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L'hypoderme : qu'est-ce que c'est? Comment le combattre?

Contents

Preface

This booklet replaces *Control of cattle grubs* (Agric. Can. Publ. 1309), last revised in 1974, which focused primarily on the use of systemic organophosphate insecticides to control cattle grubs and to reduce their effects over large areas. Dr. M.A. Khan, Mr. J. Weintraub, and their colleagues at the Lethbridge Research Station played a primary role in developing and testing these compounds for control of cattle grubs and other livestock pests. The use of systemic insecticides for grub control is now a standard management practice in the Canadian cattle industry.

Since 1974, much new information on cattle grub–host interactions has become available and several efforts to develop integrated management programs and biological control programs have been initiated. For those reasons it became important to update Publication 1309 and to orient this presentation somewhat differently.

Introduction

Cattle grubs, or warble flies, are unique among the insect pests of cattle in that both larval and adult stages cause economic losses to both beef and dairy industries. Two species, the common cattle grub [*Hypoderma lineatum* (de Vill.)] and the northern cattle grub [*H. bovis* (L.)], occur in Canada where cattle are raised.

Economic losses to the Canadian cattle industry are substantial. The estimated annual loss to the beef industry alone exceeds $14 million dollars and includes only those costs associated with larval stages in the backs of cattle.

Control of these cattle parasites through the use of systemic insecticides has become routine and has dramatically reduced the prevalence and intensity of infestations over wide areas of Canada. However, significant numbers of young calves become infested with grubs each year, which indicates that cattle grubs can reproduce effectively at low population levels. Persistent low levels of cattle grubs can lead to outbreaks if control efforts are relaxed.

Life cycle

Cattle grubs have four developmental stages: egg, larva (or grub), pupa, and adult. The egg, pupa, and adult stages occur outside the host. The parasitic larvae (grubs) develop in three distinct stages: the first is deep within the host tissues, the second and third are within the tissue cyst or "warble" formed as a host response under the skin on the host's back. Both species of cattle grub in Canada have similar life cycles, although there are differences in

- the behavior of the female flies
- the seasonal occurrence of each species
- the migration route within the host
- the tissues favored by the migrating grubs.

Eggs, grubs, and pupae

Eggs are laid by the female flies on the hairs of cattle, usually on the lower and hind regions. The eggs hatch within 3–7 days, and the small, newly hatched grubs (about 1 mm long) migrate down the hair shafts to the skin. These grubs (Fig. 1) penetrate directly through the skin using both mechanical means and enzymatic digestion. They enter underlying layers of connective tissue, using digestive enzymes that break down the tissue in front of them, and begin migrating throughout the body via the connective tissue. The exact route of migration is unknown but larvae of the common cattle grub congregate in connective tissue of the esophagus[1] whereas those of the northern cattle grub generally congregate in the fat surrounding the spinal cord and major nerves[1] where they enter the

[1] A few small grubs can be found at these sites within a few weeks of their entering the host. However, they are most abundant at these locations in late November and December.

Fig. 1 Head of newly hatched cattle grub as viewed with a scanning electron microscope. Enzymes that digest host tissue are regurgitated through the mouth. Mouth hooks and spines aid the larva in penetrating the skin.

Fig. 2 Back of animal with large number of warbles.

spinal column. First-stage grubs complete their migration by moving to the back of the animal where they digest a small hole through the skin. Shortly after grubs arrive on the back, the host responds by surrounding the parasite in a cyst usually called a "warble." The warble isolates the parasite from the host and provides the grubs with a rich source of nutrient (Fig. 2). Grubs grow substantially during their migration in the host, increasing from 1 mm in length at the time of entry to 15 mm in length by December (at 8 months of age). The first grubs appear on the back between 32 and 34 weeks after eggs are laid, and they continue to arrive at the back for another 6 weeks. In Canada the first common cattle grubs appear between mid December and mid January. The northern cattle grub appears between mid February and first of May. Their numbers build slowly reaching a peak in mid February (common cattle grub) and late March (northern cattle grub).

