Pests of Livestock: I-Stomoxys calcitrans (Insecta: Diptera: Muscidae) (Stable fly)

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Abstract
The current review focused on the importance of Stomoxys calcitrans, stable fly, at the level of transmission of protozoal, helminthic, bacterial, and viral pathogens. The review found that S. calcitrans can transmit Besnoitia besnoiti tachyzoites, Trypanosoma evansi, and Theileria, Babesia. In the case of helminth transmission, S. calcitrans was found to be able of transmitting Habronema muscae, H. microstoma, Trichuris vulpis, and some species of Onchocerca and Dirofilaria. The review also identified that S. calcitrans can transmit Escherichia coli, Campylobacter, and mycobacteria. For the viral pathogens, S. calcitrans can transmit lumpy skin virus (LSV), African swine fever virus (ASFV), and bovine papilloma virus (BPV). The stable flies are a massive member of disease vectors that can ranks number one in inducing huge economic losses around the world.
Keywords: Stable, fly, Stomoxys, calcitrans
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1. Introduction

S. Calcitrans (L.) (Diptera: Muscidae) is the most extensively dispersed species in the genus, and it is widespread in the world. Since they are ectoparasites that feed on the blood of their hosts and may spread a variety of pathogens, stable flies, or "dog flies," are regarded a significant economic threat to livestock producers. There are four black stripes on the thorax of the stable fly, two (outer) of which are broken, and black blotches or checkering on the abdomen. The stable fly is similar to the house fly and the horn fly, which is 4- to 7-mm long, grayish-yellow with a greenish-yellow sheen. Slender proboscis protrudes out in front of the head and has distinct wings (Figure 1) [1].

Figure 1: Stomoxys calcitrans.

Eggs are placed in clumps of 20–100, deep inside the ovipositor's substrate. Dung is not included in ovipositional substrates unless it is part of, combined with, or dropped on top of the decaying plants. There must be enough moisture in the substrate for larval growth, and the fermentation of the plant matter is very beneficial. In addition to the aforementioned, rotting hay, alfalfa, hay, sugarcane stalks, sea grass, grass clippings, and heaps of discarded vegetables are also substrates where the insect may thrive. there are instances where stable flies lay their eggs in dried out cattle manure [2]. This occurs most frequently in the areas with high summer temperatures that lead to subjected manure to dry out and form a crust on the surface, sealing in moisture and creating a long-term, protected nesting environment. It is common for females in the wild to produce 60–800 eggs over the course of their lifetimes, which typically occurs between four and five occasions. In addition to cattle, stable flies may infest a broad variety of other creatures, including rats, guinea pigs, rabbits, primates, horses, and even humans [3]. In 3 to 4 minutes after a bite, the stable fly is engorged and is ready to feed again. This cycle repeats as the fly moves from one animal in a herd to the next. The flies tend to attack cow front legs, where lighter hair presents less of an interruption and where the pests are less likely to be distracted by the wagging cow tail [4]. Anxiety and discomfort are felt by the animals as a result of the bites, resulting in blood loss and decreased weight growth or breastfeeding. Annual losses in cattle production due to stable flies and their management in the United States were approximated at US$100 million in 2011 [5].

Stomoxys calcitrans (Diptera: Muscidae)

As one of the most common zoophilic fly species to infest livestock and poultry farms is S. calcitrans (Diptera: Muscidae), which is found across the world. Stable fly populations on animal farms may range from low to high percentages, based on Russian researchers. Spread of S. calcitrans in recent decades has been linked to waste material from winter food, massive crop production near cow house building, and/or accidental organic fertilizer utilization [6].

Microorganisms are spread mechanically across ranges of many hundred meters by S. calcitrans in agricultural settings. Warm-blooded animals attacked by S. calcitrans

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establish elevated defense response, like alterations in blood levels of cortisol, inflammation of the perivascular and interstitial dermal layer, a rise in neutrophilic and monocyte cells, which are linked to a particular inflammatory process, diminished mean of daily gain, and disrupted behavioral reactions including anxiety and stress. It is possible to manage the population of S. calcitrans and the spread of pathogens by studying their life in livestock farms and grazing regions [1].

