

INSECTS AND ALLIED PARASITES INJURIOUS TO LIVESTOCK AND POULTRY IN CANADA BY ERIC HEARLE



DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
PUBLICATION 604

Published by direction of the Hon. James G. Gardiner, Minister of Agriculture
Ottawa, March, 1938

630.4
C212
P 604
1938
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PUBLICATION 604
Farmers' Bulletin 53

ISSUED MARCH, 1938
First Printing


DOMINION OF CANADA – DEPARTMENT OF AGRICULTURE

INSECTS AND ALLIED PARASITES INJURIOUS TO LIVESTOCK AND POULTRY IN CANADA

By ERIC HEARLE

ENTOMOLOGICAL
BRANCH

Published by Authority of the Hon. James G. Gardiner, Minister of Agriculture,
Ottawa, Canada



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FOREWORD

The original manuscript of this bulletin was prepared by the late Eric Hearle prior to his untimely death on April 17, 1934, and was largely based on studies and investigations carried out by him, or under his direction, as officer in charge of livestock insect investigations at the Entomological Branch laboratories at Indian Head, Sask. (1926-28), and Kamloops, B.C. (1928-34).

In 1923, the department published Bulletin No. 29—new series, on insects affecting live stock, prepared by Dr. Seymour Hadwen, now Director of Veterinary Science, Ontario Research Foundation, Toronto. That bulletin has been out-of-print for some years, and the present publication, embodying extensive recent advances in the knowledge of this subject is intended to replace it. Mr. Hearle paid the following tribute to Dr. Hadwen: "Dr. Hadwen's research into the insect pests affecting live stock in Canada has been so extensive and important that it must form the foundation for any publication dealing with these pests. The writer wishes to acknowledge the fact that the published results of these investigations have been freely consulted and utilized in the preparation of the present bulletin." Mr. Hearle also expressed grateful acknowledgment to the following: Dr. R. A. Cooley and Dr. R. R. Parker, of the U.S. Public Health Service tick laboratory, Hamilton, Montana, for valuable suggestions and corrections of the section dealing with ticks; R. K. Helmer, late Manager of the Nicola Lake Stock Farms, for examining the manuscript from a practical stock man's viewpoint; T. P. McKenzie, late Provincial Grazing Commissioner for B.C., and G. Challenger, Assistant Provincial Live Stock Commissioner for B.C., for suggestions regarding cattle and sheep ranching practices; the Bureau of Entomology and Plant Quarantine, Washington, D.C., the Department of Entomology, Ontario Agricultural College, and Dr. E. A. Bruce, of the Dominion Health of Animals Branch, for the loan of certain specimens used in the preparation of illustrations.

The late Mr. Hearle was indeed a keen and outstanding student of the various groups of insects and bloodsucking arthropods that attack animals and humans, and at the time of his death had built up a well-deserved and widespread reputation among live stock men in Western Canada. Although much of the investigational work on which this bulletin is based was carried out in the western provinces, Mr. Hearle consulted a large number of relevant publications from various sources, and prepared it with a view to serving the needs of live stock owners in all parts of the Dominion. It will undoubtedly prove to be a most valuable contribution to the live stock industry.

Necessary editing and revision of the manuscript subsequent to Mr. Hearle's death was carried out largely by C. R. Twinn, of the Entomological Branch staff at Ottawa. A number of valuable suggestions received from Prof. G. J. Spencer, of the Department of Biology, University of British Columbia, who was in temporary charge of the Kamloops laboratory during the summer seasons, 1934-36, and T. K. Moilliet, formerly a member of Mr. Hearle's staff, both of whom carefully read the manuscript, have been incorporated. The excellent series of illustrations was prepared by Frank Hennessey, Artist, Entomological Branch, Ottawa.

ARTHUR GIBSON,
Dominion Entomologist.

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Insects and Allied Parasites Injurious to Live Stock and Poultry in Canada

BY ERIC HEARLE

INTRODUCTION

No stock owner can afford to ignore the insects affecting his animals, which in many districts constitute the most serious adverse factor affecting stock raising and which sometimes may even determine success or failure. It is no exaggeration to state that few of those even closely connected with the stock industry fully realize the enormous annual toll levied by insects and other parasites of domestic animals. For instance, the annual loss due to warble flies alone has been estimated at 50 million dollars in the United States. In 1923 Hadwen found that 27·5 per cent of Canadian hides were warbled, and the author estimated in 1929 that the loss from these flies in British Columbia was in excess of a quarter of a million dollars a year at the most conservative computation. Dr. L. Stevenson has placed the annual loss from warble flies in Ontario at five million dollars. Dr. W. E. Graham, in a report to the National Research Council, dealing with a survey of warble fly damage to hides in 1930, stated that "well over 50 per cent of Canadian cattle must have been infested during 1930." He estimated that 95 per cent of the hides showed open or healed warble holes and that Canadian hides were worth \$700,000 less than if they had been free of warble injury.

More than 200 species of insects are known to attack live stock, and this is exclusive of mites and ticks. In the pages that follow considerable attention has been given to the life-histories and habits of the more important species, for without some knowledge of these, live stock owners cannot hope to deal with insect pests in an effective manner.

WAYS IN WHICH INSECTS INJURE STOCK

Injury to live stock by insects and their near allies is caused in several ways, the principal ones being as follows:—

(1) Irritation and loss of blood caused by blood-sucking insects and arthropods, such as mosquitoes, blackflies, horse flies, stable flies, horn flies, sucking lice, sheep keds, true ticks and others.

(2) Poor condition in the affected animals and lessened milk yield in dairy cattle, resulting from infestation by the parasitic grubs of various flies which develop in the body of the animal, as in the case of cattle warble grubs, horse bot flies, sheep nostril fly, and various blow flies.

(3) Worry and serious interference with grazing, resulting in loss of condition, due to the attacks of the first group when coming for a blood meal, and more particularly the second group when egg laying. The efficiency of work animals is often greatly impaired when they are constantly fighting flies and they are then sometimes very difficult to handle.

(4) Irritation and loss of condition through lack of sleep induced by immense numbers of house flies in stables, incessantly crawling over the animals and over their food.

(5) Irritation, loss of condition, and serious sickness, due to the attacks of minute mites such as scab and mange mites.

(6) Losses due to the transmission of diseases in a mechanical way by insects such as house flies which may carry harmful bacteria. Anthrax is often transmitted mechanically by biting flies such as stable flies and horse flies, the intermittent feeding habits of the latter making them especially liable to carry this disease. Biting flies serve as the intermediate hosts of certain diseases; a common species of blackfly is the vector of an important leucocytozoon blood disease of ducks. Ticks and certain biting flies especially deer flies, transmit tularaemia which affects sheep and some other animals. House flies and a number of other insects may also act as the intermediate hosts of various parasitic worms which they transmit to domestic animals.

CONTROL MEASURES USED AGAINST LIVE STOCK INSECTS

The losses caused by most of the major pests attacking live stock can be greatly reduced by the proper application of present knowledge, and a number of the most serious of these insects can be completely eradicated, at least in restricted areas.

Some of the means of bringing about these results are briefly, as follows:—

(1) *General farm practice, sanitation and proper disposal of manure.*—The latter will lessen the breeding places of house flies and stable flies.

The disposal of all carrion in such a way that blow flies cannot develop will reduce the danger of sheep and other animals becoming infested with maggots. Protection from warble flies and various biting flies can, in large measure, be secured by utilizing pastures in which dark sheds are provided for shelter, or in which there are dense clumps of trees wherein suitable shelters can be made. In many cases animals can be given a great deal of protection from fly attack by housing them during the day and letting them graze and exercise at night. Proper drainage and the filling of depressions in fields during the course



Fig. 1—Sketch showing section of grove containing fly shelter for live stock (after Hadwen).

of cultivation may eliminate the breeding places of mosquitoes, and of snails which are the intermediate hosts of liver flukes in sheep. In flocks where early lambing is practised, and sheep are crutched and cleaned up early, little trouble is experienced from blow flies.

The temporary isolation of all new stock brought on to the farm is an excellent practice to reduce the danger of introducing parasites and diseases to the other animals.

(2) *The use of chemical repellents or mechanical protectors.*—While the use of repellents or fly “dopes” for the purpose of protecting animals is very general throughout Canada, most preparations are not really effective, and some in fact may even cause injury. Under certain restricted conditions, however, these methods may be of value, as for instance in the protection of accidental or surgical wounds in animals from blow flies by the application of such materials as oil of tar, the tarring of noses of sheep to prevent infestation by the sheep nostril maggot, the application of oily and tarry dressings along the base of the mane in horses to prevent tick infestation, and spraying of milch cows at milking time to lessen their restlessness when mosquitoes and other biting flies are abundant. The use of repellent dressings may be necessary, when work or saddle horses and other stock are attacked by numbers of blackflies.

In general, the use of fly sprays is somewhat disappointing, and in spite of careful tests of hundreds of materials by many competent investigators, the ideal substance which will give efficient protection over a long period has yet to be found. A word may be said of the use of certain proprietary cattle salts that have had a wide sale both in this country and the United States, due to the claim of the manufacturers that animals fed such salt throw off exhalations that render them immune from the attacks of flies: careful tests have shown these claims to be entirely without foundation.

Of mechanical protectors, mention may be made of nose and throat guards now used generally to protect horses from the attacks of bot flies; and also the linen ear bags used to protect work horses that are tormented by blackflies, certain kinds of which crawl into the ears when feeding. Fly nets are sometimes placed over horses to protect them from the bites of horse flies. In some places in the United States where stable flies are unusually troublesome, canvas coverings and even canvas trousers are made use of to safeguard the animals from fly attacks. Hoods of canvas over the heads and necks of horses are sometimes used to protect horses from certain horse flies which prefer these parts when feeding.

(3) *The use of insecticides, dips, etc., for the destruction of insects and allied parasites on infested animals.*—Among the substances used are the derris-soap wash, for killing warble grubs while under the hide in cattle; carbon bisulphide and carbon tetrachloride, for ridding horses of the bots attached to their stomachs; benzol, for killing maggots in struck sheep; arsenical and other dips, for destroying sheep ked, mange mites and ticks; raw linseed oil and certain bland proprietary petroleum oils, for killing lice on horses and cattle, and sodium fluoride and pyrethrum and derris powders for use in this connection, and also for other external parasites of domestic animals and poultry.

(4) *Special fumigation methods.*—Two methods of interest have as their basis stupefying fumes given off by certain substances. (a) A spray made by mixing from one-half a pound to a pound of pyrethrum powder, or its equivalent of extract, in a gallon of coal oil (kerosene) when sprayed in the air of a closed room or stable kills or stupefies flies so that they drop to the floor and can be swept up and destroyed. A number of commercial sprays are used in a similar manner. Others are used to kill horn flies and stable flies, as they come to alight on animals for a meal. (b) Nicotine sulphate (40 per cent strength) lightly painted on the roosts in poultry houses very effectively rids the birds of lice and other external parasites. The value of smoke smudges in stupefying insects and protecting animals from their attacks is well known in some areas.

(5) *The use of chemicals for the destruction of insects in their breeding places.*—The following methods are in use: oiling of stagnant pools where mosquitoes are breeding; the use of miscible oils for the destruction of blackfly larvae in running streams; the use of hellebore, borax and sodium fluosilicate on manure heaps to destroy house fly larvae; and the use of copper sulphate as a dust, or dissolved in water, for destroying the snails that serve as the intermediate hosts of liver flukes in sheep.

(6) *The elimination of breeding places or the rendering of these unfit for the production of insect pests.*—Included here are: the drainage of low places where water collects in which mosquitoes are produced, and where favorable habitats are formed for the snails essential to the life cycle of liver flukes; dyking to prevent the flooding of low areas as a means of preventing the development of mosquitoes and snails; making manure piles square and compact to limit favourable fly-breeding conditions; burning straw stacks and ploughing-in the outer edges of these to limit the production of stable flies, and the destruction of carcasses to prevent the breeding of blow flies. Certain very injurious ticks must have small rodents on which to feed during their immature stages, and the elimination of these animals by various means is used as a method of reducing the ticks.



Fig. 2—Natural clump of trees suitable for fly shelter (original).

(7) *Trapping and poisoning.*—House flies, and also the blow flies whose maggots sometimes infest sheep and other domestic animals, can be much reduced by the use of special traps baited with suitable attractants. There is some evidence that horse flies can be materially reduced by the use of large trap cages which provide the dark shelter that these flies are particularly apt to seek. Formalin and milk can also be used to poison the house flies, and the spraying of carcasses with arsenical poisons has been used with success in reducing blow flies.

(8) *The use of parasites in combating live stock insects.*—Many insects have parasites which prey upon them and which can be utilized effectively in insect control work. Attention has been given to the control of the paralysis tick in Montana by the rearing and liberation of large numbers of imported parasites. The same parasites have been stated to have proved effective in reducing the dog tick in certain eastern sections of the United States. Similarly, in Australia, the control of the serious blow fly pest is being attempted by means of parasites.

(9) *Community effort and importance of co-operation in combating insect pests of live stock.*—The importance of community effort in dealing with these pests needs emphasis. Co-operation of farmers is essential in attempts to control many pests of live stock, such as warble flies, bot flies, house flies and certain other species.

THE PROTECTION OF ANIMALS DURING FLY TIME

During the season when flies of various kinds are abundant, live stock on the farm are usually left out-of-doors to suffer these insects as best they can. Many kinds of fly repellents and dressings are purchased and used by farmers, but any beneficial effects they may have last for too short a period to be really satisfactory. A more certain method of protecting the animals is to provide them with shelter during the day time. Milch cows, work-horses and other live stock usually kept close to the farm buildings may be put back into the stables. In the case of the cows such shelter is absolutely necessary if the milk flow is to be maintained. For horses, cattle and sheep grazing on pastures remote from the farm buildings, dark sheds with a curtain hung over the door



Fig. 3—Cattle being chased by warble flies (after Hadwen).

will provide adequate protection. In bush pastures, serviceable dark shelters can be readily constructed by attaching poles to standing timber to form a brush roof, and thickening the sides a little. In wooded areas brush fly shelters are of value, as the animals seek the shelter of timber when flies are troublesome. In figure 2 a clump of trees is shown that would make an excellent shelter if the underbrush were thinned in the centre, and a roof and sides added.

Among other means of protecting live stock are smoke smudges. Smoke has a stupefying effect on insects, and where mosquitoes and blackflies are a serious pest smudges are of considerable value. Lakes and streams are of service where cattle are exposed to the attacks of warble flies, as the animals can secure protection by standing in water. Range animals should not be driven or put into corrals when flies are abundant, especially if these include warble flies. Large "roundups" should be made before or after the fly season. The above are general statements; further recommendations will be found in other sections of the bulletin where the various species are discussed in more detail.

THE CARE AND DISPOSAL OF MANURE

Manure is a great asset to farmers, as it is invaluable in maintaining the fertility of the soil. However, it is also a prolific source of flies, such as house flies, stable flies and horn flies, and the agency through which many parasites and diseases are carried from one animal to another. Fortunately, the breeding of flies and the dangers of parasite and disease transmission may be reduced by certain simple and inexpensive sanitary measures that also help in saving the manure. Barnyards and stables should be kept tidy, level, and adequately drained. Droppings should be collected twice a week during hot weather and placed on the manure pile, which should be fenced off or built outside the barnyard, to prevent the animals from eating the litter or trampling it about. It is preferable to construct the manure pile on hard ground or concrete, to prevent fly larvae from having access to soil in which to pupate. The sides of the pile should be clean-cut and almost vertical, but sloping slightly towards the centre.



Fig. 4—Cattle standing in water to avoid warble fly attacks (after Hadwen).

As fresh manure is added to the pile it should be tightly packed by means of a shovel. The heat produced by fermentation is effective in destroying all fly eggs, larvae and pupae, except possibly those close to the surface of the top layer.

Small quantities of manure may be chemically treated to prevent fly breeding. One-half pound of hellebore in ten gallons of water, or one pound of sodium fluosilicate mixed in fifteen gallons of water and allowed to stand for 24 hours is sufficient to treat ten cubic feet or eight bushels of manure. These chemicals are poisonous, and stock should be prevented from drinking them. They may be used for treating the top layer of the manure pile. Borax is more efficient as a larvicide but may injure the manure when used as a fertilizer.

Another method of preventing flies from breeding recommended in the United States is to use a maggot trap consisting of a shallow concrete basin sloping slightly, and connected with a cistern by means of a drain fitted with a stopper. Over this basin is erected a wooden platform constructed of strips of wood nailed on a frame one foot high, the strips being about $1\frac{1}{2}$ inches apart. On this platform the manure is piled. Water is kept in the basin and the maggots migrating in search of soil to pupate fall into the water and are drowned. The water can be drained into the cistern by removing the stopper at intervals. Manure should not be allowed to collect in the basin. Figure 5 illustrates the construction of such a trap.