Shortly after they complete the hole the grubs molt to the second stage. The entire second and third stages are spent within the warble where the grubs grow rapidly and store energy reserves necessary to complete the pupal and adult stages. When the grubs reach maturity they crawl out of the warble through the breathing hole, fall to the ground, and bury themselves under surface litter or soil. The entire larval period takes from 7 to 9 months (Figs. 3 and 4).

Common cattle grubs may begin to drop from the host during mid March, northern grubs in mid to late April. On the ground, grubs harden to form the pupa within which they will undergo the change to the adult fly. Development of the fly within a pupa depends on temperature and may require 4–12 weeks.

Adults

Adults are moderately large, hairy flies with black bodies and broad, distinctive yellow or gold bands. They resemble bumblebees and are very active, rapid fliers on warm sunny days. Adults of the common cattle grub are about 13 mm long and are active in April and May. Northern cattle grub adults are larger (20 mm long) and are active later in the year, in June and July.

Shortly after emerging from the pupa, male flies move to specific sites known as aggregation sites. These sites are generally located in small narrow valleys with little tree or brush cover and where a small body of water is present. Male flies rest on prominent objects at these aggregation sites and will fly up to meet passing females and other small insects (or even pebbles tossed by entomologists). The males and females meet in flight but quickly fall to the ground to complete mating. Females apparently only mate once before they begin searching for a host on which to lay eggs.

The adults have no functional mouthparts and thus are not able to feed and do not bite. They must complete all of their adult activities on nutrient reserves built up during their development in the host. These factors contribute to the short life-span of the adults, which may range from a few days to 2 weeks.

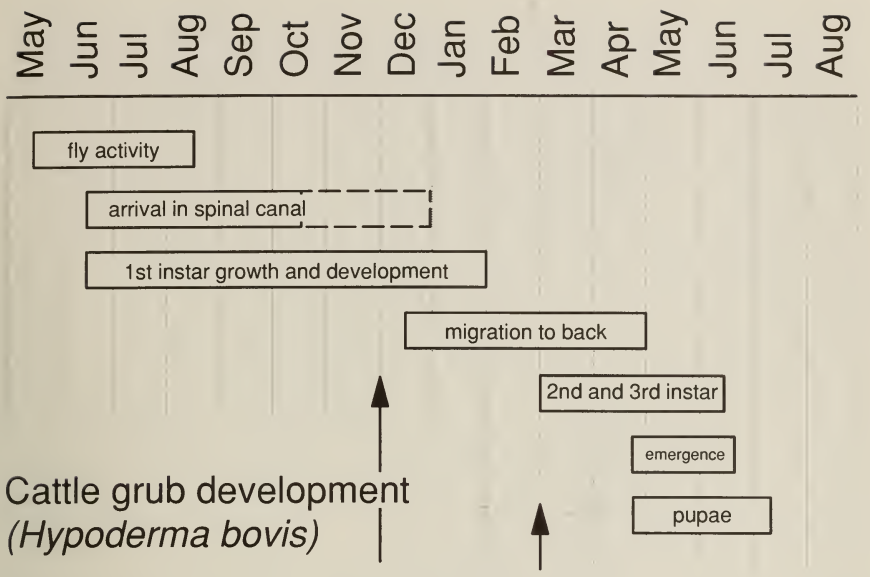

Fig. 3 Diagram of the seasonal pattern for each stage in the life cycle of the northern cattle grub (*H. bovis*).

