Fly Infestations of Cattle in the United States

John B. Campbell, *PhD, Professor Emeritus*
University of Nebraska Department of Entomology, West Central Research and Extension Center, 402 W State Farm Road, North Platte, NE 69101-7751

Abstract

Several species of the order Diptera (flies) impact the performance of cattle in the United States. The most important of these is the horn fly, *Haematobia irritans* (L.) followed by the face fly, *Musca autumnalis* De Geer and the stable fly *Stomoxys calcitrans* (L.). Less important because of their restricted infestation area are several species of black flies (*Simuliidae* species), biting gnats (*Culicoides*), deer flies (*Tabanidae*) and horse flies, mosquitoes and two species of heel flies (cattle grubs). All of these species except the face fly and the heel flies are blood feeders. Several species can transmit disease to cattle.

Résumé

Plusieurs espèces appartenant à l'ordre des Diptères (mouches) influence la performance du bétail aux États-Unis. L'espèce la plus importante est la mouche des cornes Haematobia irritans (L.) suivie de la mouche faciale Musca autumnalis De Geer et de la mouche charbonneuse Stomoxys calcitrans (L.). D'autres espèces ont moins d'importance en raison de l'aire plus restreinte de leur infestation telles plusieurs espèces de mouches noires (espèces de Simuliidae), de moucherons piqueurs (Culicoides), de mouches à chevreuil (Tabanidae) et de mouches à cheval, de moustiques et deux espèces de varrons. Toutes ces espèces à l'exception de la mouche faciale et des varrons se nourrissent de sang. Plusieurs espèces peuvent transmettre des maladies au bétail.

Horn Fly

Introduction

Campbell and Thomas reviewed the history, biology, economics and control of the horn fly, *Haematobia irritans*.[3] This fly is considered the most important ectoparasite of cattle in the US because of its widespread distribution, abundance and effect on cattle performance.[3] The literature on the horn fly is voluminous and scattered through the journals of several disciplines and countries. Morgan and Thomas published an annotated bibliography and a supplement that cites most of the world literature on the horn fly through 1974.[17,18]

Biology

The horn fly was introduced into the US in the late 1980s and has spread throughout most of North America and into areas of Central and South America.[14,30]

After mating and egg maturation, a female fly deposits eggs in fresh bovine dung. Each female has the potential to deposit 300-400 eggs during her lifetime. The life cycle, egg to adult, is usually completed within 10 to 14 days depending on the temperature. The high fecundity and short life cycle times allow the horn fly to build up high numbers rather quickly in the spring (500-1000).

In northern latitudes, the horn fly overwinters in the pupal stage. Horn flies start to enter diapause in late August and continue until the first frost. Only a certain percentage enters diapauses, so horn flies are present until a frost kills them. In southern latitudes they may breed throughout the year, but generation time increases during colder months.

Diapause starts to break as warm weather occurs in late March or April, and is generally completed in May. When the first flies emerge from diapause, cattle may not be present on range or pasture, in which case the flies will move to feedlot cattle or even horses, but larval development doesn't occur at these sites.

Economic Effects

The horn fly is a small, dark colored fly that is considered a facultative parasite since it stays on the animal except to deposit eggs. It is a blood feeder and may feed many times in a 24-hour period. When the immature part of the life cycle is complete, adults emerge and immediately seek cattle. They usually move downwind. Horn flies flare and move between animals or herds if they are in close proximity. Flaring is caused by tail switches or the head being thrown back to dislodge flies. The economic impact or economic threshold for horn flies on cattle is somewhat in dispute in the literature. Laake conducted large scale tests in Kansas using DDT sprays.[13] In that study, horn fly numbers were estimated to range from 3,000 to 20,000, the latter on older cows and bulls. The economic effect of this level of fly numbers ranged from 30-59 lb per animal.[13] As indicated in the reviews of both Drummond and Schreiber most of the early economic studies on the impact of horn flies on annual performance was conducted on steers.[10,24] Campbell was the first to monitor the indirect effect of horn fly control on cows in terms of weaning weights of

calves.[4] Part of a study by Kunz was also concerned with weaning weight economics.[11]

In general, horn fly numbers presently range from an average of 300-1,000 per animal and weight reductions range from 10-15 lb (4.5-6.8 kg) per animal. Long-term studies by Schreiber and Campbell over several years indicated weaning weight decreases ranging from 3-22 lb (1.3-10 kg) per animal, depending on the year. The heaviest losses occurred in hot, dry years and the lightest during cool, wet years.[26]