During the fly season it is an excellent practice to haul manure out to the fields frequently, at least twice a week in hot weather, and to scatter it thinly by means of a manure spreader. When this is done the drying effect of sun and wind prevents flies from breeding. The droppings of live stock kept in small paddocks or fields near farm buildings should also be scattered frequently during the summer by means of a chain harrow or other implement. Likewise, accumulations of manure in and about sheds and shelters constructed in the fields

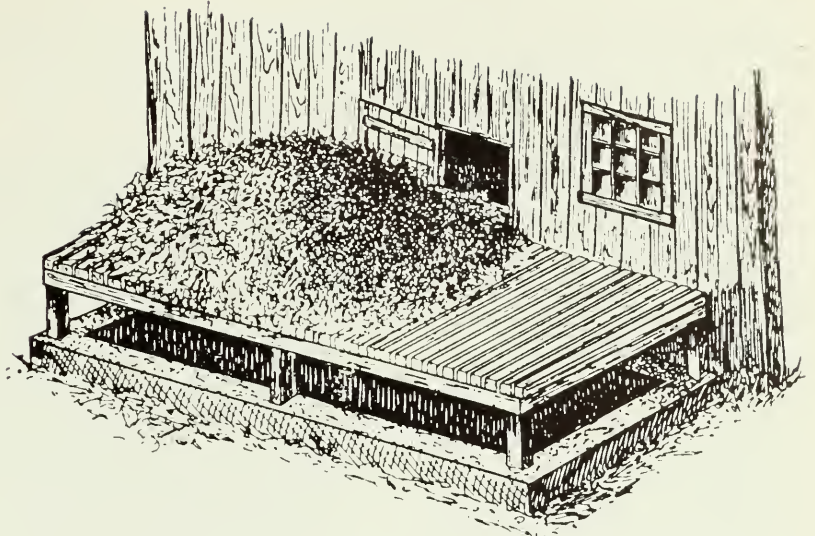


Fig. 5—A maggot trap (after Brittain).

to protect stock from flies should be removed and scattered, to keep the animals clean and to prevent the breeding of flies.

Live stock, especially pigs, should not be allowed to get under stables and other buildings; to prevent this, these should be boarded up. It is a good practice to scatter lime about after tidying up the barnyard, and to spade or plough soil that has become soaked with manure.

Co-operative clean-up campaigns give the best results in fly control, and it is very desirable that these be undertaken wherever farms are sufficiently close together to render co-operative effort feasible.

MANURE AS A CONVEYOR OF PARASITES AND DISEASES OF ANIMALS

The importance of the proper care and disposal of manure as already discussed is emphasized by the fact that a number of parasites and diseases are conveyed from one animal to another through the agency of this material. Various bacterial diseases such as anthrax, black leg, hog cholera, and tuberculosis, may be carried in this way. This is especially true of tuberculosis, as

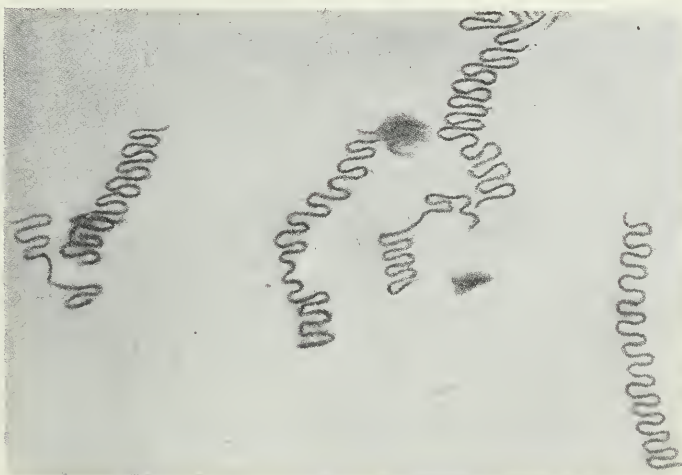


Fig. 6—A round worm, *Gongylonema scutatum*, commonly found in the gullets of cattle, sheep and horses (after Hadwen).

the bacteria which cause this disease are often found in the manure from tubercular cattle. Moreover, it is not an uncommon practice, although a deplorable one, for stablemen to use the stables as privies, so that human excreta is often thrown on the manure pile. For these reasons, cattle, pigs, or other live stock, should never be permitted to feed on the manure pile. Measles, a disease of hogs and cattle, due to the presence in the body of larvae of tapeworms, may be contracted by the animals eating the eggs or portions of tapeworms voided by man.

Furthermore, the eggs of parasitic worms occur in the dung of almost all farm animals, and may be swallowed by live stock when eating food contaminated by manure. Paddocks and fields that are rarely cultivated are a source of danger in this regard, particularly as such places are usually infested with dung beetles which serve as secondary hosts or carriers of the worms. A further statement relating to this matter is given in the following section.

DUNG BEETLES AS CARRIERS OF WORMS

Our knowledge of insects as carriers of worms has been summarized by Ransom. Among the most important worms which pass certain of their stages in dung beetles are the following:—

Gongylonema scutatum (Leuckart 1873), a round worm which lives in the oesophagus or gullet of cattle, sheep, and horses. The worm eggs are passed out by the animals and are eaten by dung beetles, several species of which act as intermediate hosts. The beetles are swallowed by stock while grazing.

Stomach worms in pigs, *Arduenna strongylina* Rudolphi and *Physocephalus sexalatus* (Molin 1860) Diesing 1861. These are two species of stomach worms in pigs which are very harmful to them. They pass certain stages of their life-history in beetles, such as scarabs and other species.

The giant thorn-headed worm of pigs, *Macracanthorhynchus hirudinaceus* (Pallas 1781) Travossos 1916. This is a large white worm which lives in the small intestine of pigs and causes large sores or ulcers on the walls. The eggs which pass from the pigs are swallowed by the larvae of dung beetles (white grubs). The eggs hatch out and develop in the grubs, and are in turn eaten by their host the pig, in whose body they reach maturity.



Fig. 7—(A) The giant thorn-headed worm of pigs, *Macracanthorhynchus hirudinaceus*; (B) white grub (after Hegner, Root and Augustins).

Prevention.—Dung beetles, as their name indicates, live in manure, so that the recommendation made for the control of the horn fly will be found useful (see page 19), the principal requirements being to haul out the manure frequently or else to scatter it thinly and dry it out. Permanent hog yards on bare ground soon get badly infested with all sorts of parasites and it is especially in such places that pigs pick up beetles. Digging, or ploughing under, the surface soil is a good measure, but cannot be repeated often as some kinds of worm eggs are very resistant and when they are turned up again are still capable of hatching.

TWO-WINGED FLIES INJURIOUS TO LIVE STOCK

Flies which Breed in Manure

THE HOUSE FLY, *Musca domestica* L.

Description and Life-history.—Since the house fly is so commonly known a description may appear superfluous, but other flies such as the stable fly and the cluster fly are often mistaken for it. It is dusky grey in colour and about one-quarter of an inch in length. On the thorax are four dark stripes, and there is a dark central area on the abdomen, the sides being paler. The mouth parts are not sharply pointed, as in the stable fly, but are pad-shaped at the tip. Droplets of moisture are constantly being regurgitated and extruded from the mouth parts, and, as these frequently contain harmful bacteria, infection may be brought about by this means.

The usual four stages of insects are passed through; the egg, larva or maggot, pupa and adult winged fly. One female may lay from 600 to 2,000 glistening white eggs, resembling minute grains of rice, small clusters of these being deposited in crevices in manure, garbage and other decomposing matter.

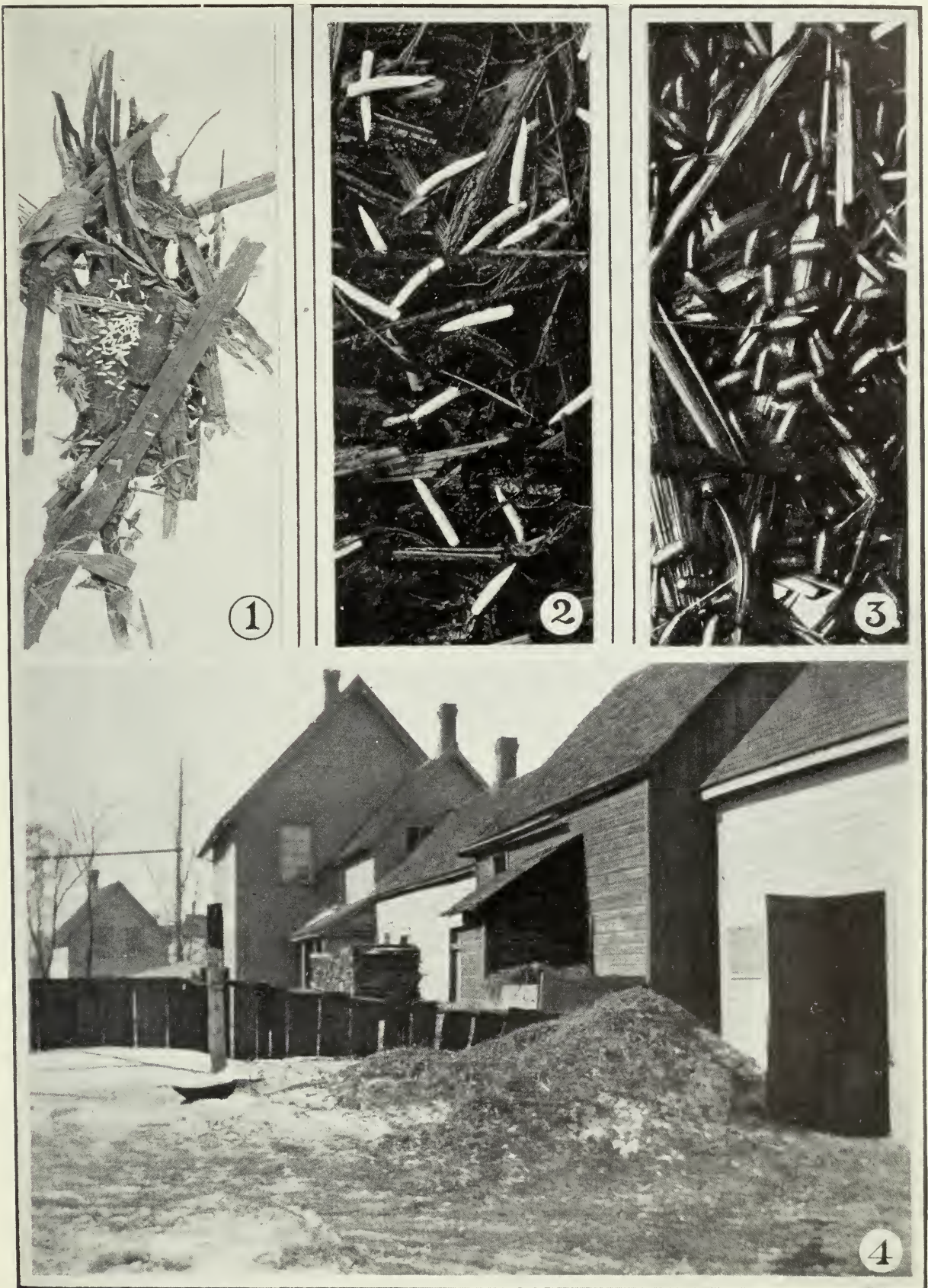


Fig. 8—The house fly; 1, eggs; 2, larvae; 3, pupae; all natural size; 4, manure pile—a typical breeding place (after Gibson and Twinn).

Hatching may take place in as short a time as one day, and the slender, white, legless maggots attain the full growth of half an inch in less than a week under favourable conditions. Nearly 7,000 of these larvae have been taken from a four-pound sample of manure. Herms has estimated that a ton of manure may contain 900,000 maggots after only four days' exposure to egg-laying. The maggots on attaining full growth migrate to the drier parts of their habitat and change to smooth, dark brown, barrel-shaped pupae, and the adult flies may emerge from these in about a week, under favourable conditions. Successive broods follow each other through the summer, resulting in a great increase towards autumn.

House Flies as Carriers of Parasites and Disease.—The role of the house fly as a carrier of human diseases is notorious, but its relation in this respect to animals has not been extensively studied. It is probable, however, that many diseases of animals are transmitted by flies, especially as these insects commonly have greater access to the faeces of infected animals, and also to their wounds and sores, than they have to those of man. In addition to their role as disease carriers, house flies greatly worry live stock by their persistent attentions, and, when numerous, may materially reduce their condition and productive capacity.

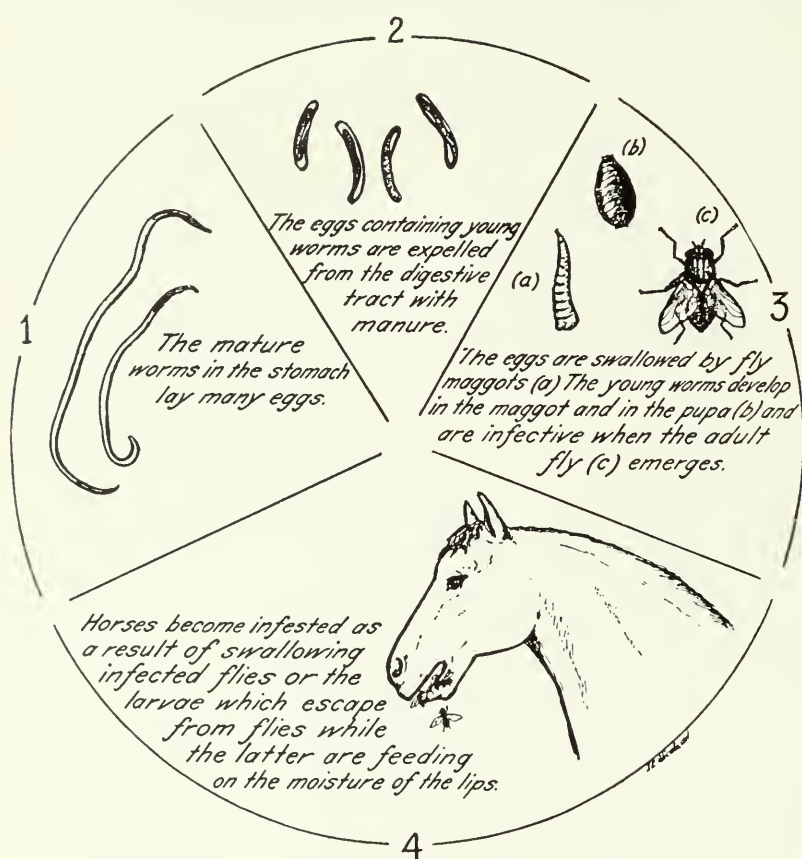


Fig. 9—Diagram illustrating transmission of *Habronema muscae* by the house fly (after Schwartz, Imes and Wright).

Three species of roundworms of the genus *Habronema*, which live in the stomachs of horses and are sometimes found in summer sores of these animals, spend part of their life-cycle in house flies and stable flies, and through the agency of these insects are carried from one equine host to another. This takes place as follows (see figure 9):—the worm eggs are voided in the manure of infected horses, and are subsequently taken into the intestine of fly maggots infesting the manure. The eggs hatch and the roundworm larvae persist in the bodies of their insect hosts until the latter transform to the adult fly stage. Although the actual method of infection of the horse is not definitely known, it is thought that this takes

place when the horse eats the flies that swarm about it, or that the roundworm larvae pass from the flies to the horse when the latter alight on the horse's lips. When the worms reach the stomach of the horse, they produce tumors in which they complete their development. The eggs from the mature worms pass out with the faeces of the horse and the cycle is complete. These roundworms, or nematodes, are also sometimes found in summer sores of horses, and are carried there by flies, which are attracted to unprotected sores and wounds. The presence of a number of young worms causes intense itching, with the result that the animals bite and gnaw at the sores, and thus enlarge and aggravate them, so that they may reach a diameter

of several inches. Sometimes the larval nematodes are carried to the eyes of horses by infected flies, where they may set up a condition known as habronemic conjunctivitis.

The advice of a veterinarian should be sought in the treatment of large summer sores and conjunctivitis. Preventive measures include the reduction or elimination of fly breeding, and the proper screening of stables. All wounds, sores, and cuts should be dried up and healed as quickly as possible by dusting them with boracic acid or some other suitable antiseptic powder, so that they will not be attractive to flies.

At least three species of tapeworms that occur in the intestines of poultry pass their intermediate stages in the house fly. The seriousness of these infestations in poultry may be judged by a glance at the accompanying illustration (figure 10). The minute and abundant eggs of the tapeworms are voided with the droppings of infected birds, and it is probable that the flies which transmit the parasites become infested in the larval stages while breeding in these droppings.

Cattle often suffer with inflammation of the eyes during fly time. This condition may spread through a herd, and is commonly believed to be carried

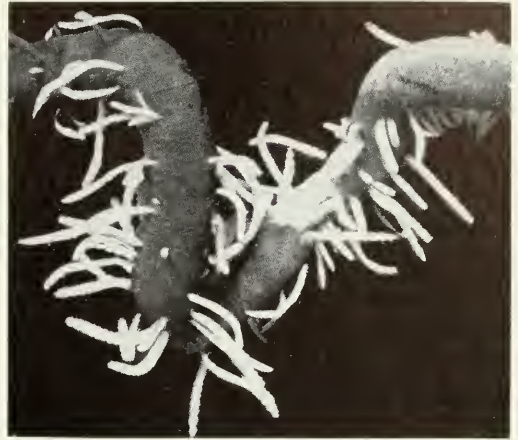


Fig. 10—Intestine of fowl grossly infested with tapeworms, *Chaonotaemia infundibuliformis* (after Herms).