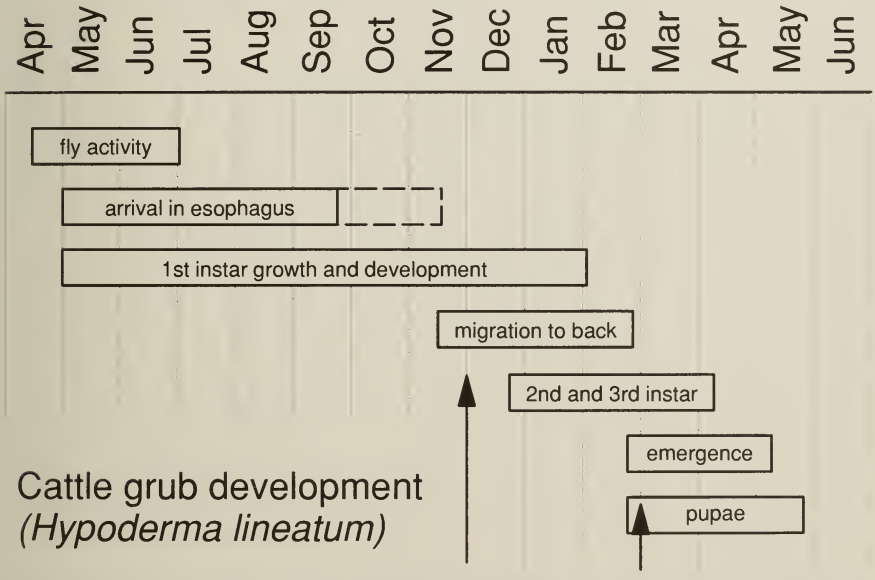

Fig. 4 Diagram of the seasonal pattern for each stage in the life cycle of the common cattle grub (*H. lineatum*).

Female flies are most active on sunny, warm days when the winds are light. Activity occurs mostly during midday when temperatures exceed 18°C. Egg-laying behavior of the females differs between the two species. Females of the common cattle grub approach resting animals, circle the target animal once or twice, and then land either on the shady side of the host or on the ground nearby. After landing on the ground, they back up to the host and, thrusting with their ovipositor, lay eggs in strings of up to 25–30 on the hair of the lower leg or other available parts. Those landing on the animal lay eggs on hairs near where they land (Fig. 5). Females of the northern cattle grub hover low near the rear of their target and dart toward the host to lay eggs. The flies dart in and out to lay several eggs, one at a time (Fig. 6). This behavior disturbs the cattle, which run away, exhibiting the classic gadding posture with the fly pursuing. Occasionally, flies will dart in to lay an egg and then will drop to the ground for a few seconds before resuming pursuit of a host. Eggs of both species are laid on the underside of the hair near the base of the shaft, where they are somewhat protected from removal by grooming or by being accidentally brushed off.

Immunity

Cattle that have been exposed to infestation with grubs develop at least partial immunity to further infestations. The number of larvae that survive in previously infested cattle is greatly reduced. Following several infestations, most cattle become completely resistant to cattle grubs. A few cattle appear to have an innate immunity and will kill all the grubs from a primary infestation. Development of immunity is slowed by treatment with organophosphate systemic insecticides.

Recognition that cattle acquire immunity to grubs and that the immune response is directed, in part, against secretions from the grubs has led to the development of techniques for early diagnosis of infestation and to efforts to develop a protective vaccine. Grub-infested cattle produce antibodies to the excretory and secretory products (e.g., digestive enzymes) released by the grubs. These antibodies can be detected in the blood as early as 6 weeks after infestation, which enables identification of grub-infested cattle. A test for antibodies in the blood, used in combination with mathematical modeling techniques, now allows producers to estimate the size of cattle grub populations in an area by determining the proportion of calves testing negative for antibodies. In general, as the percentage of calves positive for antibodies in a herd increases, so does the mean number of grubs per animal in that herd. This approach can be useful in evaluating control campaigns and in planning follow-up treatments.

Attempts to develop vaccines to protect cattle against cattle grubs have a long history, but no success was evident until it was recognized that digestive enzymes from the grubs were a major target of the immune response. Stimulation of an immune response by vaccinating with crude

Fig. 5 Eggs of common cattle grub (*H. lineatum*) with newly hatched larvae emerging. Note that eggs are laid in a string.

