive measure, while adult flies can be excluded from living areas with bed nets and/or window screens.

Internet Resources

The Merck Veterinary Manual

United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS). New World Screwworm

World Organization for Animal Health (WOAH)

WOAH Manual of Diagnostic Tests and Vaccines for Terrestrial Animals

WOAH Terrestrial Animal Health Code

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