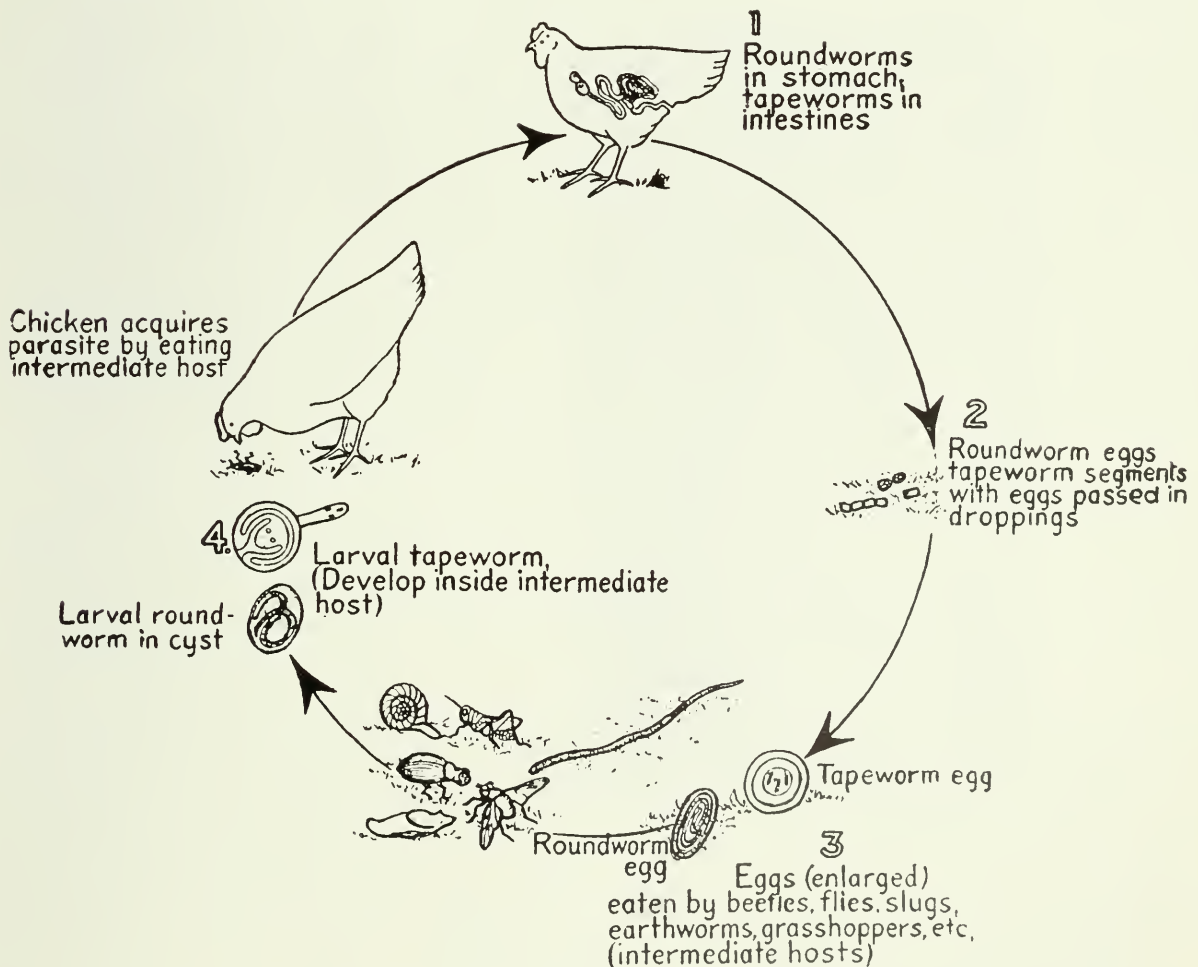


Fig. 11—Diagram showing how chickens become infested with tapeworms and round worms in eating intermediate insect hosts (after Buckley, Bunyea and Cram).

from one animal to another by flies which are attracted by the discharges from the eyes. Affected animals should be kept in dark stables and the advice of a veterinarian sought.

Control of the House Fly.—The most effective method of controlling house flies consists of eliminating or reducing their breeding places by properly treating, or disposing of, manure and garbage. Fresh horse manure is a prolific source of house flies and this material is probably chiefly responsible for the majority of flies in rural sections. In the cities, where horses have been largely replaced by the internal combustion engine, garbage is an important factor in fly production. Control measures are most effective when organized on a community basis, as one neglected manure heap or garbage dump may be sufficient to infest a whole neighbourhood. The care and disposal of manure have been discussed in an earlier section of this bulletin. Organic refuse such as household garbage should be wrapped in paper and stored in fly-proof garbage cans or other containers, until it can be finally disposed of by burning.

Measures should be taken to exclude flies from dwellings and to prevent them from contaminating food. Doors and windows of houses and other buildings should be screened and all flies that gain access destroyed. This may be done by the use of fly swatters, sticky fly paper and poisoned fly pads, or by exposing in saucers poisoned bait made by mixing one teaspoonful of formalin in a cupful of sweetened milk or water. The latter should be placed out of reach of children or domestic animals. As the flies are attracted to light,

the poisoned baits or fly traps will prove most effective when placed near windows. A simple and easily constructed fly trap designed by Bishopp, which may be used to good effect in farm buildings is shown in figure 12. On one large dairy farm in the United States, ten such traps caught 86 gallons of flies estimated at half a billion individuals, during the course of a single season. Baits consisting of sour milk sweetened with brown sugar, or molasses one part to three parts of water may be used. It is necessary to renew them often.

A pyrethrum-kerosene spray is effective against flies in buildings. This may be cheaply and easily made by steeping one-half pound of fresh pyrethrum powder in one gallon of kerosene for two hours (or longer), stirring at intervals. After standing, to allow the sediment to settle to the bottom, the clear yellow liquid is

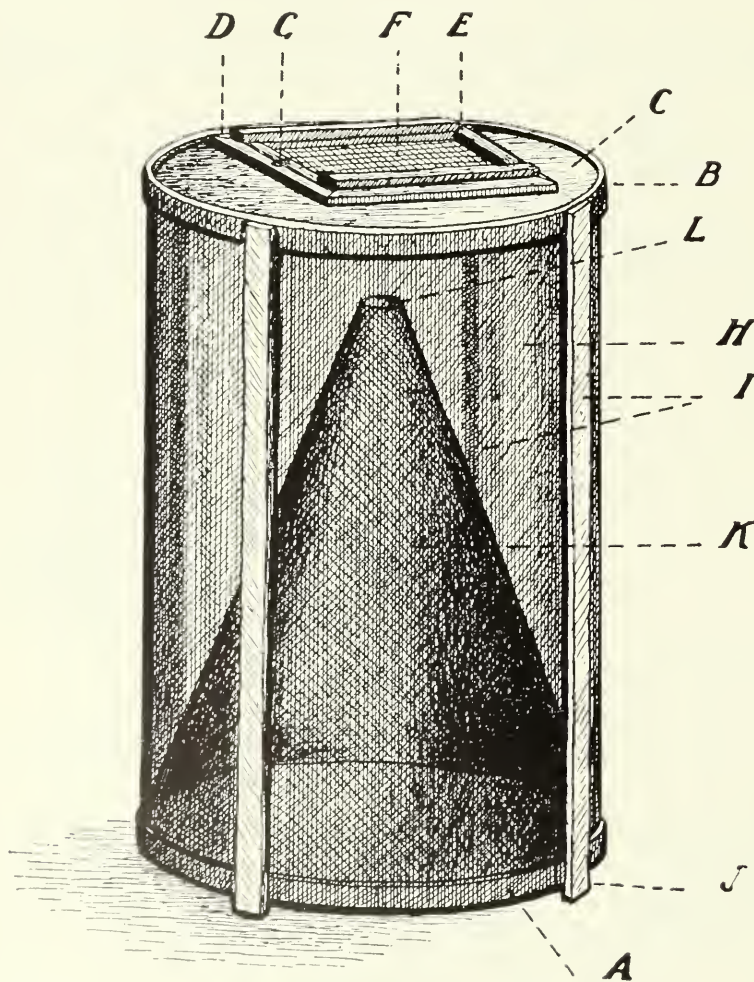


Fig. 12—Bishopp's fly trap: A, hoop forming frame at bottom; B, hoop forming frame at top; C, top of trap made of barrel head; D, strips around door; E-F, door; G, fastener; H, screen on outside of trap; I, strips on side of trap between hoops; J, tips of these strips projecting to form legs; K, cone; L, united edges of screen forming cone (after Bishopp).

filtered or siphoned off and poured into a tightly corked container. A stronger spray may be made by using one pound of pyrethrum or its equivalent extract. The spray is applied in the form of a fine mist and gives best results when doors and windows are closed. The dead or paralysed insects should be swept up and destroyed. The spray is not harmful to live stock or man. Proprietary fly sprays of similar composition may be purchased ready for use.

THE STABLE FLY, *Stomoxys calcitrans* L.

The stable fly, which may often be noticed resting in sunny situations on the walls of stables and farm buildings in summer, is sometimes referred to as the "biting house fly." It is much the same size as the common house fly, but is somewhat more robust, and is brownish grey in colour. The abdomen is grey and is marked with several large, rounded, dark spots, giving a chequered appearance. It can always be recognized by the piercing beak or proboscis, which is slender and not broadened as in the house fly, and is held straight out in front of the face. Unlike its smaller relative, the horn fly, it does not discriminate in its feeding, and horses, cattle and pigs are subject to its attacks, and also man. "Cattle and horses are bitten principally on the legs, and when stable flies are numerous the animals get no rest from daylight until dark, but constantly stamp their feet and twitch their bodies. When house flies and horn flies add their quota of discomfort, the irritated animals present a complete picture of unrest."* Pigs suffer very much from their attacks, and when stable flies are numerous, endeavour to protect themselves by wallowing in mud to obtain a protective coating, lying in holes in the ground, or burrowing under buildings. While these flies will breed in excrement, especially horse manure, when this is mixed with much straw or hay, they prefer rotting vegetation, and breed particularly abundantly in scattered material at the edges of old hay and straw stacks. When this material is moist and decaying, enormous numbers of flies may be produced. Rotting lawn clippings in gardens are sometimes the source of many of these flies. Owing to their preference for rotting vegetation as a breeding place, stable flies usually attain their greatest abundance in the major grain-growing and mixed farming sections of the Dominion.

Life-history.—The life-history and early stages are very similar to those of the house fly, the cycle from egg to egg being complete in from two to three weeks. A number of broods are produced and the flies first appear in April, in the coastal sections of British Columbia, and nearly a month later in the Prairie Provinces. They become increasingly numerous as the summer advances and are troublesome until the cold weather sets in. Adult flies have been known to live for more than two months, and to lay successive batches of eggs in this time.

Control.—The advice given previously with regard to dealing with manure will assist in reducing the numbers of stable flies, but especial attention should be paid to moist and rotting straw and hay and other vegetation. Straw and hay stacks should be well rounded, so as to make the top rain-proof. They should also be made as straight-sided as possible, and litter should not be allowed to accumulate at the base. It is good practice to plough-in the edges of old burned straw-stacks.

A repellent dressing consisting of a mixture of fish oil, oil of tar and oil of pennyroyal added to a little kerosene, has been recommended, but will at the best, give only temporary relief against the attacks of the flies. One part of pine oil to nineteen parts of kerosene or pyrethrum-kerosene spray, is also used as a repellent spray on live stock. Canvas trousers are effective and do not need to come much higher than the knees or hocks since the flies usually bite fairly low down. In districts where the flies are particularly abundant screens should be provided on stables. Flies cease to annoy in darkness or deep shade, and the provision of darkened shelters is a simple and effective measure of relief.

* Hadwen.

THE HORN FLY, *Lyperosia irritans* L.

Horn flies originally came from Europe and spread fairly rapidly following their introduction into North America in 1887. This species was first noted in Canada in 1892, and spread completely across the continent during the succeeding eleven years, causing very serious apprehension in the minds of cattle owners.

The horn fly is considerably smaller than the last two species dealt with, and is a uniform dark grey colour. The proboscis, which is fitted for piercing, is less conspicuous and is shorter and stouter than that of the stable fly, from which the horn fly can readily be distinguished when on cattle by its smaller size and by the peculiar characteristic of resting with the head facing downwards. As will be seen by the accompanying illustration these flies have a tendency to congregate in clusters. They prefer the side of the animal that is in the shade,



Fig 13—Horn flies on cow (original).

and are often thickest on the withers where the animal cannot easily switch at them with the tail or reach them with the head. As the common name of this insect indicates, the base of the horn is a favourite site for resting when the flies are not feeding. When very abundant they may form a dense covering completely surrounding the basal third of the horns. Since dehorning has come so much into practice the common name of the insect is not quite so suitable as it used to be. When feeding, the wings are held out and are fairly widely separated, but they are held close to the body when the flies are merely resting. It is of interest to note that these flies feed only once a day. They also differ markedly from most other biting flies in that they remain on the cattle persistently, even at night. They do not appear to bother the cattle, however, when these are in the stable. While their attentions are almost entirely restricted to cattle (and they even show a marked preference for black animals as compared to white or pale coloured cattle), they have on rare occasions been noted attacking horses, sheep and dogs. In many districts in Canada, during seasons favourable for development, this fly is the worst biting species affecting cattle. The cold

winters fortunately serve as a material check, and the flies seldom attain serious proportions until June, or even later in the summer, in the colder sections of the Dominion. July and August are the worst months for this fly, which decreases in numbers in the chilly days of September.

Life-history.—The female flies dart from their resting places on the cattle to lay reddish-brown eggs on manure immediately it is dropped and return to the cattle. Less than two dozen eggs are laid during the life of each female. The larvae, which are white, burrow into the manure, but remain fairly close to the surface. When full grown they migrate down to the soil, where they change to barrel-shaped, dark brown pupae. Development is fairly rapid, the entire time from egg to adult occupying about two weeks. Succeeding generations follow each other throughout the season.

Control.—The most satisfactory control measure consists of scattering the cow pats, so that they will dry out. Fresh moist manure is essential to the maggots, which die if the manure dries out while they are still in the young stages. During hot weather the manure should be scattered about twice a week. Around the barnyard and in small pastures this is well worth the short time it takes to do. The manure may be scattered with a rake or scraped over with a shovel. If hogs are permitted to run with the cattle they usually scatter the manure sufficiently well to prevent much fly breeding. While repellent dressings have proved disappointing on account of the short time they are effective, the flies can be considerably reduced by spraying them as the cattle pass through a narrow passageway. The pyrethrum-kerosene spray (see pp.7, 16) to which has been added one part in twenty of pine oil may be used effectively for this purpose, although with this and other sprays having kerosene as a base, it is advisable to avoid wetting the skin of the animals.



Fig. 14—The horn fly, *Lyperosia irritans* L., enlarged and natural size (original).

Biting Flies which Breed in Ponds, Sloughs and Streams

MOSQUITOES—Culicidæ: *Aedes*, *Culex*, *Anopheles*, *Theobaldia*

These slender, delicately-built insects are among the worst blood-sucking flies which affect live stock in many parts of Canada. More than sixty species occur in Canada, many with widely differing habits. This being the case, a knowledge of the main kinds occurring in a district is of great value when control measures are attempted. Frequently midges, small crane flies and the like, are confused with these insects, but mosquitoes can always be recognized by the long slender proboscis or beak, and the fringe of scales around the margin of the wing.

The losses occasioned by mosquitoes worrying stock are considerable. In some of the worst affected districts a marked drop in milk production is noted in dairy cows at the onset of the mosquito season, and practical dairymen have stated that this may be as much as 40 per cent. Other classes of stock lose flesh through loss of blood and worry, and in extreme cases the death of animals, especially calves and foals, has been directly attributed to mosquito attacks. Cases are known where there was difficulty in preventing ewes leaving their lambs due to excessive worry from mosquitoes. No class of stock is exempt, even poultry being affected.

All mosquitoes require water for the immature stages to develop, and it is impossible for them to develop in damp grass, dew on vegetation, and so forth. Different species, however, vary greatly in their preferences for definite types of breeding places. Many develop almost entirely in flooded areas adjacent to rivers and lakes; others, such as the common prairie forms, prefer the shallow pools resulting from the melting of snow in the spring. Rain-filled ditches and pools, and, from Manitoba eastwards, rain-water barrels and other containers are often the source of large numbers of troublesome mosquitoes.