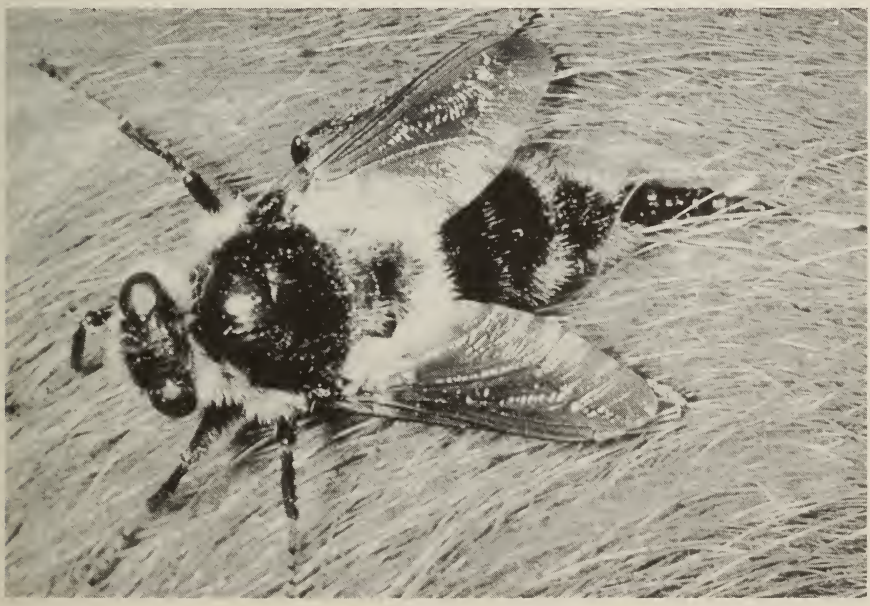

Fig. 6 Female northern cattle grub fly (*H. bovis*) laying eggs on a calf. Note that eggs are laid singly.

or purified combinations of digestive enzymes mixed with compounds that encourage the immune response generally has produced high levels of grub mortality in vaccinated cattle. However, vaccination has yet to produce complete protection against cattle grubs in all vaccinated cattle. Complete protection of all cattle may be unachievable but vaccination as part of an integrated control program over large areas can greatly reduce cattle grub populations and can also limit the ability of grub populations to rebound when chemical control is reduced.

Natural enemies

Few parasites or predators cause mortality in cattle grubs. Generally, mortality of larval stages within the host is considered to be caused by host effects. There are, however, several reports of corvid birds (magpies and starlings) feeding on larvae that they have removed from the backs of cattle. A fungus has been reported to attack pupae in the field, but little is known of its rate of infection or its effect on populations because cattle grub pupae are rarely collected in the field. A parasitic wasp has been reported to attack the mature larvae or pupae, but its distribution is limited and little is known of its biology. Rodents are known to feed on mature larvae and pupae and may represent a significant mortality factor in field populations. Ants feed on adult flies and may cause significant mortality of newly emerged adults or adults resting during adverse weather conditions.

Other hosts

Cattle grubs are highly host-specific and will only complete their development in cattle. However, other host animals can become infested with the grubs, which suggests that female flies lay eggs on other hosts. Horses are perhaps the most important other animal host affected by cattle grubs, particularly working horses on ranches. Warbles form under the skin on the back commonly where the saddle is placed and, because of the irritation associated with the warble formation, affected horses cannot be ridden. However, despite surviving to reach the back and form warbles in horses, the grubs do not survive to produce pupae or adult flies.

For humans to be affected by cattle grubs is rare in North America. This occurrence is more frequent in Europe and other regions where cattle management practices are more intensive, involving greater human contact with the cattle, and where control campaigns are less active. It is possible that female flies lay eggs that subsequently hatch on humans. However, it is more likely that people are infected by contact with cattle when the newly hatched grubs are active and searching for skin to penetrate.