Horn Fly Control

Drummond and Campbell *et al.* reviewed the historical evolution of the horn fly control methodology.[11,] Originally, chlorinated hydrocarbons were used as sprays, then oilers which were made from wire and burlap. Eventually, chlorinated hydrocarbons were phased out and replaced with phosphate insecticides. Dust bags generally replaced oilers as a self-treatment device for horn fly control and later. Insecticide-impregnated ear tags became the treatment of choice for horn fly control. Unfortunately the traits that made the ear tags so effective--long residual, highly toxic migration over the haircoat and convenience (last a fly season)--led to the development of resistance.[2,13,22] Resistance in the ear tags was a pyrethroid resistance. Companies replaced pyrethroids with phosphate insecticides which, although not as effective, provide fair control. There are also newer more toxic pyrethroid insecticides available in ear tags at present.

Face Fly

Introduction

The face fly, *Musca autumnalis* De Geer, was first detected by Vockeroth in Nova Scotia.[29] The fly probably accompanied imported dairy cattle from Europe.[27] In a few years it had spread across northern US and southern Canada.

Biology

Moon and Meyer reviewed the life cycle of the face fly. It also deposits eggs in bovine manure.[17] The life cycle takes about three weeks. This longer period of development is probably beneficial to range states. The fly was once present is most of the northern ranges, but is not at present.[1]

It seems possible that as drought developed in the northern range states, the face fly was unable to complete its life cycle before the manure dried out. Both sexes must require energy – yielding carbohydrates from plants and dung. Females must obtain protein from hosts to develop eggs. They feed on facial secretions such as tears, nasal mucus and saliva. They also consume blood from wounds, milk from calves' faces and any other body discharges.

When the face fly was first noted in the US, it was assumed that the mouthparts of the fly were spongy like the house fly. However, the research of Shugart *et al.* demonstrated that cattle exposed to face fly feeding developed petechial lesions, some of which progressed from the petechial stage to the ecchymosis stage.[27] This injury could allow an entrance for secondary microbes of the eye.[24] Later, Broce and Elzinga, by using an electron microscope, found that the face fly mouthparts were of a rasping type that caused lesions when the fly fed on the conjunctiva of the eye.[1]

The biology of the face fly is somewhat different than the rest of the muscoid species in that it overwinters in sheltered areas as an adult and that the pupal case is white.

Economics

The feeding of the face fly around the eyes of cattle and horses in all probability causes annoyance. However, economic studies have been concerned primarily with the face fly's ability to transmit pinkeye.

Face Fly control

The same procedures used for horn fly control are used for face fly control. At this time, face fly resistance to pyrethroid or other insecticides is unknown. When face fly populations are high, two methods of control may be needed to provide relief to the cattle. Ear tags plus periodical spraying are the usual combination. Control of face flies is more difficult than for horn flies because the face fly infests calves as readily as it does cows, and consequently both cows and calves must be treated. Horn flies don't infest calves unless populations on cows reach a high level.

Stable Fly

Introduction

The stable fly, *Stomoxys calcitrans* (L.), is worldwide in distribution. Adult stable flies resemble house flies in appearance, but have checkerboard abdominal markings and the mouthparts protrude forward like a bayonet.

Biology

The female fly deposits eggs in wet, decaying organic matter mixed with manure. The larvae move to drier areas of the media to pupate. When adults emerge, they move to cattle to feed on blood. They will also feed on horses and other animals.[24]

Economics

Because of the worldwide distribution of the stable fly and its annoyance to man and animals, the literature

on the pest is voluminous. Rasmussen and Campbell published a bibliography on the stable fly but citations were primarily on studies conducted in the US[23] Morgan *et al.* published a more complete, annotated bibliography.[20]

Determining the economic significance of the stable fly has been difficult. The mobility of the insect and the lack of a good control method which would prevent fly feeding makes a comparison in weight gain or milk production between fly-infested and fly-free cattle difficult.

Stable flies are probably the most serious insect pests of feedlot and dairy cattle during summer months. In addition, in the past 20 to 30 years the stable fly has become a pest of range and pasture cattle.