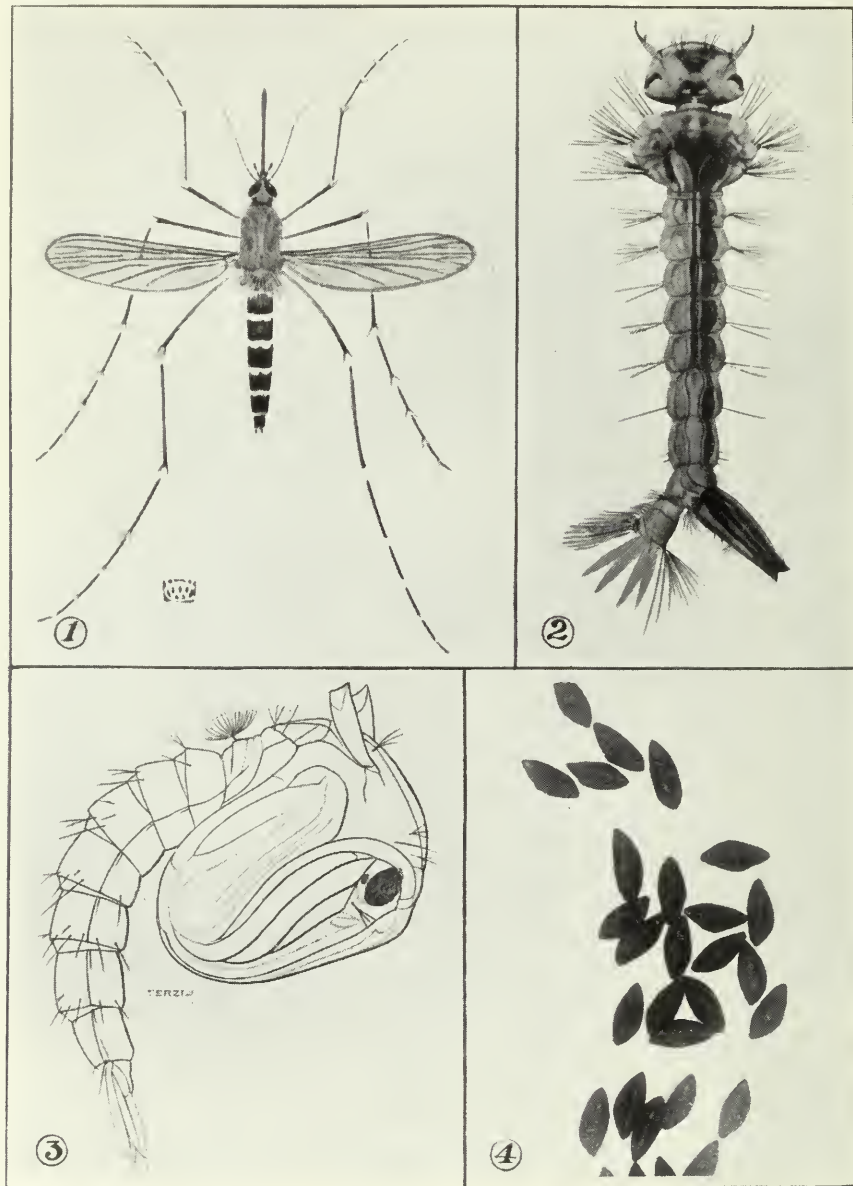


Fig. 15—Life-stages of a mosquito: 1, adult female; 2, larva; 3, pupa; 4, eggs; all of the genus *Aedes* (author's illustration).

Life-history.—The majority of mosquitoes in Canada belong to the genus *Aedes*. The life-history of a typical *Aedes* mosquito breeding in flood water is as follows:—The winter is passed in the egg stage on the sod, in depressions in river bottom lands. On being covered with water from the spring freshets, the eggs hatch into active larvae, or “wrigglers.” These have a well marked head and are provided with a tube at the tail end through which they are able to breathe when resting at the surface of the water. They feed on the minute forms of life that are abundant in the water, the mouth parts having special fans or brushes which draw these to the gullet. Substances held in solution in

the water are also utilized to some extent. On attaining full growth they change to the robust "tumbler" or pupal stage, which after several days splits and the adult insect emerges, and if a female, commences her life of annoyance to man and beast, which may last one or two months. The female lays several hundred eggs, these being deposited singly in depressions likely to become filled with water. While in most of our species there is only one generation a year, all eggs do not hatch at one filling of the pools, and successive floods may give several broods during the season. In the case of snow-pool mosquitoes the eggs hatch in the spring when the snow melts.

Control.—The control of mosquitoes has developed rapidly in Canada during the last decade and a number of successful anti-mosquito campaigns serve as practical demonstrations illustrating what can be accomplished. While most of these have been in towns and cities, some of them have been under farm and country conditions, and there is no doubt that the nuisance and losses to stock could be greatly reduced in many farming communities. The co-operation of owners of closely placed farms is necessary for success, mosquito control being essentially a community problem.



Fig. 16—Flood water breeding places of mosquitoes, and oilers at work (original).

The drainage of water areas producing mosquitoes is the ideal method of combating these pests, since it permanently eliminates their breeding places. Filling is of value where it can be employed. Where the above measures are not practicable or desirable, oiling the water surface with cheap fuel oil is very effective if carried out at the right time. A thin film of oil may be applied with a watering can, but a portable spray pump is less wasteful and more efficient.

It is particularly difficult to protect stock from the attacks of mosquitoes, as they bite day and night and some kinds are persistent in entering buildings. Repellents such as fish oil, pine oil and citronella give temporary relief and are of some use in reducing restlessness of animals at milking time. Smoke provides one of the simplest and most efficient protectors, both outside and when animals have been tied in buildings. When mosquitoes are particularly numerous a continuous smudge should be available for stock. Well screened stables are very necessary for the protection of valuable dairy cows and other stock. Even with screened stables it is sometimes necessary to resort to a "smoking out" after the animals have been tied up, since many mosquitoes may enter the building with the herd. In rough barns and stables the numbers of mosquitoes

entering may be greatly reduced by spraying the walls and ceiling with creosote, using two to four gallons to a stable. The repellent action following such treatment has been stated to last for several months.

HORSE FLIES, *Tabanus*, *Chrysops* and *Haematopota* spp.

The robust, thick-set, horse flies are second only in importance to mosquitoes among the blood-sucking insects affecting live stock in Canada. The larger, more robust species constitute the *Tabanus* group, and are commonly referred to as "bull dog flies," a name that suits them well in view of their persistent attacks; the genus *Chrysops* contains the smaller, shorter species known commonly as "deer flies," and the mottled winged and more delicately built "breeze flies" belong to the *Haematopota*. A characteristic common to most of these insects is the brilliancy of the eyes, which are banded, spotted or striped with rainbow colours. The short, thick set antennae or feelers consist of three joints and vary characteristically in each genus. The horse flies constitute a large group, about 100 species occurring in Canada.

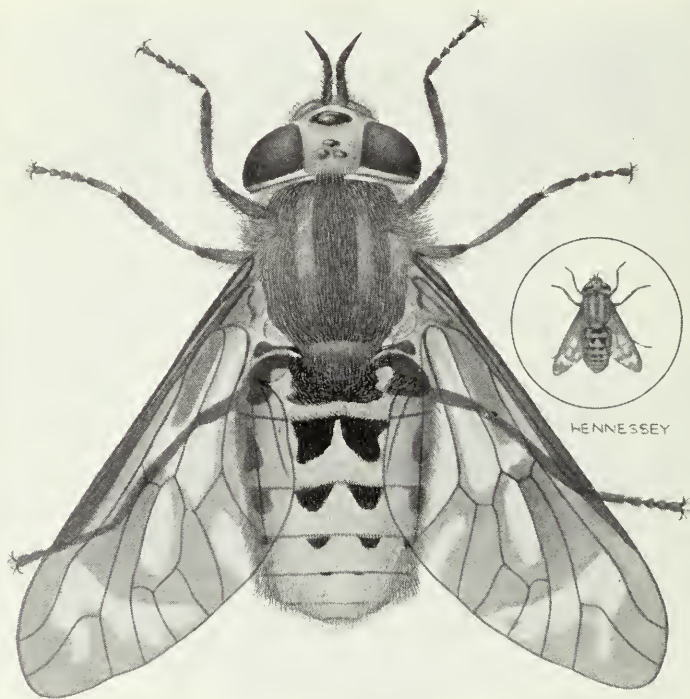


Fig. 17—A typical deer fly, *Chrysops discalis* Will., enlarged and natural size (original).

While live stock in general are more tolerant of small numbers of these flies than of many other blood-sucking insects, or of the attacks of others such as horse bot flies and cattle warble flies, an abundance of them will drive animals almost frantic. Cattle with their thick hides are less affected than are thin skinned horses. Dogs appear to be particularly afraid of them. In districts where extensive marshy areas occur, in prairie sections containing many sloughs, and in high mountain sheep ranges the flies may be an intolerable pest, especially in the year following a particularly wet season. In the better developed, long established farming districts, the pest is usually of less importance than in more recently settled agricultural areas. The importance of these flies may be realized from the statement of an observer in one of the south-eastern states, who estimated that beef cattle lost an average of 100 pounds in weight due to the constant annoyance resulting from a particularly bad outbreak. At times, in some of the prairie sections where these flies are especially prevalent, it is

almost impossible to work horses during much of the day, and during the haying season runaways are a frequent occurrence. In addition to this, the intermittent feeding habits of the flies, due to their nervousness, renders them especially likely to transmit anthrax from infected to healthy animals. There is also a possibility that they may be implicated in the transmission of swamp fever of horses. One species, *Chrysops discalis* Will. which is especially common in the Dry Belt of British Columbia and extends east as far as Manitoba, is known to transmit tularaemia in the western states. This is a disease of rodents, which may be contracted by sheep and other animals and by man.

While there is only one brood of each species of horse fly in a year, and the life cycle may extend over ten months and may sometimes take as long as two years, we have noted from observations made during a number of seasons both in British Columbia and Saskatchewan, that each species has a regular period of abundance and that a succession of kinds follow each other continuously



Fig. 18—A female bulldog fly, *Tabanus punctifer* O.S., enlarged and natural size (original).

from spring until autumn. The first appearance and time of greatest abundance of several species may, however, coincide. June, July and August are the months when the greatest trouble is experienced from these flies, and their numbers are usually much reduced by September. The different species vary also in their biting habits, some biting the abdomen almost exclusively, others the face and neck, and so forth. Unlike mosquitoes, they are active only during the day.

Life-history.—The breeding habits and life-history are as follows: The eggs, which are laid in a compact mass of several hundreds, are placed on the leaves of aquatic plants, on trees and bushes overhanging sloughs and swamps; or, by some species, on the rocks at the edges of streams. They have even been observed on barbed wire overhanging irrigation ditches. The egg masses are usually dirty white or grey in colour, but in some deer flies are jet black. Hatching occurs in about a week, the young larvae dropping to the water or moist ground. The larvae or maggots are elongate in form, tapering sharply at both ends, with marked ridging at each segment. The principal habitat is in the mud at the edges of sloughs, swamps and pools. Small, soft bodied organisms provide food for development during the summer and autumn. Little growth

occurs, however, during the winter, and in the following spring or summer the fully developed larvae work their way into drier ground and change to the elongate pupal stage, from which the adult flies emerge after a period of from two to three weeks.



Fig. 19—Egg masses of the deer fly, *Chrysops moerens* Walker (original).

Control.—The nature of the breeding places renders it extremely difficult, if not almost impossible, to control horse flies in the immature stages; in fact, no very satisfactory control for these flies has yet been devised. Hine has suggested that since the eggs of most species are laid over water, a film of oil on the water surface would kill the larvae when they hatch and drop into it. The collection and destruction of egg masses has also been recommended by this authority, but this has only a very limited application, such as in places where suitable breeding places are not too scattered. Parman writing on Texas conditions stated that a boy was able to collect nine pints of egg masses, or approximately 2,000,000 eggs in one day, and a total of over 20,000,000 eggs were collected in this manner. A Russian worker, Porchinsky, observed that the adults had the habit of skimming over certain pools and dipping their bodies in the water in passing. By pouring kerosene on these pools he converted them into traps, and in one pool of about a square yard, succeeded in killing nearly 2,000 horse flies in three days: a large proportion of these, however, proved to be the harmless males. The adult flies have the habit of entering buildings or other enclosures. We have found them in numbers in the inside of automobiles. Criddle in Manitoba, took advantage of this habit by converting a small unused building into a trap by providing flanges of wire screening at the edges of the door. The flies accompanying the cattle which were watered nearby,

sought the shade of this building and on entering were trapped. Many thousands were caught in a few days, resulting in a marked decrease in the numbers noted subsequently around the animals. Darkened shelters are of value and are only required during the heat of the day, since the flies are not active until late in the morning and disappear about sundown. Owing to their persistence of attack the use of fly “dopes” for repelling these flies has proved of little value. In the case of work horses, fly nets give some protection. When the flies are particularly abundant, canvas coverings should be provided, due consideration being given to the different parts of the body selected by the various species in biting. For instance, the common green-headed fly (*Tabanus phaenops* O.S.) prefers

the head and neck, so hoods should be provided to cover these parts. When the large black horse fly with grey thorax (*Tabanus punctifer* O.S.) which is the commonest species in many parts of the dry belt of British Columbia, is abundant, the covering should be over the back and rump.



Fig. 20—Typical breeding place of deer flies (original).

The larval, pupal and adult stages are preyed upon by certain enemies, but not sufficiently to result in appreciable reduction. The eggs, however, are often heavily parasitized by very minute wasp-like insects. We have, at times, noted extensive parasitism in Saskatchewan. There seems little doubt that



Fig. 21—*Tabanus punctifer* O.S., life stages: 1, egg mass; 2, larva; 3, pupa; much enlarged (after Webb and Wells).



Fig. 22—The blackfly, *Simulium venustum* Say, female, enlarged and natural size (original).

these small enemies of horse flies reduce their numbers. The presence of parasites was noted in 90 per cent of the egg masses of one kind of deer fly. One species of these parasites (*Trichogramma minutum* Riley) can be reared on a variety of hosts, including several orders of insects.

BLACKFLIES, Simuliidæ

Unlike the horse flies, this family is a small one in number of species and in size of individuals. Thirty-eight species had been recorded or described in Canada by 1936. Few of these exceed a quarter of an inch in length, the majority being about one-half this size. In spite of their small size, they are venomous and persistent blood-suckers, and in some districts constitute a terrible pest both to man and to wild and domestic animals. Fortunately they are not so generally distributed in Canada as are mosquitoes and horse flies. The blackflies have wide, short wings, short thick-set bodies, and the thorax is prominent and humped, a characteristic which is probably responsible for the name "buffalo gnat". While most kinds are black or dark coloured, some are grey and a few



Fig. 23—A typical blackfly stream (original).

are red. Their attack is marked by a fierce and stubborn insistence, much more so than that of mosquitoes. When they alight on an animal they crawl through the hair to the skin. On human beings they crawl into the sleeves, under the neck-band, around the tops of the boots and other vulnerable places; they especially favour the head just beneath the brim of the hat. In animals, the nostrils, chest and belly are severely attacked, the chest often becoming quite raw. The ears, however, are a particularly favorite site for feeding in many species, and when the flies are abundant their ceaseless coming and going reminds one of the activity of a beehive. The poison introduced in biting is particularly bad in that it results in swelling and a numb

soreness that may persist for many days. Fortunately the flies only bite in the daytime, although, unlike the horse flies, they may start at dawn even if the temperature is low, and are by no means restricted to the warmer portions of the day as are horse flies. While usually at their greatest abundance during June and July, blackflies often make their appearance in late April and May and have a longer season than most biting flies, sometimes being quite troublesome as late as mid-October in some districts. They have been observed on the wing in small numbers as late as November in certain regions. They have a wide range of flight; large swarms sometimes travel considerable distances, and the insects have been noted in numbers as far as 15 miles from any possible breeding place.

Where abundant these flies are of the greatest economic importance, as may be gauged from the fact that the losses during a single week in one county alone in one of the southwestern United States was placed at half a million dollars. "When a large swarm of black flies envelope a herd of cattle, the effects are sometimes disastrous. Owing to the irritating effects of bites around the nostrils, the animals snort, take deep breaths, and sometimes inhale such large numbers of flies that suffocation ensues and the animals die with great rapidity. In Saskatchewan there have been a number of what would appear at first sight to be outbreaks of a suddenly fatal disease"*; due to the deaths caused in this way by blackflies. In one place, for instance, 300 head of cattle perished. Death may also be due directly to the effect of the poison introduced in biting. All classes of stock, wild animals, birds and man are attacked, but different species have marked host preferences. One of the species most widely distributed throughout Canada, known as the white-stockinged blackfly (*Simulium venustum* Say), attacks man freely. This species, too, serves as the intermediate host of a protozoan blood parasite of ducks (*Leucocytozoon anatis* Wickware) which causes a serious and widespread disease of wild and domestic ducks.

Life-history.—Blackflies breed in shallow, fast-running water, in rivers and streams. While the life-history of the various species appears to be very similar, we have noted, as in the case of horse flies, that in some districts there is a definite succession of different species throughout the season. There is also much seasonal variation in numbers. In the case of a very abundant species breeding in the Saskatchewan river, Cameron found that the life-history occupied about six weeks and that there were four broods in a year.