Stomoxys is a genus that includes 18 species. Numerous countries see them as severe economic pests of livestock and other warm-blooded animals, since they are obligatory bloodsuckers. Species S. calcitrans is worldwide in its distribution. Other flies of this genus that target domestic animals include S. indicus, S. niger, and S. sitiens [7]. A blood-sucking fly, the stable fly is capable of attacking people in the absence of its favorite victim and may be aggressive and persistent in feeding. Sugars from flowers and mature fruits have lately been found to be consumed by those flies [8] Despite the fact that animal farms are where they tend to be busier and annoying, they may also be a bothersome bug along the shore and in neighborhoods near agricultural output [9].

Economic effect

Most devastating arthropod pest of cattle globally is stable fly S. calcitrans (L.). Twenty years ago, an estimated $608 million in damages to the United States' cattle industry was reported. As a result of these research, stable flies are now widely regarded as a pest of cattle on pastures and ranges as an impediment to weight increase and feed effectiveness. Stable fly invasion rates of individual herds have been shown to cause reductions of 139 kg of milk for dairy cows, as well as 6 and 9 kg of body weight for young calves and feeder cattle [10]. Annual milk output of dairy cows is reduced by an approximated 890 kilograms, and the weight increase of young calves or feeder cattle is reduced by 58 or 84 kg. There would be losses of $254, $132, 1,279 or $154 in 2009 USD for each of these situations. National losses for dairy cattle are estimated at $360 million, for cow-calf herds at $358 million, for pasture-based herds at $1,268 million, and for feed-based herds at $226 million based on average prices for 2005–2009 [11].

Transmission of pathogens

Protozoa

S. calcitrans can transmit Besnoitia besnoiti tachyzoites from experimentally treated bovine blood to blood negative of B. besnoiti in a laboratory environment utilizing glass feeders. The identification of the parasite DNA offered this proof of transmission [12]. It was shown that S. calcitrans can transfer the virulent B. besnoiti bradiozoites from persistently affected cows to vulnerable rabbits more effectively than was previously thought. The quick destruction of B. besnoiti bradiozoites in the abdomen of S. calcitrans after 48 hours of testing suggests that mechanical transmissions can only occur during brief periods between fly feedings[13].

Besnoitiosis progression was studied by Gollnick et al. [13] by observing cows co-located with healthy heifers and diseased cows for 12 weeks on pasture. In this investigation, the experimental group was separated from the control group by a distance of no less than 20 meters. Antibodies to B. besnoiti were found in two formerly healthy animals in the intervention group. Visible skin alterations, body damage, and chronic laminitis regarding non-recovered sole ulcers were identified in animals with high amounts of parasite DNA in specimens by polymerase chain reaction (PCR) [14].

T. evansi (causes trypanosome) distribution within camels in the Canary Islands zone of Spain is most likely to be transmitted by S. calcitrans flies, as shown by trapping in this area throughout a year round [15]. Researchers in Kenya conducted experiments to see whether S. calcitrans flies could transfer T. evansi from sick goats to other goats or camels, only needle injections but not the flies were capable to spread the disease from infected goats to camels. By 89 percent in disease-prone locations, S. calcitrans seems to be influencing the spread of T. vivax in cattle and small ruminants in Ethiopia, according to Sinshaw et al. [15].

S. calcitrans infected with Theileria and Babesia (animal pyroplasmidoses) was found for the first time by Changbunjong et al. using molecular detection techniques (PCR and sequencing) in the flies captured in Khao Yai National Park, Thailand [16]. A. marginale was found in S. calcitrans that was caught close to a group of cattle that had been maintained tick-free for 40 years and in which infrequent clinical cases of anaplasmosis had emerged, leading Bautista et al. (20) to propose that mechanical transfer of A. marginal happens and this helps towards the circulation and persistency of the bacterium in the specific cattle herd [17].

Mycoplasma

As well as via their body surface, stable flies may spread pathogens while feeding on blood. Mycoplasma suis may be transmitted mechanically by S. calcitrans under normal circumstances, but only with limited success. Stable flies from 7/20 (35 percent) farms were found to have hemotrophic mycoplasmas. There was no anemia, icterus, fever, or stunted growth in animals at the time of sampling, but one farm had a lengthy history of eperythrozoonosis and it was still probable to find hemotrophic mycoplasmas. Because bioassays would be necessary to determine whether or not these hemotrophic mycoplasmas were infectious, it is impossible to conduct a full investigation [9].