Our research in Nebraska indicates the economic injury level for feeder cattle occurs when fly population levels average about five flies per front leg.[16] The most obvious effect of stable flies on cattle is the change in the behavior of the animals. When stable flies are numerous, cattle bunch up as each animal attempts to protect its front legs, the preferred stable fly feeding site. Campbell *et al* determined the effect of stable flies on weight gains of feedlot cattle.[5,9] Stable flies affect both weight gain and feed efficiency. The average reduction for a five stable-flies-per-leg infestation was 3.85%, and feed efficiency by 5.05%, in 84 day trials. Heavier stable fly populations caused a greater decrease in cattle performance.[29,7] In a later study, Wiseman *et al* determined that bunching and subsequent heat stress caused 71.5% of the reduced weight gain, and the direct effect of the biting flies accounted for 28.5% of the loss.[30]

In 2001, a study on yearling grazing steers indicated a weight gain reduction of 0.44 lb (0.2 kg) from an average stable fly population of only 3.64 stable flies per front leg. In two of the three years of these 84-day trials, the yearlings were placed in a feedlot and fed a finishing ration. There was no compensatory gain by the steers in the feedlot after the stable fly stress was removed.[7]

Some researchers might question why house flies, *Musca domestica* (L.), were not included in this discussion. In our trials, house fly populations of 5, 10 and 40,000 per-fly screened feedlot pen (10 animals per pen) had no effect on cattle weight gains.[6]

Black Flies

Introduction

Black flies, *Simuliidae* species, have several common names including black flies, buffalo gnats, and turkey gnats or chiggers. The distribution of this group of biting flies is worldwide and they attack a wide range of domestic and wild mammals and birds.

Biology

Black flies are considered aquatic since they deposit eggs in layers as irregular strings on the surface of objects kept moist by water movement. Larvae sink to the bottom of the water and attach to stones, branches or other debris in swift-flowing water. They attach to these objects by a set of suckers. Most species have mouth brushes with which they filter food from the water.[24]

Economics

Adult black flies are small, dark 'humpbacked' flies. In the northern Great Plains states they generally feed on horses, cattle or other animals' ears. Southern species feed on livestock and humans, and one species feeds on the comb and wattles of poultry. The southern buffalo gnat can develop in slow moving water, and populations may suffocate livestock. There is no known economically feasible way to control black flies, and the economics of the impact of black fly infestations are unknown.[24]

Ceratopogonidae

Introduction

The *Culicoides* have the common names of biting gnats, punkies, no-see-ums and ceratopogonidids. Their distribution is worldwide in temperate and warmer areas. They are blood feeders that feed on a wide range of domestic and wild animals. The biting gnats are small and the females have piercing, sucking mouthparts.

Biology

In addition to the short, piercing mouthparts of the females, the fly's legs are short and stout and the wings are superimposed over the back when at rest. These flies are also classified as aquatic. Breeding areas include streams, lakes, pot holes, tree holes, and other water-filled areas. Some of the important livestock species breed in water containing animal waste. Most species overwinter as either larvae or eggs.[24]

Economics

The primary economic concern with the biting gnats is their capability of transmitting viral diseases including bluetongue, eastern equine encephalitis, Venezuelan equine encephalitis and bovine ephemeral fever. Bluetongue is the most important of the diseases because of infestation pressure. Although considered an important disease of sheep and white-tail deer, it also infects cattle. While Bluetongue is not severe in cattle (less than 5% infestation), it affects calf production seriously through abortion.[28]

Control, except for draining known culicoides breeding areas, is generally considered non-effective because the flies are nocturnal.

Tabanids

Introduction

The Tabanids, or horse and deer flies, are distributed worldwide. They feed primarily on horses and cattle, but also on other mammals including humans. Worldwide there are many species, with over 325 recognized in North America.

Biology

Tabanids are aquatic, with most species depositing eggs on vegetation that overhangs water. After hatching, the larvae fall into the water or mud, where they feed on organic debris or on other aquatic life. Most species live along ponds, marshes or streams. The mouthparts of the adult female tabanid are stout and blade-like and in a scissor-like mode they inflict a deep, painful bite. They feed on blood by sponging it with the labellum.

The eyes of many species are brilliantly patterned with shades of green (green heads), yellow-orange and violet. Tabanids range in size from the small deer flies, being similar to a house fly, to the horse fly which may be 3 mm long. Only females feed on blood, while males feed primarily on nectar.[21]

Economics

Tabanids are not only serious pests of livestock because of their feeding, but are also vectors of anaplasmosis, a rickettsial disease of cattle. Losses in livestock production from tabanids in the US are estimated to exceed $40 million annually.[24]

Control of tabanids is difficult, as sprays are generally not effective. Moving cattle away from Tabanid habitat areas may be of some help. In some cases, drainage or manipulation of water level in breeding areas may help, and traps may help for some species. However, in general, adequate tabanid control is not achieved.