The small glistening yellow eggs of blackflies are laid in compact masses on stones and vegetation in fast-running streams where their sticky covering enables them to adhere tenaciously. The flies sometimes even enter the water to lay their eggs and have been observed actually ovipositing a foot below the surface. About 500 eggs are laid by each female. The larvae that hatch from these eggs are able to retain their position, in spite of the force of the current, by means of sucker-like discs and tiny hooks at the tail end of the body. In appearance and

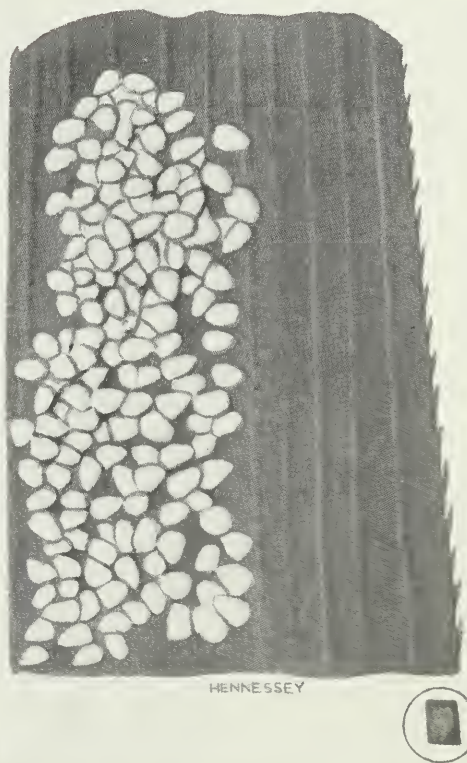


Fig. 24—Eggs of *Simulium venustum* Say, on aquatic grass, enlarged and natural size (original).

* Hadwen

in their looping movements they somewhat resemble small leeches, although they have well-marked heads, at the sides of which are a pair of shaggy mouth fans that project like large ears. They spin a fine thread which anchors them and prevents them from being washed away when moving from place to place. Feeding is accomplished by the fanlike mouth brushes much as in mosquito wrigglers, but they obtain oxygen from the well-aerated water in which they live, by means of triple gills at the tail end, and through the body integument. They may be dark brown, green or pale in colour, and congregate in dense, slimy, moss-like coatings on stones and other supports in the water, such as submerged logs and vegetation. When full grown they spin a cocoon, open at one end, which is attached to various objects, and within this they transform to the pupal stage. The shape and character of the cocoons vary in different species, but a common form is slipper-shaped. The pupae, which are thick-

set, breathe by means of two bunches of filaments on the thorax, the number and arrangement of these also varying in the different species. The adult flies on emerging are able to take flight when they reach the surface of the water. They are fairly long-lived. In many species the winter is passed in the larval stages.

Control.—The control of blackflies is no easy matter and is usually rather costly, but a number of good demonstrations have indicated decisively that a marked reduction of these flies can be realized by the use of suitable oils applied to the rivers and streams in which they breed. A necessary quality of the oil is that it be miscible, that is, readily mixed with water. This type of oil is much more expensive than the low grade fuel oils that are effective against mosquito "wrigglers." Where the streams are small or the areas of rapids limited, the method is feasible. Oil should be applied so as to give an opaque milkiness to the water, and should be in such quantity that it takes about three minutes for the milky water to pass a given point. About two gallons of oil are sufficient to treat a small stream for a distance of approximately 300 yards. Unfortunately, it is extremely difficult to arrange for such an exact dilution that the blackfly larvae are destroyed and fish remain uninjured, moreover, the pupae are not destroyed by it. Owing to the rather extensive range of flight of these flies, control should be carried out over a fairly extended area, and is essentially a community problem.

While the adult flies do not appear to be attacked very much by natural enemies, the larvae are preyed upon quite extensively. Cameron found in Saskatchewan that the common sucker subsists during the summer mainly on the larvae and pupae of blackflies,

the peculiar mouth of the fish being well adapted for this prey. Parasitic worms and protozoan diseases sometimes reduce their numbers, but unfortunately none of these enemies appear to be such that they can be developed and made use of in a practical manner.

Dense smoke "smudges" provide the easiest and quickest method of protecting live stock from the attacks of blackflies. "Quick action is necessary to protect stock when a large swarm of blackflies arrive," and "the place chosen for the 'smudge' must be somewhere in easy reach of the farm buildings, and it should be the special duty of one person to attend to the 'smudges' whenever the cattle need protection." "Once the animals have found relief by smoke

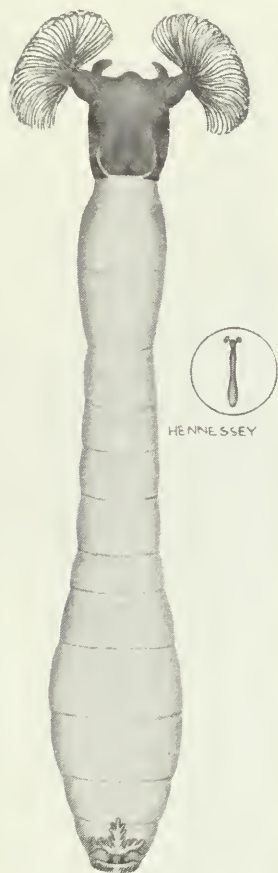


Fig. 25—Dorsal view of full grown larva of *Simulium venustum* Say, enlarged and natural size (original).

they will return to the same spot just as soon as the flies become troublesome.”* The application of oily dressings to the coats of work horses, saddle horses and milch cows will provide some protection, and special attention should be paid to the chest, belly, and inside of the ears. There is some danger of injury if oily dressings are applied extensively (especially on the back) during sunny weather. Fortunately the flies appear to prefer the lower parts. Fish oil or raw linseed oil, with a small quantity of oil of tar, and kerosene emulsion are among the materials most recommended. Small cotton bags are found to be very useful for enclosing the ears of work horses to prevent the entrance of the flies since, as mentioned above, some species, such as the common *Simulium vittatum* Zett, are particularly inclined to attack the inside of the ears.

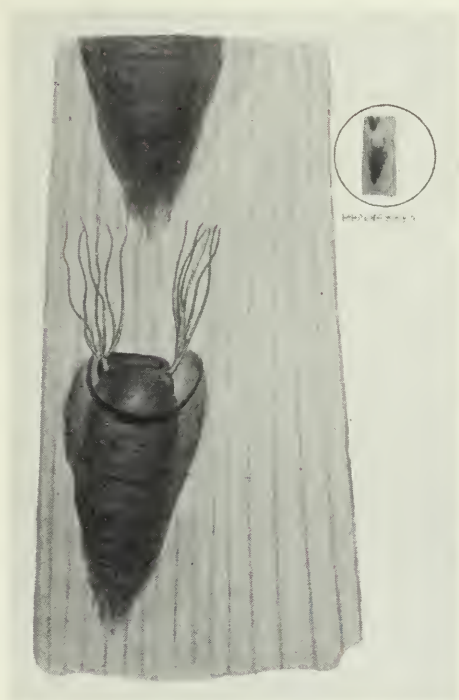


Fig. 26—Pupa of *Simulium venustum* Say, in cocoon on aquatic grass, enlarged and natural size (original).



Fig. 27—Work horse wearing ear bags to protect it from attacks of blackflies, many species of which select the ears for biting (original).

Biting Flies of Lesser Importance: Punkies or Midges, and Biting Snipe Flies

Although the flies already dealt with constitute most of the commoner kinds that cause trouble to stock, reference must be made to a few others, which, while much more restricted in their distribution, are the source of great annoyance both to man and animals in places where they are abundant.

PUNKIES, *Culicoides* spp.

These little flies, which are known also as midges, sand-flies and no-see-ums, somewhat resemble minute mosquitoes in appearance, although the proboscis is quite short. The wings and thorax in most species have characteristic markings, giving a mottled effect. The name “no-see-un” is particularly descriptive since these flies seldom exceed one-sixteenth of an inch in length, and some are

* Hadwen

even smaller. Comparatively few species are known in Canada. One of the larger members of the genus, known as *Culicoides obsoletus* Mgn., occurs in British Columbia and has been observed in considerable numbers in Alberta, where horses were viciously attacked. It also has been recorded attacking man and animals in Eastern Canada. Several other species have been noted in Alberta and Saskatchewan. In spite of their minute size they inflict great suffering, and an attempt to milk cows in the open when they are plentiful is a trial of patience for both man and beast. They avoid wind and sun and full daylight, and are particularly active at dusk and fairly early in the morning on calm days. Fortunately, they are very localized and do not fly far. They breed in a variety of situations, but mainly in water or water-saturated sand or soil. The immature stages have also been found, in various parts of the world, in tree holes and water held in rotting tree stumps, under stones, moss or bark and even in the flowing sap of trees. A few species have been found in cow dung. The larvae are white and very slender; the brown pupae are slender and are provided with two short breathing tubes on the thorax.

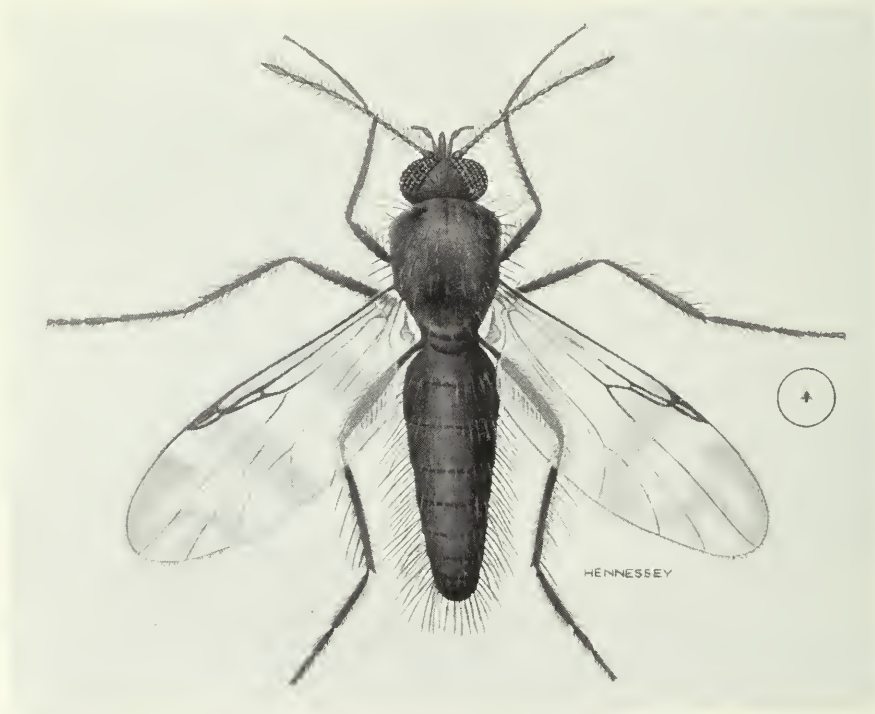


Fig. 28—Female punkie or “no-see-um”, *Culicoides obsoletus* Mgn., enlarged and natural size (original).

Until more is known of the breeding places of the pest species control by means of larvicides will not be feasible, and smoke smudges and oily repellent dressings must be resorted to. The small size of the flies permits easy entrance to screened buildings, but to prevent this the mosquito netting may be sprayed with a repellent mixture.

BITING SNIPE FLIES, *Symphoromyia* spp.

The distribution of these flies is even more restricted than that of the last group, but in some seasons they are extremely troublesome in mountain districts in British Columbia and Alberta.

These are robust medium-sized flies, a little smaller and more slender than house flies, and with tapered, cone-shaped abdomens. Most of them are dark,

and some are shining black, although others are reddish-brown. At present, only about half a dozen species are known to occur in Canada. During a recent exceptionally wet year, they were extraordinarily abundant in parts of British Columbia and Alberta, and since the bite is very painful, they were the source of much annoyance to man and domestic animals, and many complaints were received from live stock owners. Pack horses and sheep in the high mountain ranges suffer very greatly from them. An observer in the state of Washington



Fig. 29—The biting snipe fly, *Symphoromyia hirta* Johns, enlarged and natural size (original).

noted as many as 100 of these flies hovering over a team of horses and biting them on the head, the part most usually attacked. They are most active during the warmer part of the day, in which respect they resemble their close relatives the horse flies.

Very little is known of the breeding places, early stages or life-history, but some other members of the same family are aquatic or breed in rotting wood and decaying vegetation. Due to our lack of knowledge on these points no control measures can be suggested. Repellent dressings or smoke smudges should be used for the protection of animals when the flies are particularly abundant.

Bot and Warble Flies

HORSE BOT FLIES, *Gasterophilus* spp.

There are three different species of bot flies parasitic on horses in Canada: *Gasterophilus haemorrhoidalis* L., *G. nasalis* L., and *G. intestinalis* De Geer. None of these species is native, but they were probably introduced into North America in quite early times. Their spread to some of the more newly developed districts in Canada, has been fairly recent, and there have been very marked increases in numbers during the last two decades. While horses and mules are the animals habitually attacked, cases have occurred where hogs and other animals have become infested and a number of cases of human myiasis from bot fly larvae are on record in Canada and elsewhere. Although there is much in common in the life cycle of these insects, in that they all lay eggs on the host animal and the barrel-shaped larvae develop in the digestive system, the various species differ somewhat in habits and are best dealt with separately in order of importance.

THE NOSE BOT FLY, *Gasterophilus haemorrhoidalis* L.

The nose fly or red-tailed bot fly is the smallest of the three species, but causes by far the most annoyance. It occurs in the three western provinces and is particularly abundant in open prairie districts and range lands. The adult fly is about one-half an inch in length, and in appearance somewhat resembles a

diminutive bumblebee with an orange red tail. There is a black shining area between the wings on the thorax, and on the central part of the abdomen; the fore parts of both abdomen and thorax are clothed with yellowish grey hairs. This is much the quickest species on the wing. It will hover near the ground between the fore legs of a horse and then dart with considerable force and roughness against the muzzle of the animal, where it attaches its black, stalked eggs firmly to the base of the short hairs on the lips. It is only during the actual egg-laying that horses are bothered by the flies. The mere presence of flies in the vicinity does not appear to upset them (as cattle are disturbed by the heel fly, for instance). Some writers have stated that the fear shown by the horses results from pain because the sharply pointed and screw-like egg stalk is



Fig. 30—Adult female of the nose bot fly, *Gasterophilus haemorrhoidalis* L., enlarged and natural size, (original).

thrust into the skin, but the majority of entomologists who have studied these insects have failed to corroborate this, and claim that the stalk is never thrust into the skin, the fear exhibited by the horse being entirely due to the roughness of the fly in striking against the very sensitive lip. It grasps the hairs with its feet when egg-laying, and the repeated attacks incite terror in the animal. In one case observed, a fly struck at the brim of a hat and examination showed that an egg had been laid with the stalk completely buried in the felt.

Injury Caused by Nose Bot Flies.—This fly is considered to be the most troublesome insect affecting the horse, whenever it is abundant. Its egg-laying habits terrorize the animals to such an extent that they are kept from grazing and resting during much of the day, and lose condition from constant milling and running around. On warm bright days they get no peace and are kept in a state of nervous irritation. Horses in harness are not able to do their work properly when their attention is focussed on the nose flies striking at them; run-aways and accidents are all too frequent. The irritation following egg-laying and the hatching of the grubs on the lips causes horses to rub the mouth on hard surfaces, and the sores resulting render the animals even more unmanageable.

Injury is also caused by the presence of the larvae or bots attached to the stomach and other parts of the digestive system. More than one thousand bots have been taken from the stomach of a horse. While there is still some difference of opinion as to the exact extent of such injury, there seems little doubt that poor condition and lack of energy are often occasioned by the presence of these parasites in large numbers, and it is probable that the drain on the system may even result in the death of animals during severe winters, when feeding conditions are particularly bad, although when feed is plentiful and only moderate infestations occur, horses do not appear to be much inconvenienced.

The larvae of these, and other bots, contain a substance that has been found to be very toxic to horses when injected under the skin, and it is possible that the disease known as "jiggers" may result from the absorption of this poison from the bots in the stomach.



Fig. 31—Egg of the nose bot fly, greatly enlarged (after Hadwen and Cameron).

Life-history.—The life-history of the flies is as follows: The adults are on the wing from late June to the end of August and are usually at their worst during July. An occasional belated fly may be noted in the first week of September. Egg-laying activities are restricted to bright sunny days, and the flies do not worry horses to any extent when it is overcast, or if there is a strong wind blowing. Egg-laying may commence on the day the flies emerge from the pupae in the ground, and each female is capable of laying about 150 eggs during her short life, which seldom extends over a week. Hatching of eggs occurs in from one to two weeks, moisture and friction not being absolutely essential for this, as is the case with eggs of the common bot fly. Our knowledge of the life-history is a little uncertain at this point. It has been proved experimentally that newly hatched larvae will burrow into flesh and in fact numerous cases are on record of creeping myiasis in man caused by the larvae of bot flies. It is probable that the larvae reach the stomach by a less direct route than ingestion with food and water. They attach to the wall of the stomach where they remain until the following late winter or spring, when they move to the rectum, and, on attaining full growth attach close to the anus, and may be observed protruding in this location. This is the only species with this habit and it is from this that the name *haemorrhoidalis* is derived.

The larvae drop to the ground in two or three days and burrow therein to pupate, the pupal stage lasting from three weeks to two months. No food is taken by the adult flies; in fact the mouth parts are rudimentary and unsuited for feeding, as are those of other members of this family. The flies are provided with no stinging apparatus, although it is sometimes difficult to persuade horse owners that this is the case in view of the dread horses have of them. Fortunately for the success of community control work these insects have a comparatively restricted flight and probably seldom fly more than half a mile.