Helminths

Helminths may use S. calcitrans flies as an intermediary host. Habronema muscae and H. microstoma (Nematoda, Spirurida), both of which induce stomach and dermatological habronemosis, were identified in the field using a PCR-based assay by Traversa et al. (2011), Nematode larvae of H. muscae, H. microstoma, and Draschia megastoma were found in Musca domestica flies in the United Arab Emirates by PCR, however they could not be confirmed in S. calcitrans flies by PCR. Environmental pollution was observed in a dog training facility due to S. calcitrans, which distributed larvae of exogenous types of Trichuris vulpis, which produces trichurosis in carnivorous animals, disseminating

throughout the facility. In addition, it was proposed that the sable flies may transmit some species of Onchocerca and Dirofilaria [1].

Bacterial microorganisms

S. calcitrans is thought to be a vector for a variety of animal illnesses. By cultivating Enterobacteriaceae from S. calcitrans harvested in the region of Rio de Janeiro dairy farms, the participation of S. calcitrans in the spread of these infections was indirectly established. Escherichia coli was the most often seen among the Enterobacteriaceae, as reported by Castro [18], who recovered and recognized twenty distinct species [19].

A natural reservoir for E. coli is thought to exist in the larval and pupal stages of flies that have been infected with the microbe. The discovery of shigatoxigenic E. coli (STEC) isolates in three distinct anatomical areas of S. calcitrans suggests that these flies might serve as carriers of dangerous germs. According to research, stable flies may be capable of spreading E. coli. These flies are unlikely to be a biological carrier and/or repository of STEC-8 in cattle feedlots [20].

Campylobacter and mycobacteria might be transmitted by S. calcintrans flies. There is evidence to support the probability of Campylobacter spread by S. calcitrans fly that swarms in the area of poultry farms and that S. calcitrans may spread Campylobacter in North American chicken farms [21]. Mycobacterium scrofulaceum was identified from mature S. calcitrans flies collected from cattle and pig rearing sites. Adult S. calcitrans flies may spread mycobacteria if they have been subjected to contaminated substances [22].

2. Viruses

Risk of LSV that is triggered by a DNA virus of the Poxvirus family; Capripoxvirus genus, is connected in France with vector arrivals from other countries, such as S. calcitrans, in animal transport [23].

It is also probable that S. calcitrans might transmit the ASFV. Olesen et al. [23] claim that the existence of the virus in these insects after ingesting virus-containing blood indicates that these bugs are potential of transmitting the virus. It was shown that intramuscular inoculation of a suspension solution of flies fed on virus-containing blood may be used to infect pigs, and that was validated the virus viability in these stable flies [24].

To determine whether or not Porcine reproductive and respiratory syndrome virus could be transmitted from pig to pig, [24] looked at the blood volume stored in S. calcitrans closed mouth components throughout blood feeding and found that it was inadequate to produce an infective dose of the virus [25].

Cattle nodular dermatitis is an extremely contagious illness that has the potential to inflict substantial financial harm. It was initially discovered in the European Union in 2014 in Cyprus, then in Greece in 2015, and finally in the Balkans in 2016. Short-distance dissemination occurs mostly via indirect spread. The transportation of infected cattle or vectors, such as S. calcitrans, which is primarily found in livestock transport, is responsible of distant dissemination of the virus. Also established is that S. calcitrans may spread the illness on dairy farms. It was reported that 14 of 17 dairy cows in the Israeli community of Peduim had been infected en masse with the illness. Skin nodules appeared throughout a 37-day period in August and September of 1989, according to the researchers. S. calcitrans transferred the initial infection to Peduim, according to the same scientists [26].

A study by Haspeslagh and colleagues [26] found that S. calcitrans flies are engaged in the dissemination of bovine papillomavirus and equine sarcoidosis, and that the first virus dissemination using S. calcitrans flies is feasible and more prevalent after the subjecting to BPV than to equine sarcoids. They also found that flies can only transmit the disease after coming into interface with injured tissue.

S. calcitrans injection of third-stage larvae in ulcerated lesions is a common cause of equine sarcoidosis, which is generally seen in formerly wounded skin regions, including foci of habronemosis [27].

When S. calcitrans flies were fed meals constituting 104.5 TCID50 of tissue culture of non-cytopathic bovine viral diarrhea virus/ml serum and then fed blood from animals in separation from this microorganism, the chance of virus recovery from the recipient animals remained for 72 hours after transfer and from the insects infected with the virus 96 hours after getting the infected meal [28].

3. Conclusion

The stable flies are a massive member of disease vectors that can ranks number one in inducing huge economic losses around the world.

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