Mosquitoes

Introduction

Mosquitoes are distributed worldwide from tropical to Arctic climates. Some 3,000 species attack a great number of domestic and wild animals. Only females feed on blood.

Biology

There are four stages in the life cycle of mosquitoes: egg, larvae ("wriggles"), pupae (tumbler) and adult. The larvae of all mosquitoes are aquatic, as are the pupae. After adult emergence mating may occur individually or in mating swarms.

Economics

Mosquito populations vary greatly, and generally reach high numbers in the South and in Canada. Current estimates of losses are estimated at $38 million annually.[24] Control is generally not considered economical. Sprays are ineffective, and most species have several generations per year. The most important species from a cattle perspective is probably *Aedes vexans*, a daytime feeder. Most species feed more at night. Draining mosquito breeding areas can be beneficial, particularly for flood-water species such as *Aedes vexans*.

Heel Flies (cattle grubs)

Introduction

There are two species of cattle grubs that infest cattle in North America. The common grub is found throughout the US and Canada, and the northern grub is found in the northern part of the U.S. and Canada. Over the years, the common grub has almost replaced the northern grub.

Biology

The adults of both species resemble honey bees. The name "heel flies" results from the fact that female flies deposit eggs on the back legs of cattle. Cattle react to the egg-laying efforts of the flies by curling its tail over the back and running (gadding). When the eggs hatch, the larvae bore into a hair follicle and spend the next several months migrating through the tissues of the animal. Eventually, the grubs migrate to the loin area of the animal and cut a breathing hole. The common grub usually emerges from the back in late February, and the northern grub in March. The grubs migrate to protected grassy areas and pupate. Adults are present in late May or June, or perhaps later for the northern grub.

Adult heel flies do not have mouthparts, and generally live only three or four days.

Economics

At one time, cattle grubs were assumed to be the most costly insect affecting cattle in the US except for ticks in the south. At present, control measures are so effective that there is little impact from grubs. Most cattle are treated at fall weaning time with a systemic insecticide which is broad-spectrum (endectocides) which also controls internal parasites.[4]

References

1. Broze AB, Elzinga RJ: Comparison of prestonal teeth in the face fly (*Musca Autumnalis*) and the house fly (*Musca domestica*) (Diptera: Muscidae). *J Med Entomol* 21:82-85, 1984.
2. Byford RL, Quisenberry SS, Sparks TC, Lockwood JA: Spectrum of insecticide resistance in pyrethroid resistant populations of *Haematobia irritans* (L.). *J Econ Entomol* 78:768-773, 1985.
3. Campbell JB, Thomas GD: The history, biology, economics, and control of the horn fly. *Haematobia irritans* (L.). *Agric-Pract* 13:31-36, 1992.