Reindeer are infested with a species of grub that is not known to affect cattle. However, as ranching of these animals becomes more common the possibility for exchange of grub species between traditional domestic livestock and ranched reindeer increases.

Distribution of species

Cattle grubs generally occur anywhere that cattle are raised. However, local climatic conditions may have differential effects on the two species and as a consequence little is known of the precise distribution of the two cattle grub species in Canada. Traditionally, both species have been present in the western provinces of British Columbia, Alberta, and Saskatchewan, although the common cattle grub has been more abundant than the northern cattle grub. Recently, populations of the northern species in Alberta and Saskatchewan have declined dramatically, even in areas where cattle have not been regularly treated. Weather may have been a significant factor in this decline as it has been shown in Great Britain that cool, wet spring weather reduced grub infestations. In Manitoba, Ontario, and Quebec the northern cattle grub is apparently the only species present. This discontinuity may be the result of differences in the tolerance of the two species for various climatic conditions.

Economic losses

Cattle grubs cause huge economic losses to beef and dairy producers. In 1979 it was estimated that cattle grub infestations cost the Canadian beef industry in excess of $14 million dollars annually. That estimate did *not* include the cost of insecticide now used commonly countrywide, the effects of adult fly activity, or overall reductions in animal health that result from infestation. It has been estimated that the cattle industry receives a benefit of $11.00 for each dollar spent on cattle grub control. No estimates are available for the economic losses incurred by the Canadian dairy industry. However, estimates from European countries indicate that they experience substantial losses in milk production from cattle infested with grubs. The economic effects of cattle grubs can be divided into two interrelated categories:

- direct effects include reductions in weight gain and milk production that result from the activity of adult flies and grubs within the host
- indirect effects result from the activities of migrating grubs and grubs present in the back.

Direct effects

Reduced weight gain and milk production Oviposition activities of the adult females cause cattle to gad (a wild running behavior characterized by the tail being pointed upward) and seek shelter in water or in shaded areas. This behavior reduces weight gain and milk production (up to 10% during fly activity periods) by interrupting grazing patterns. It also may result in local degradation of pasture quality where cattle seek protection from flies.

The presence of grubs within the deeper tissues and in the warbles induces irritation in affected cattle. This host response to the larvae is reflected in decreased weight gains in cattle harboring grubs. Reduced weight gain may result in longer feeding periods in finishing cattle and in longer periods needed to reach critical breeding weights in replacement beef and dairy heifers.

Other effects The stress resulting from fly attack is another factor that reduces productivity because stress can influence appetite, the immune system, and reproduction. Gadding may result in injuries and induce abortion. Gadding also may interrupt breeding, resulting in extended calving periods or a higher proportion of culls because of late conception.

Penetration of newly hatched grubs through the skin produces a rash that can be intense in previously exposed cattle. This rash irritates and leads to scratching and rubbing that increases the skin damage. Affected regions are prone to secondary infections by bacteria. High numbers of migrating larvae in the esophagus can result in swelling, which may interfere with swallowing and cud regurgitation and lead to bloat. Similarly, high numbers of northern cattle grubs in the spinal canal may injure the spinal cord and cause paralysis.

Enzymes secreted by the migrating grubs are known to have general debilitating effects on the cattle when grub numbers are high. The enzymes secreted by grubs have deleterious effects on the inflammatory and immune systems, which may render cattle more susceptible to other infections. This susceptibility can be extremely important in calves both at weaning and at feedlot entry, when the combination of stress and exposure to high concentrations of cattle influences the development of respiratory diseases.

Indirect effects

Damage to the carcass and hide of cattle results from the presence of grubs and from the associated host response that forms the warbles. Grub-infested carcasses require trimming to remove both the jelly-like material formed around the warbles and the discolored fat resulting from inflammation that surrounds the warble. Trimming requires extra time at the packers, reduces the weight, and devalues the carcass. Net losses range from $25 to $45 for each grub-infested carcass, depending on the number of grubs present.