Control of Nose Bot Flies.—Through co-operative efforts among horse owners bot flies can be markedly reduced in numbers, and it may be possible to completely eradicate them from restricted areas. Since the winter is passed in the larval stages in the stomachs of horses, the medicinal treatment of all horses and mules in a district, with suitable substances for the expulsion of bots, is the most logical method of dealing with the problem. The co-operation of all horse owners in a district could make the establishment of definite bot-free areas quite feasible.

Carbon bisulphide has proved to be the most satisfactory substance for expelling bots from the stomach. This gas-producing liquid is administered in gelatine capsules, a single dose of six drams being sufficient for a thousand pound horse, the amount being reduced in proportion to the size of smaller or younger animals. A preliminary fasting of eighteen to twenty-four hours is advisable before administering the drug, and food and water should be withheld for five to six hours after. No purgative is necessary following treatment. This drug should only be administered by a qualified veterinarian since serious injury to the animal may ensue if the capsule is not properly swallowed; also, injury may result if an animal is not in a fit condition for treatment, and only a trained veterinarian is in a position to ascertain this. The time of treatment is of considerable importance, the best time being in the early winter after all bot fly activity has ceased. All horses should receive treatment before mid-December.

There are several effective methods for protecting horses from the attacks of nose flies. For work animals a leather band cut into strips encircling the nose is effective, but this should be so constructed that no gap occurs in the center of the nose, and good protection should be given from underneath, since the flies usually strike from below. The illustration shows a well made and effective protector of this nature.

The United States Bureau of Entomology recommends an even simpler device, a piece of leather or belting about four to six inches wide being attached

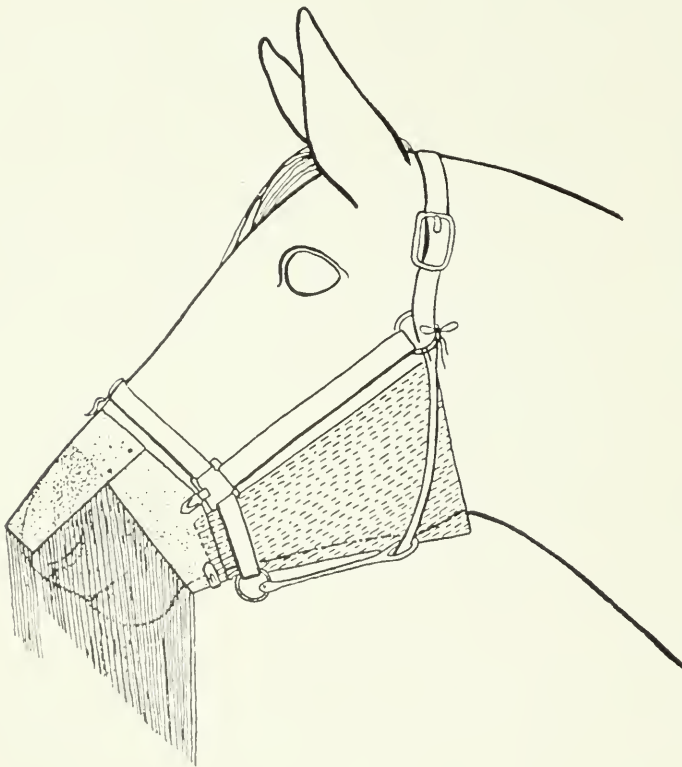


Fig. 32—Improved leather fringe to protect horses from nose bot fly attacks; the canvas cover protects the region between the jaws from the throat bot fly (after Hadwen and Cameron).

at each end to the bit rings with a string or snap, so that the entire lips, including the corners are protected. The wire basket protectors in common use have several objectionable features and are less satisfactory than either of the above. Simple halter attachments have also been devised which provide protection against egg-laying and yet permit grazing. They also prevent the animal from becoming infested with the common bot.

For animals on pasture, darkened sheds or brush shelters should be provided and will give them all the protection needed, since this species of bot fly will not enter dense shade. If the horses are in the open all day at the mercy of the flies, eggs will be very numerous on them and the bots will

be correspondingly abundant in their stomachs during the following winter. Suitable shelters undoubtedly reduce bot infestation and lessen the worry occasioned by the adult flies. It is often feasible to stable animals in the daytime and to let them out to pasture only at night. This ensures freedom from bots, since neither this nor the other species ever lay eggs when in buildings.



Fig. 33—Above: horses protecting themselves from bot fly attacks, those on the right with their heads over a water trough; below: characteristic attitude of horses protecting themselves from attacks of nose and throat bot flies (original).

Horses derive much protection by standing in pools and sloughs when these occur in the pasture; and we have noted that in the absence of ponds the animals would gather around a drinking trough with their heads resting over the water. A quick movement of the head would strike a fly into the water, and during two days we noted nearly sixty flies drowned in this way. Fifty of these were nose flies and the remainder the throat bot fly.

THE THROAT BOT FLY, *Gasterophilus nasalis* L.

This is a slightly larger fly than the nose bot fly. The thorax is of a uniform rusty-red colour and the end of the abdomen lacks the red colour characteristic of the nose bot, but is yellowish-grey, both before and behind the central black shiny area. Eggs are laid almost exclusively toward the base of the long hairs of the upper throat between the jaws. Like the nose bot, the flies hover between the fore legs of a horse and dart suddenly upwards to attach the eggs. As soon as the animal feels the fly it draws its head into the neck. It is for this reason that horses are perpetually nodding their heads during the bot fly season. Horses

will also rest their heads over each other's backs and necks in order to protect themselves from the attacks of both this fly and the nose fly.

This species has a somewhat wider distribution than the nose fly. It occurs in greatest numbers in the western provinces, but is not so abundant in Canada as the common bot fly and does not occur so generally in the eastern provinces; although it is reported as being equally numerous in New York State.



Fig. 34—Adult female of the throat bot fly, *Gasterophilus nasalis* L., enlarged and natural size (original).

The adult flies first appear about mid-July, and may be common throughout August, but few are seen after the end of the latter month. While horses are less afraid of this species than they are of nose flies, they are, nevertheless, the source of considerable worry. One injurious feature not characteristic of other bots is the peculiar habit of the young larvae of attaching themselves to the inside of the throat, where they sometimes occur in such numbers as to cause death through choking.

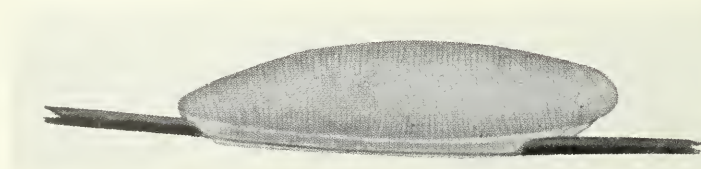


Fig. 35—Egg of the throat bot fly, greatly enlarged (after Hadwen and Cameron).

Life-history.—In general this somewhat resembles that of the nose fly. Four or five hundred yellowish eggs may be laid by each female, these being deposited singly, usually near the base of the long hairs between the jaws, and attached by a groove for nearly their whole length. As many as 68 eggs have been noted on one hair, although, owing to their location, they are often overlooked. The eggs hatch in a little under two weeks, no friction or moisture

being needed to bring this about. Present evidence indicates that the larvae penetrate directly through the skin and migrate through the tissues of the animal to the throat region. Numerous scabby areas have been noted on the skin in the vicinity of the eggs at the time the grubs were hatching. The grubs are later found in the duodenum or region of the small intestine immediately behind the stomach. The larvae ultimately pass out with the dung in the spring months, transform to pupae and change to the adult fly about two months later. The adult flies live for about two weeks.

Control.—The carbon bisulphide treatment and darkened shelters are as effective against this species as they are against the nose fly, but a different protector for preventing egg-laying must be used. In this case a piece of canvas should be suspended from the throat latch to the bit-rings in order to completely cover the region between the jaws.

THE HORSE BOT FLY, *Gasterophilus intestinalis* De Geer.

This species is the largest, commonest and most widely distributed of the horse bot flies. In size, brown colour, and hairy appearance it somewhat resembles a honey bee. The abdomen is long and tapering, but, when at rest, the distal portion is held tightly appressed under the body. When preparing to lay eggs, the insect assumes a V-shaped position, as do the other bot flies, the large ovipositor or egg-laying tube being bent upwards, giving the insect a characteristic and peculiar appearance. Unlike the other two species which are clear-winged, the horse bot fly has dark smoky patches clouding the wings.



Fig. 36—The horse bot fly, *Gasterophilus intestinalis* DeG., enlarged and natural size (original).

This is a later species than the other two, and is seldom on the wing until the third week in July. The flies become markedly more abundant in August, and continue to be noticeable during much of September. We have noted them to be still numerous in the third week of September in the Prairie Provinces.

On the Pacific coast, they may be active until even later, having been observed on October 5.

The egg-laying activities of these flies are less affected by weather conditions than in the case of the nose fly and they will oviposit in cloudy, or dull weather, and are not deterred by a slight breeze. Horses take little notice of this fly in districts where the other two species also occur. The movements are sluggish, especially in comparison with the quick darting flight of the nose fly.

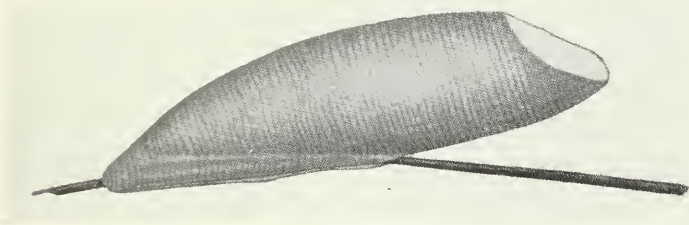


Fig. 37—Egg of the horse bot fly, greatly enlarged (after Hadwen and Cameron).

Life-history.—The yellowish eggs are attached one after another along the hairs, usually towards the outer end. They are attached only at the basal two-thirds, the capped end projecting at an angle of 30 degrees. About 550 eggs are laid by each female. The fore legs, especially the long hairs on the inner sides, are a favorite site, although the sides, should-

ers and mane may have large numbers. Places easily reached by the mouth of the animal are especially selected, as the eggs rarely hatch without the moisture and friction resulting from the horse licking and biting at itself. The angle at which the eggs project apparently helps the newly hatched larvae to stick to the lips or tongue of the animal. Eggs seldom hatch in less than ten days, the average time being about two weeks. They may remain viable on the horse for as long a period as three months, a point of considerable importance in control. When the minute larvae hatch under the stimulus described above they enter the mouth and probably burrow under the tongue and finally reach the stomach where they remain attached to the stomach lining for about ten months. They are passed out in the manure, pupate in the soil and emerge as adult flies in about five weeks. The life of the adult appears to be longer than in the other species and may extend to three weeks.

Control.—Carbon bisulphide treatment is very effective against the larvae of this species, but the long period over which eggs may remain viable should be kept in mind, and the treatment should not be given too soon after the activity of the adult has ceased. If unhatched eggs are found, clipping should be resorted to, or a wash for the purpose of killing the eggs should be applied. Kerosene has been used very generally for this purpose but is of little value; instead, a 2 per cent solution of any of the standard coal-tar-creosote dips will be found effective.

While darkened brush shelters provide much protection to animals, they are somewhat less effective than for the other two bot flies, since the common bot fly will sometimes follow horses into the shade for the purpose of egg-laying. Stabling animals in the daytime provides absolute protection.

Due to the location and diversity of places on the body in which eggs may be laid, it is obviously out of the question to provide protectors for the purpose of preventing egg attachment, as can be done with the other two species. Halter attachments have been devised, which serve the same purpose by preventing the horse from reaching the eggs with the mouth and causing them to hatch.

Systematic clipping of the hair on the parts infested with the yellow eggs or nits can be undertaken with considerable benefit during the summer. Such

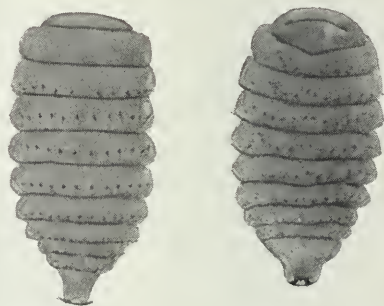


Fig. 38—Larva of the horse bot fly, dorsal and ventral views, somewhat enlarged (original).

clipping or the application of egg-killing washes should be carried out every week during the entire egg-laying season. When horses are able to stand in sloughs and muddy water, the coating of mud that covers the legs acts as an efficient prevention against egg-laying on the fore legs. The use of repellents to prevent egg-laying is not very satisfactory, but equal parts of pine tar and lard may be used, in the case of saddle and work horses, and will reduce bot infestation to some extent if applied on the parts where eggs are most commonly laid.

The Warble Flies of Cattle

The warble flies are fairly large, dark, hairy flies with bands of yellow or orange which give them a superficial resemblance to small bumblebees. Two

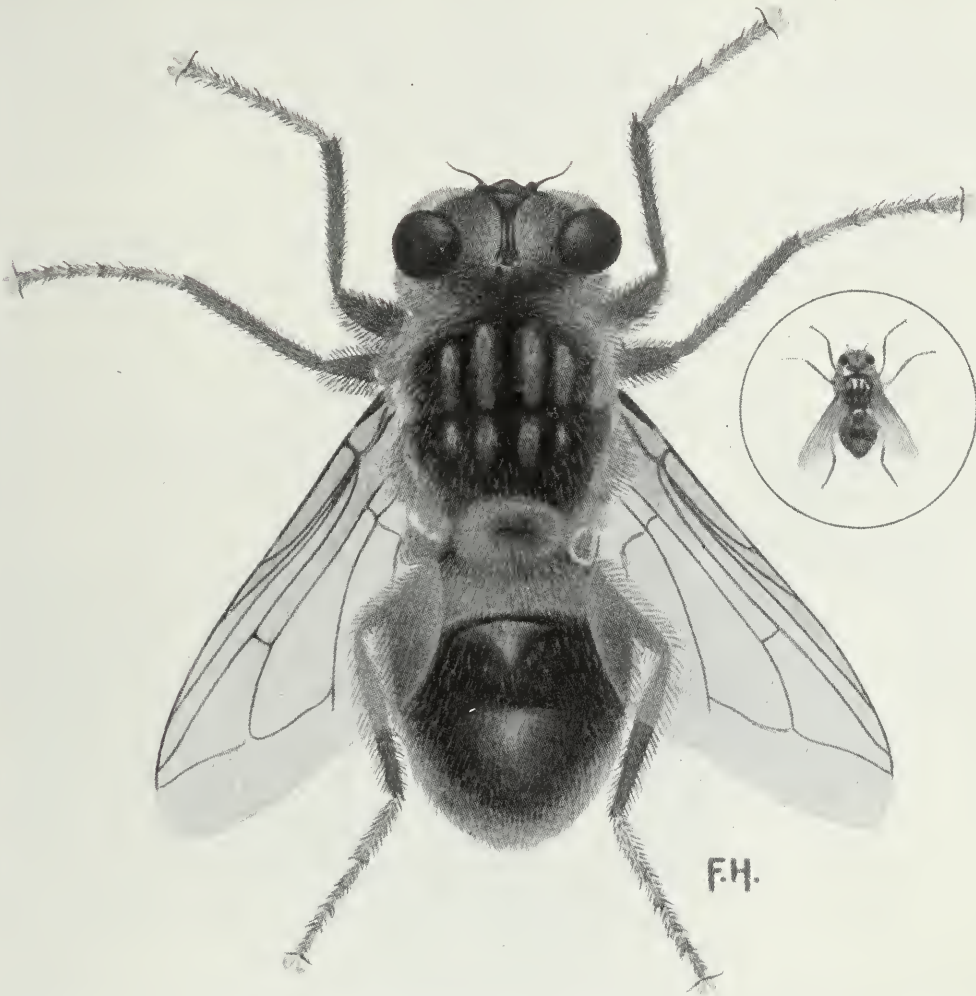


Fig. 39—The common cattle grub or heel fly, *Hypoderma lineatum* de Vill., enlarged and natural size (author's illustration).

species (*Hypoderma lineatum* de Vill. and *H. bovis* DeG.) have become very widely distributed in many parts of the world, particularly in Europe, North America and to a lesser extent in Asia, and constitute the worst insect pests of cattle wherever they are abundant. They occur in every part of Canada where stock is raised. They are injurious both as adults, due to their terrifying effect on cattle when egg-laying, and as parasitic grubs in the body, due to their effect on the health, condition, and milk yield of infested animals, and the damage they do to hides by boring holes for the purpose of breathing. While the normal hosts are cattle, they will occasionally attack other animals, and grubs have been noted in horses, American buffalo and goats. Infestation in man has been reported on many occasions.