4. Campbell JB: Effect of horn fly control on cows as expressed by increased weaning weights of calves. *J Econ Entomol* 69:711-712, 1976.
5. Campbell JB, White RG, Wright JE, *et al.*: Effects of stable flies on weight gains and feed efficiency of calves on growing and finishing rations. *J Econ Entomol* 70:592-594, 1977.
6. Campbell JB, Berry IL, Boxler DJ, *et al*: Effects of stable flies (Diptera: Muscidae) on weight gains and feed efficiency of feedlot cattle. *J Econ Entomol* 80:117-119, 1987.
7. Campbell JB, Skoda SR, Berkebile DR *et al*: Effects of stable flies (Diptera: Muscidae) on weight gains of grazing yearling cattle. *J Econ Entomol* 94:780-783, 2001.
8. Campbell JB, Boxler DJ, Schugart JI, Clanton DC, Crookshank R: Effects of house flies on weight gains and feed efficiency on yearling heifers on finishing rations. *J Econ Entomol* 74:94-95, 1981.
9. Campbell JB: *Nebraska Management Guide for Arthropod Pest of Livestock and Horses*. Univ. Nebr. Ext. Publ. EC1550, 2006.
10. Drummond RO: Economic aspects of ecotoparasites of cattle in North America. *Proc. MSD AGVET Symp: The Economic Impact of Parasitism in Cattle,* pp 9-14, 1987.
11. Kunz SE, Miller JA, Sims PL, Meyerhoeffer DC: Economics of controlling horn flies (Diptera: Muscidae) in range cattle management. *J Econ Entomol* 77:657-660, 1984.
12. Kunz SE, Schmidt CD: The pyrethroid resistance problem in the horn fly. *J Agric Entomol* 2:358-363, 1985.
13. Laake EW: DDT for the control of the horn fly in Kansas. *J Econ Entomol* 39:65-58, 1946.
14. McLintock J, Depner KR: A review of the life history and habitats of the horn fly, *Siponia irritans* (L.)(Diptera: Muscidae) *Can J Entomol* 86:20-33, 1954.
15. McNeal CD, Campbell JB: Insect pest management in Nebraska feedlots and dairies: a pilot integrated pest management project. *Univ of Nebr Dept Entomol Rept No 10.*
16. Moon RD, Meyer HJ: Nonbiting flies: Musca autumnalis in Williams RE, Hall RD, Broce AB, Schohl PJ (eds): *Livestock Entomology*. New York, John Wiley & Sons 1985, pp 66-70.
17. Morgan CE, Thomas GD: Annotated bibliography of the horn fly *Haematobia irritans* (L.) including references on the buffalo fly, *H. exigna* (de Meijere) and other species belonging to the genus *Haematobia. USDA Mic. Publ*: 1278, 1974.
18. Morgan CE, Thomas GD: Supplement 1: Annotated bibliography of the horn fly *Haematobia irritans* (L.) including references on the buffalo fly, *H. exigna* (de Meijere) and other species belonging to the genus *Haematobia. USDA Mic. Publ*: 1278, 1979.
19. Morgan CE, Thomas GD, Hall DD: Annotated bibliography of the stable fly *Stomoxys calcitrans* (L.) including references on other species belonging to the genus Stomoxys. *N Cent Res* Publ. No. 291, 1983.
20. Mullens BA: Horse flies and deer flies (Tabanidae), in Mullen G, Durden L (eds.) *Medical and Veterinary Entomology*. San Francisco, Academic Press Elsevier Science, 2002, pp 263-267.
21. Quisenberry SS, Lockwood JA, Byford RL *et al*: Pyrethroid resistance in the horn fly, *Haematobia irritans* (L.) (Diptera: Muscidae). *J Econ Entomol* 77:1095-1098, 1984.
22. Rasmussen RL, Campbell JB: Investigation of environmental factors and their relationship to populations of the stable fly *Stomoxys calcitrans* (L.). *Environ Entomol* 47:245-253, 1981.
23. Scholl PJ, Petersen JJ: Biting flies: *Stomoxys calcitrans* (L.) in William RE, Hall DD, Broce AB, Scholl PJ (eds): *Livestock Entomology*, New York, John Wiley & Sons. 1985, pp 59-60.
24. Schreiber ET, Campbell JB, Kunz SE, *et al*: Effects of horn fly (Diptera: muscidae) control on cows and gastrointestinal worm (Nematode: Trichostrongylidae treatment for calves on cow and calf weight gains. *J Econ Entomol* 80:451-454, 1987.
25. Schreiber ET, Campbell JB, Boxler DJ, Petersen JJ: Comparison of beetles collected from dung of cattle untreated and treated with Fernalerate ear tags and pastured on two range types in western Nebraska. *Environ Entomol* 16:1135-1140, 1987.
26. Schugart JI, Campbell JB, Hudson DB, Hibbs CM, White RG, Clanton DC: Ability of the face fly to cause damage to eyes of cattle. *J Econ Entomol* 72:633-635. 1979.
27. USDA: *Bluetongue: A Threat to U.S. Exports*: USDA Prog. Aid No. 1280. 1981.
28. Vockeroth J: *Musca autumnalis* De Geer in North America (Diptera: Muscidae). *Can Entomol* 85:422-423, 1953.
29. Wienman GA, Campbell JB, DeShazer JA, Berry TL: Effects of stable flies (Diptera: Muscidae) and heat stress on weight gain and feed efficiency of feeder cattle. *J Econ Entomol* 85:1835-1842. 1992.
30. Zumpt F: The Stomoxyine Biting Flies of the World (Diptera: Muscidae) Taxonomy, Biology, Economic Importance and Control Measures. Stuttgart, Gustov Fisher Verta, 1973.