Hide damage from grub infestations can be extensive (Fig. 7). Holes in the hide and weak spots result from scar tissue formed over healed warbles. Hides are generally discounted when more than five holes are present. The economic damage varies dramatically with the state of the leather market. Current interest in blemish-free hides by European manufacturers has increased the cost of grub damage to the leather industry.

Fig. 7 Hide from a heavily infested animal. This hide has little value because of the many holes and scars.

Control

At present no practical method kills adult flies or eggs laid on cattle. However, proper management of cattle herds can reduce grub populations. Providing access to shelters and shallow water protects cattle from fly activity. Moving cattle from winter pastures, where grubs are dropped, to new pastures that are separated from them by natural barriers, such as rivers or treed areas, is another management practice that reduces grub populations. The most practical way to control warble flies is either to kill the migrating larvae within the host or to physically remove the older larvae from warbles on the back. Removing warbles is laborious and therefore not practical except for only a few animals.

Systemic insecticides

Most products available for grub control are insecticides or broad-spectrum parasiticides, which have a systemic action. They are transported throughout the animal's tissues in the blood and kill the grubs. The systemic products available for grub control fall into two major groups (Table 1):

- organophosphates are predominantly available in pour-on formulations but are also available in injectable, spray, and dust formulations
- avermectins are active against a broad spectrum of arthropod and helminth parasites and are available in pour-on and injectable formulations.

Table 1 List of insecticides available for cattle grub control

Active ingredient	Trade name	Method of application
Systemic insecticides		
• coumaphos	Co-Ral	spray
trichlorfon	Neguvon	pour on
fenthion	Spotton	spot on
famphur	Warbex	pour on, inject
phosmet	Prolate	spray, pour on
• ivermectin	Ivomec	pour on, inject
Contact insecticides		
rotenone	Derris, DriKill	spray, pour on

Treatment with systemic insecticides may be applied after the end of fly activity, generally after September 15. Products containing ivermectin are known to have activity against migrating cattle grubs for at least 4 weeks after application. This activity allows their use prior to the end of fly activity if that practice is required as part of an overall parasite management program. Treatment as early as possible limits the damage to tissue from migrating larvae and reduces negative effects on the immune system. Several systemic products cannot be applied for grub control after December 1. This limitation is applied to reduce the possibility of adverse host reactions such as bloat and hindquarter paralysis following death of larvae. Adverse host reactions occur when the most larvae, at nearly their maximum size, are killed in sensitive locations such as the esophagus or the spinal canal. The number of adverse reactions has declined over the last few years because the intensity of grub infestations has declined. However, it is imperative that producers follow label recommendations specified by the manufacturers.

Contact insecticides

Contact insecticides, which contain rotenone, are effective against grubs in the warbles. Contact insecticides (Table 1) must be applied in such a way that they are able to reach the larvae within the warble. They can be applied either manually with a scrub brush, or as a high-pressure spray,

but must be used several times during the warble season to achieve complete control. The use of contact insecticides is only practical for dairy cattle and show stock, which are handled frequently.

Integrated management

Cattle grubs were eradicated from two defined geographic areas in southern Alberta using the sterile-insect technique. This technique involves suppressing cattle grub populations with standard pesticide treatment, and then releasing large numbers of sterilized male insects. In one area the common cattle grub was eliminated from a 235-km^2 ranch. In the second area, which involved about 1950 km^2 spanning the Canada–United States border, the integrated approach successfully eliminated both species of grub following three successive releases of sterilized male flies. Large-scale application of this management approach is limited by the logistics of rearing large numbers of cattle grubs, which at present can be done only in cattle hosts. Development of an artificial, mass rearing method for grubs is required to allow large numbers of sterile flies to be produced for use in a control program of this kind.