The life-histories and habits of the two species have many points in common and are here briefly summarized before being dealt with individually in detail. Eggs are laid during bright sunny days on the legs and lower parts of the animal and are attached to the hairs. The small grubs hatch in from three to seven days, penetrate through the skin, and migrate through the system of the host, in some cases congregating in numbers in the region of the gullet. They remain here during the late summer, and until late winter, when they undertake a second migration and come to rest under the skin of the back, which they perforate in order to make breathing holes. After about two months in this position, during which they feed on matter in the tumor-like cysts formed, they squeeze their way through the breathing holes, drop to the ground, and pupate as hard, black, seed-like objects measuring nearly three-fourths of an inch in length. Many authorities have stated that the matured grubs seek protection under debris or even bury themselves in loose soil, as do the allied bots of rodents, and Bishopp has shown that they may crawl ten feet in order to find shade. Recent experiments by R. C. Gaut indicate that the grubs do not attempt to burrow and if they are buried will work their way to the surface. Emergence of the adult flies occurs in from one to two months; mating may take place on the same day as emergence and egg-laying commence at once; a maximum of 800 eggs may be laid during the life of the female, although the average is probably a little over half that number. While the life of individual adults is very short, about a week in nature, the period of adult activity is a long one of five months or more from March on. Successive adults are developing and emerging during this period, and one species appears later on the wing than the other. The total period of development from egg to egg requires about a year, and at least nine months of this is passed as a grub in the host animal. A number of moults occur and there are five distinct grub stages during this period.

COMMON CATTLE GRUB OR HEEL FLY, *Hypoderma lineatum* de Villers

The common heel fly is the smaller of the two species and is approximately one-half inch in length. Much of the body is clothed with black hair, but there are broad areas of pale yellowish hair at the sides of the thorax and base of the abdomen. The latter is tipped with reddish-orange hairs. The pale and dark hairs on the thorax are sparse on the fore part, and do not obscure the four distinct dark marks or lines in this location. The legs are rough and hairy.

Warble fly surveys undertaken in various sections of the Dominion indicate that this species is very generally distributed and is common in almost every district where stock farms occur.

The common heel fly is the earlier of the two species, and adults usually appear on the wing during the first warm days of spring, and, over much of Canada, the period of adult activity is from March or April until June. Bright sunshiny days are favored for egg-laying, but the insect appears to prefer laying its eggs on the shaded parts of the body. It has the "habit of settling on the ground in the shade of the heels of a cow and reaching up with its long egg tube, attaching its eggs to the hairs around the coronet. . . . When cattle are lying down, the heel fly deposits its eggs quietly on those parts of the animal's body which come close to the ground. The line runs from a point six inches below the pin bones, along the flanks to the elbow, and the sides of the brisket,"* as shown in figure 42. It is usually very quiet and careful in its attack and is less liable to cause gadding than the rougher and less stealthy large warble fly. The eggs are laid in series of from a few to a dozen or more and are firmly cemented to the hairs by a clamping arrangement at the base; they are usually placed about mid-way along a hair and are, therefore, not readily discernible. From 400 to 800 eggs may be laid by a female, and observers have recorded the laying of over 500 eggs in less than an hour by one fly.

* Hadwen

The eggs hatch in from four to seven days, and the minute white grubs, only one-thirtieth of an inch in length, immediately crawl down the hair to the skin and bore through this until they disappear in the underlying tissue. "Adult cattle resist the penetration of the grubs by a reaction which takes place in the skin. A swelling occurs where the grubs have gone in, and watery matter comes from it. In a day or so a scab is formed which can be lifted off leaving a conical pit filled with pus."* This rash and swelling has been given the name "hypodermal rash." Undoubtedly many of the grubs are destroyed by this reaction, and this may be one of the main reasons why adult cattle seldom mature as many grubs as do younger animals which have not yet developed this defensive reaction. There is little certainty at present, as to the route taken by the grubs after they enter the body, but it is known that in this species they ultimately reach the walls of the gullet, where they may be found in large numbers. They first reach this location in June, and the last individuals to leave it do so in March; they are at their greatest abundance there in mid-winter. Usually the larvae are in the body for about two and a half months before appearing in the gullet. Hadwen states that "the larvae leave the gullet at its lower end near the paunch and find their way up to the back bone by the diaphragm or skirt and in some cases along the back of the ribs. They enter the spinal canal and pass along it until they reach the region of the loins; there they leave it and ascend to take up their position under the skin" through which they bore a small breathing hole, apparently by means of spines at the tail end. The time at which the larvae reach their position in the back is of the utmost importance in control procedure, and for this reason it has been the subject of considerable investigation in various parts of Canada. In the warm coastal sections of British Columbia, grubs of this species may first appear as early as mid-December, although they are seldom in very noticeable numbers until the first and second week in January. In colder interior parts of the province, however, they seldom make an appearance until mid-January, but occasionally, in some seasons, have been observed in late December. In Ontario, late December is the first period for grubs to appear, and, in the Prairie Provinces, late January.

Infestation of the backs of cattle by the common cattle grub may extend over several months, as successive grubs migrate to this position. There is some variation in different districts and, as in the case of the date of the first appearance of grubs in the back, there are undoubtedly seasonal fluctuations due to varying weather conditions during the previous egg-laying season. In Saskatchewan, this period was found to be about four months, but the occasional appearance of a few grubs may extend it to six months or more. The larvae are in the third stage at the time they reach the back but moult within four days to the fourth stage. The grubs are nourished by the matter formed in the tumor-like cysts enclosing them, and develop slowly, changing to the fifth stage in a little under a month. The period during which the grubs occupy the cysts in the back averages about two months, but Bishopp states that this period may occasionally be as short as 35 days, or may sometimes be prolonged to 89 days.



Fig. 40—Larva of *Hypoderma lineatum* deV., dorsal and ventral views, enlarged (original).

* Hadwen

The grub, which is white at first, darkens towards maturity. The two breathing arrangements (known as stigmal plates) that lie directly under the aperture in the skin also change colour from pale orange to black, and serve as a useful index of the age of the grub. It is during the two months that the grub is under the skin on the back that the insect is most vulnerable, and can best be dealt with by the control measures outlined below. On reaching maturity the grub works its way through the enlarged breathing holes in the skin, being greatly assisted in this by the numerous backward-directed spines on the segments, drops to the ground and seeks a shady location, and within a day turns into a hard, black, seed-like puparium incapable of movement. The length of time occupied in the pupal stage is much more variable than that of the larval stages within the host, since it is subject to temperature fluctuations and other vagaries of the climate. In the case of grubs that have matured early in the season it may extend occasionally to two and a half months, or, in warm weather, it may only amount to three weeks; the average pupal period is, however, about six weeks.



Fig. 41—Diagram showing life-cycle of the common cattle grub, *Hypoderma lineatum* de Vill. (redrawn after Bishopp, Laake and Wells).

Emergence of the adult fly is effected by pushing off the cap of the puparium, the insect crawling out and being able to take to the wing in half an hour. Sufficient food has been stored up during the grub stage for the development of the eggs, and no food at all is needed during the short adult life—in fact the mouth parts are degenerate and the adult insect is incapable of feeding. Mating takes place very early, and may occur within an hour or two of emergence. The fly is now ready for egg-laying, and it is during this process that cattle often become terrified and with upraised tails and terror-stricken eyes, run from their small tormentors. No really adequate explanation for this fear has yet been given since the flies are unable to inflict any pain. The buzz of the insect is, however, sufficient to start a stampede. Owing to its quieter habits and more cautious approach, this species is less feared than its larger and rougher relative.

THE NORTHERN CATTLE GRUB OR LARGE WARBLE FLY, *Hypoderma bovis* de Geer

As indicated by its common name this species is slightly larger than the small warble fly. The fore-part of the thorax is more densely clothed with a quantity of yellow hair which obscures the four lines or marks characteristic of the other species. The tail end is orange instead of red, and the legs are smoother and less hairy.

The large warble fly has been found to be as widely distributed in Canada and to be about as common, as the smaller species. Varying weather conditions may, however, cause seasonal fluctuations in the two species, and fine weather conditions during the egg-laying period of one species may cause it to temporarily predominate over the other. Greater abundance of one or the other may occur in some sections, due to prevailing fine weather during the particular period of egg-laying activity. We do not know of any farming districts in Canada where there is complete freedom from either of the warble flies.

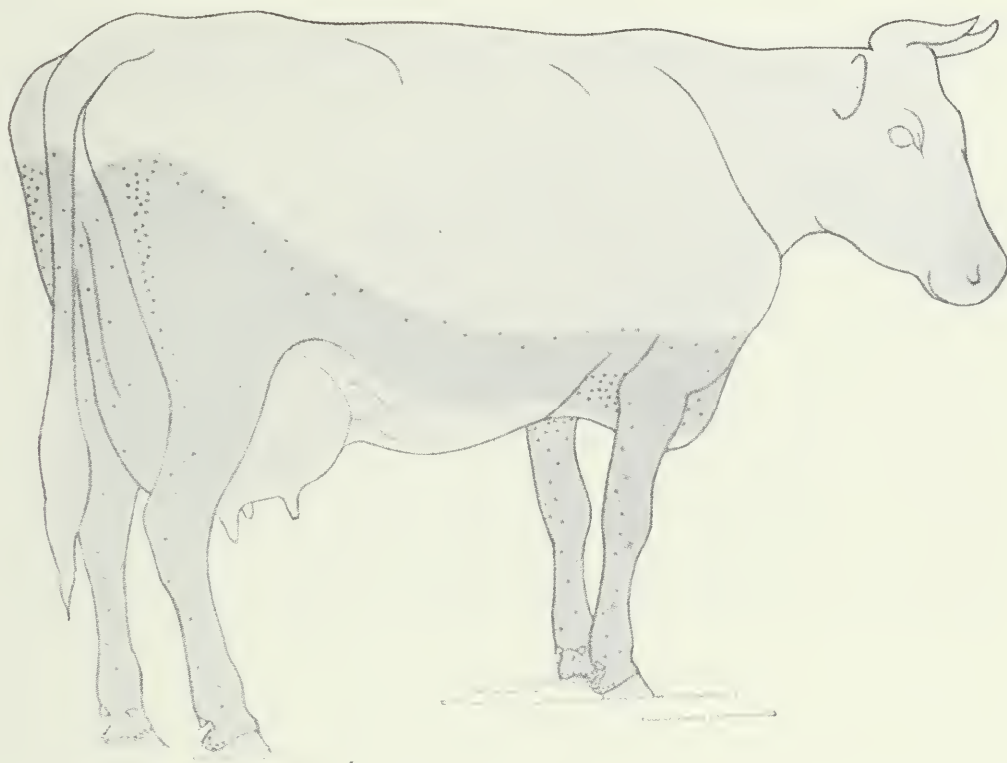


Fig. 42—The regions where warble fly eggs are deposited. The black spots indicate the places where most eggs have been found and the shaded parts the whole area where eggs may be deposited (after Hadwen).

This is a later developing species and adults are on the wing from early June until August, and are particularly annoying during July. Egg-laying activity is even more restricted to bright sunny days than in the case of the small warble fly, and the eggs are usually laid fairly high up on the legs. They are invariably placed singly on the hairs, and not in rows, as in the case of *H. lineatum*. Since an equally large number are laid, this results in a more frequent intermittent attack. This and the rougher behaviour of the insect explains the greater fear experienced by cattle when *H. bovis* is annoying them. The eggs take from four to seven days to hatch, and as soon as a larva emerges it burrows into the skin. Following the penetration of the newly hatched grub, swellings appear; but these are not so severe as those caused by the small warble fly, and only older cattle show them. Little is known of the movements of the larvae within the body, but this species does not appear to select the gullet region as a resting place for the second stage grubs. The migration to the back commences one or

two weeks later than in the case of the common heel fly, and the first grubs usually reach this position in February or March, and the period over which the grubs move to the back is longer and may extend to June. The time occupied by individual grubs under the back is also more extended than with *H. lineatum*, the average length of this period being seventy-two days, according to Bishopp. There is no difference in the position of the grub in the back or in the injury caused. The pupal period is not so long as in the previous species, as one would expect from the warmer weather conditions to which most of the grubs are subjected; the average length of this stage is one month. Egg-laying commences in June, about a week after the adults of *H. lineatum* have ceased their activities; it may continue until August.

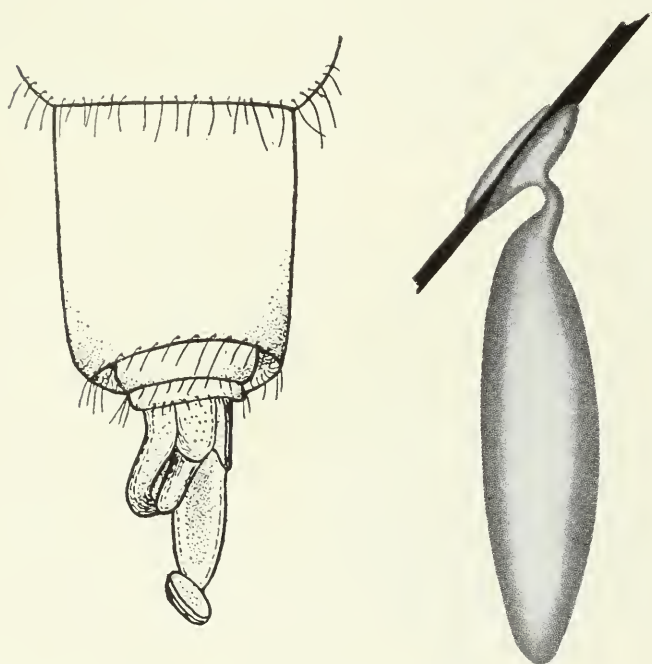


Fig. 43—Left, egg tube of *Hypoderma bovis* DeG., showing emergence of egg (after Carpenter and Hewitt); right, egg of *H. bovis* DeG., much enlarged, showing method of attachment to hair (after Hadwen).

Damage Caused by Warble Flies.—We have stated that warble flies constitute the most serious pest of cattle wherever they are common, but it is evident that even those well acquainted with the live stock industry seldom realize the full extent of the losses involved. Estimates by the United States Bureau of Entomology place the annual losses in that country at the enormous sum of from \$50,000,000 to \$100,000,000. In Great Britain the losses from damaged hides alone are placed at over \$2,000,000 a year, and in Canada proportionately large losses occur. Dr. W. E. Graham of the National Research Council in a recent extensive survey found that “at the very minimum, 50 per cent

of all Canadian hides taken off in 1930 were damaged by open or healed grub holes, and on this basis Canadian hides were worth \$700,000 less in finished leather than if they had been clear.” The total losses in Ontario have been stated by the Provincial Zoologist to be \$5,000,000 a year. We estimate that the losses from all causes attributable to warble flies throughout the Dominion are from \$7,000,000 to \$14,000,000, and in some seasons may even exceed the latter figure.

These losses are caused in a number of different ways and may be itemized as follows:—

(a) Damage occasioned by fright and worry of animals during the period of adult fly activity when egg-laying is taking place.

- (1) Reduction in milk yield and poor gains made by feeding animals due to worry and interference in grazing. The losses in milk yield from this cause are placed at from 10 to 25 per cent, depending upon the season and district.
- (2) Loss of time due to difficulty in handling range animals. Range-cattle owners find that their animals often become unmanageable during this period, and handling becomes extremely difficult, and, at times impossible, during daylight hours.

- (3) Physical injury to animals that have become frantic due to fly attacks. Animals will sometimes become bogged, or will seriously injure or even kill themselves, in their frantic efforts to escape the attacks of the flies.
- (b) Damage occasioned by grub infestation.
 - (1) Wastage and unthriftiness in infested animals. Few exact figures are available to indicate the losses due to large numbers of grubs in the back; but in one experiment recorded, animals kept free of grubs showed average gains of 34 pounds over untreated animals.
 - (2) Reduction in milk yield. Dairymen are generally agreed that milk production is reduced during the time milch cows are heavily infested with grubs in the back. This appears to be borne out by experimental evidence and a case has been cited where an increase of nearly 10 pounds was noted in the yield of a cow a few days after 80 grubs were extracted.

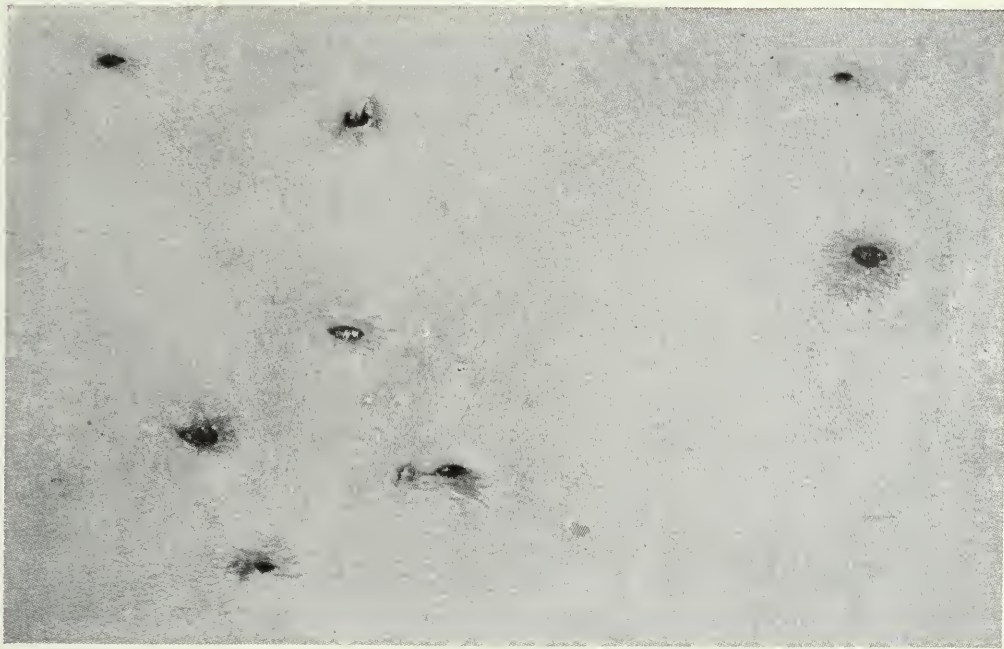


Fig. 44—Piece of leather showing damage caused by warble grubs (original).

- (3) Wastage of meat due to condition known as “licked beef.” In badly infested animals much trimming is necessary in the affected area in the back of the carcass, and such trimming often results in the wastage of as much as 2 pounds of meat in the location of the most valuable cuts.
- (4) Injury to hides. This is the most obvious source of injury and one of which a fairly accurate estimate can be obtained. In Canada the losses aggregate \$700,000 a year to hides according to Dr. W. E. Graham. This is doubtless a very conservative figure since Dr. L. Stevenson has placed the hide injury in Ontario alone at one million dollars. In Great Britain the losses are estimated to exceed \$2,000,000, and in the United States \$5,000,000 is the estimate given. Hide injury is caused in two ways: by the minute holes made by the newly hatched grubs in entering the animal through the skin; and by the larger perforations or breathing holes in the hide made by the grubs in the back. Even when healed the scars left affect the value of leather. The former are of comparatively slight importance, since the flanks and lower parts affected are the least valuable portions of leather. The holes in the back are much more serious, since if they are at all numerous,

the most valuable part of the hide is rendered worthless for most commercial purposes. About 30 per cent of all hides received throughout the year in Canada show grub injury, and during the grubby season, from January to June, 50 to 60 per cent of all hides taken off are grubby and are docked to the extent of from one to two cents a pound, even if only a few holes are present; this often means a decrease of one dollar a hide. Even those hides not taken off in the grubby season may be reduced in value, since Stevenson has found that 60 per cent of all hides show scar-tissue areas where the grub holes have healed over. Some tanners have stated that 95 per cent of all hides show some trace of grub injury. This renders the leather inferior for many purposes. While many of the larger hide dealers in Canada make an inspection of hides and classify them according to number of grub holes and so forth, it is a general trade custom among most smaller dealers to place a blanket dockage on all hides received during the warble season. Hide and leather dealers in England have secured a reform in marketing practice whereby hides clear of warble holes are given a premium on the market amounting to about 34 per cent. This is an inducement to control warble grubs and could be followed with advantage in Canada.

- (5) Injury through attacks of magpies and blow flies. Another source of injury, which is indirect and is only occasionally of any importance, is the attacks of magpies on the backs of cattle infested with grubs. A slight sore on an animal will sometimes prove sufficient incentive for persistent attacks by these birds, and the resulting wounds may even cause death. The birds are particularly plentiful in the foothills and ranges of Alberta, and we have been informed by ranchers that grub-infested cattle are sometimes subject to serious attacks by these birds. Occasionally blow-flies will be attracted by the pus-exuding holes left at the exit of the grubs from the back and maggot infestation may occur.
- (6) Anaphylactic shock. Warble grubs contain a substance which is very poisonous to cattle if injected; and when grubs break, through an animal getting under a fence, or through careless extraction of grubs as a control measure, a remarkable reaction may take place in the host animal and death may even ensue. "Cattle froth at the mouth, the skin becomes wrinkled, especially around the eyes and anus and there is diarrhoea and shortness of breath" (Hadwen). The attack is one of remarkable suddenness, but if not fatal, usually subsides fairly quickly. Dr. Graham-Gillam, secretary of the British Columbia Veterinary Association, who has had considerable experience in the treatment of anaphylactic shock, has supplied information regarding a simple treatment for animals suffering with this condition. A drench of one quart of lime water should be given slowly. The draught may be repeated in two hours, but this is seldom necessary. Local relief may be effected by sponging the swollen parts of the animal with a lotion composed of one tablespoonful of baking soda in a quart of cold water. It is always advisable to call in a qualified veterinarian directly any symptoms of anaphylaxis are noted, but the above treatment is mentioned for the benefit of those living in districts where qualified veterinary practitioners are not available.

Warble Fly Control.—The complete eradication of warble flies, at least from restricted areas, is not merely a theoretical possibility, but has actually been demonstrated. Absolute freedom from this pest was attained in Clare Island, Ireland, after five years of systematic control work. This demonstration was a comparatively small one involving only about 400 head of cattle, and was carried out under nearly ideal conditions, but larger scale demonstrations in

Canada, England, Germany and Denmark, have shown that very material reduction in warble damage is quite feasible. In the latter country compulsory control legislation was enacted in 1923. In the previous year 29·5 per cent of all hides were grubby, but after three years' operation of the Act grubby hides were reduced to 2·5 per cent and complete eradication was anticipated through continuance of the control measures employed. In Great Britain an order of the Ministry of Agriculture and Fisheries, dated January 31, 1936, requires that every person in England, Wales and Scotland having possession, or charge of, visibly infested cattle, shall take prescribed measures to destroy the grubs. The organized application of control measures in Canada has been developed to some extent in recent years, particularly in Ontario, and restricted areas in Quebec and British Columbia, with strikingly effective results. An account of this work has been published by Gibson and Twinn.*

Reduction of warble fly damage may be effected in a number of different ways. The housing of animals during the daytime or the provision of darkened sheds or brush shelters, as previously described under care of stock in fly time (see p. 9), will greatly reduce grub infestation, as it protects the cattle from the egg-laying activities of the flies. If shelters are available the cattle will make for them the minute warble flies appear. At a large western bull sale it was noticed that only one lot of animals was free from grubs. Enquiry from the owner elicited the fact that these animals were invariably housed during the daytime and were turned out for grazing and exercise only at night. At one of the western Experimental Farms, certain dairy animals on "Record of Performance" tests, which never left the cow barns, were noted to be the only members of the dairy herd completely free from grubs. Access to sloughs and shallow stretches of water also provides some protection since the flies will not molest animals standing in water.

Many live stock owners rely implicitly on the application of repellent dressings or "fly dopes" to their stock as a protection against warble fly trouble, but experimental work has failed to substantiate the practical value of any known repellents in this respect, and the following extract from a pamphlet issued by the British Ministry of Agriculture and Fisheries indicates the general impression among scientific workers regarding the efficiency of such treatment: "There is no evidence that the various washes and smears commonly recommended for use in summer are of any value in preventing flies from laying their eggs on cattle." The futility of such a method may be realized when the long period of adult activity is taken into consideration. Adult flies are on the wing during the spring and summer for at least 16 weeks, and even the best of repellents requires to be applied as frequently as twice a week. This would necessitate 32 applications, whereas complete killing of the grubs can be secured by four or five inexpensive dressings that are of little or no more trouble to apply than are the repellents. In any case the flies, especially the larger species, are so quick on the wing and strike so rapidly that there is little chance of "fly dopes" repelling them. The mere buzz of the insect causes worry and uneasiness in the cattle and no repellents can stop the flies from buzzing around them. The partial immunity against grub infestation acquired by mature animals is often lost sight of by those who claim good results from the use of fly dopes. Usually milch cows are the animals sprayed, and subsequent comparison with young animals that are running out will show many more grubs in the latter, and give the impression that spraying is beneficial. Actually no real comparison can be made between these two classes of stock. The younger animals have not yet acquired resistance and, also, usually lack the partial protection afforded the cows which are housed during part of the day.

Since development of warble grubs is almost entirely restricted to cattle, and since the grubs are in an accessible position in the back for some time during

* Sci. Agric. Vol. XVII, Dec., 1936.

a definite seasonal period, it is evident that this is the weakest spot in the whole complicated life-cycle. At no other period can the insects be so easily controlled. Hand extraction is a method that has given remarkably good results where systematically undertaken. In the case of such soft-skinned breeds as Jerseys and Guernseys, squeezing out grubs by pressure of the fingers around the cysts is not a particularly difficult matter, but with tough-skinned animals, such as Holsteins, this is an extremely laborious undertaking that would have but little chance of general acceptance under ordinary Canadian farm conditions. Enlarging the aperture with a sharp knife has objectionable features, but the use of special forceps for this purpose is of great assistance. The herd should be gone over when the grubs first appear, in January in most districts, and the process repeated five or six times at intervals of not more than 30 days. If a grub breaks, the cyst should immediately be washed out with dilute disinfectant to avoid danger of anaphylactic shock. It is quite erroneous to believe that grubs can only be removed when they are fully developed or "ripe."



Fig. 45—Warble grubs: lower figures, normal plump grubs from untreated cattle; upper figures, blackened and shrivelled dead grubs from cattle treated with derris soap wash (author's illustration).

To obviate the difficulties involved in hand extraction, experiments have been undertaken in many parts of the world to find materials that would kill the grubs in the back without injuring the host animal, and this method has of recent years been very strongly advocated; a number of washes, ointments and powders have been discovered which will accomplish these results. The United States Bureau of Entomology undertook detailed tests of two or three hundred substances in this connection and there is no lack of effective materials. Their multiplicity, however, is apt to be confusing and the following criterion should be applied to any substance used: it must have good killing properties and should destroy at least 80 per cent of the grubs present; it should be harmless to the host animal, and for dairy cattle, be odourless, so that there may be no danger of tainting milk; it should be in a form that ensures cheap and easy application, and should be inexpensive; it should also either be procurable ready for use or at least involve no complicated or slow process of preparation. Keeping-qualities when mixed are also of some importance.

Fortunately there are several materials that meet these qualifications, the most promising being an insecticide known as derris. Derris as a wash has proved effective in large scale experiments in several countries, including Canada.

Preparation and application of the derris wash is fairly simple, the quantities of material being as follows: standardized derris powder one pound, soft soap one-quarter pound, water one gallon. The soft soap is boiled in a quart of water,

and when cooled a little is poured into the derris powder in a bucket and mixed into a paste. Cold water and the remainder of the soap solution are then added slowly while stirring, to make up one gallon, and the mixture is ready for use. Standardized derris warble fly powders ready for use are sold commercially. Before application the derris wash must be agitated frequently to ensure a good mixture. Although the keeping-qualities are good, if the liquid is placed in a well-stoppered container, it is advisable to prepare only sufficient for immediate application. Where infestation is heavy, the wash should be liberally applied to the backs of the animals with a soft cloth or a worn stable brush, care being taken to completely cover the area affected by the grubs. In many cases, however, it is more economical to pour a little derris wash from a bottle on to each cyst, and to rub it in with the fingers. In the case of animals that are not stall-tied, a crush or dehorning shute is an aid to handling and treating them.

The date for the first application of the derris wash, varying in different parts of the Dominion, is in early spring when the swellings in the backs of the animals caused by the grubs first become conspicuous. In the interior of British Columbia this treatment is given in mid-February; in the Prairie Provinces and Eastern Canada, about the third week in March. The second and third applications are made after intervals of 28 days, and the fourth after a further interval of about 35 days. A fifth dressing 35 days after the fourth is necessary in milder regions such as the interior of British Columbia, where the first application is made in mid-February. The intervals between the third and fourth, and fourth and fifth dressings are longer than between the preceding ones in view of the longer period of larval development of *Hypoderma bovis*.

With regard to the treatment of beef herds for *H. lineatum*, during winter and early spring, the main objection of many ranchers is that working cattle through a chute endangers the calf crop. In our experience these fears are baseless. Ice is a more serious menace, but the danger to stock from slipping may largely be overcome by sanding the yards. The April treatment can be combined with dehorning, if this is practised.

Concerning the treatment of range beef cattle for *H. bovis*, a difficulty arises in the fact that most of the stock are on the range at the time the treatments should be made, that is, in May and June, and rounding them up would entail prohibitive expense. Experience indicates, however, that where range cattle are properly handled and are moved back to higher ranges as the lower ones dry up, they leave behind them on the lower ranges any grubs that may drop, and thus avoid infestation from the resulting flies.

While the reduction of warble flies still offers certain difficulties in the case of range animals, the above control measures in general farming and dairy districts would greatly reduce or even exterminate the pest, if generally undertaken on a community basis, as has already been fully demonstrated.

CARIBOU WARBLE FLY, *Oedemagena tarandi* L.

The warble fly affecting caribou is yellowish-orange in colour and has a bee-like appearance. Adults first appear in late June, and are on the wing until September, the egg-laying period occupying about three months. This fly is widely distributed over the range of the host animal, and is common both in northern Europe and in northern areas of the American continent. That it extends to the southern limits of its host is evident from wild mountain caribou hides showing typical injury obtained less than 100 miles north of Kamloops, British Columbia.

The life-history resembles that of the warble flies of cattle, eggs being laid on the under hair, principally on the parts touching the ground when the animal is lying down. On standing animals, eggs are mainly laid in the region of the stifle joint behind, and the elbow in front. From six to ten eggs may be placed in a row on a single hair, and each female is capable of laying 500 or more eggs.

The larvae, which hatch in about a week, penetrate through the skin and migrate directly to the back where they cut breathing holes. The earliest grubs bore through the back in September and development proceeds until May when the first grubs drop to the ground and pupate. Grubs continue to drop throughout June. Pupation is complete within two days and the pupal period lasts about a month.

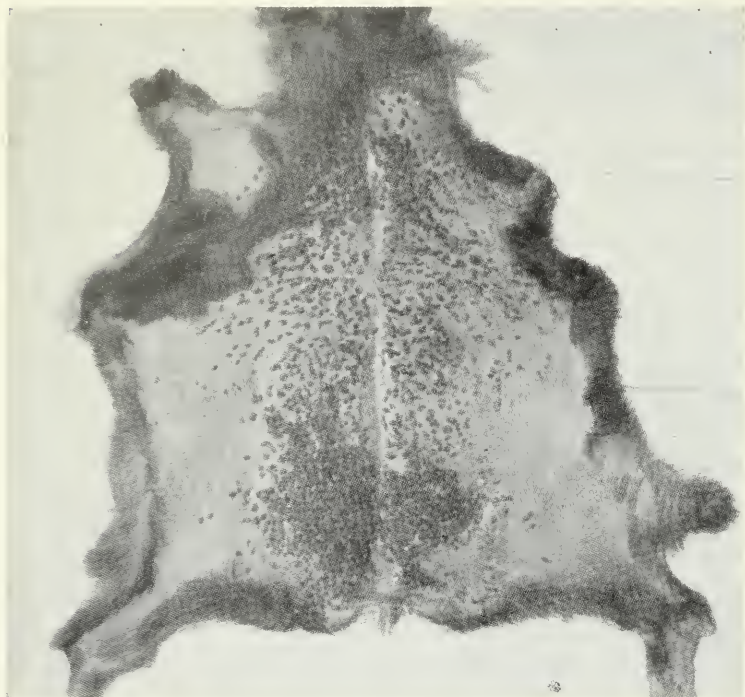


Fig. 46—Caribou hide showing about 1,000 grubs of the caribou warble fly, *Oedemagena tarandi* L. (after Hadwen and Palmer).

Injury resulting from caribou warble flies is very similar to that caused in cattle by heel flies. The animals become very uneasy and run or mill around when the flies are egg-laying. Extensive infestation may affect the health of the host, and the leather is, of course, ruined by the apertures in the skin. As many as 1,000 grubs have been counted in the back of one animal (see fig. 46). Severe pus-exuding abscesses and even sloughing of the skin sometimes result from bacterial infection following the penetration of the newly hatched grubs. Serious injury sometimes results from infestation by the maggots of a blow fly (*Protophormia terrae novae* Desv.) at the time the fully grown

warble flies are ready to leave the host. The openings are large at this time and the pus attracts the flies for egg-laying. Animals frequently die from such infestation.

In view of the suitability of arctic and subarctic Canada for the establishment of an extensive domestic reindeer industry, and of the fact that the Dominion Government has taken active steps with a view to fostering the industry, and in 1929 purchased 3,000 head of Alaskan caribou for this purpose, the control of this and of other insect pests of caribou is of considerable interest and importance. A practical method advocated by Hadwen consists of the moving of all caribou herds at least fifteen miles at the beginning of July, by which time most of the grubs have dropped and very few adults are yet on the wing. The provision of darkened shelters is also of value. Squeezing out grubs is a comparatively easy matter since the apertures are large, the grubs are comparatively tough, and the skin of caribou is thin, soft and pliable. The removal of grubs is particularly necessary if there is danger of screw-worm infestation. It should be undertaken in April and May, as the apertures in the back will then have time to heal before the blow-flies appear.

Warble Flies Affecting Rodents

The grubs of very large flies belonging to the warble fly family are often quite common in wild rodents, and sometimes affect dogs and cats. Their status as a controlling factor of rodent pests has not been ascertained, but since as many as seventeen of these large larvae have been found in one rat they may have some economic value when they are abundant. At least seven species are known to occur in Canada, two of the commonest being *Cuterebra tenebrosa* Coq.

and *Bogeria grisea* Coq., the former a very large shining blue-black species, and the latter a smaller grey and black fly. A variety of hosts have been recorded, ranging in size from mice to dogs. Complaints have been received from Vancouver Island of similar grubs affecting poultry, and Dr. E. A. Bruce records grouse being affected in the same way. Young mink were seriously affected on two fur farms in central British Columbia and the owners stated the animals would have died had not the grubs been removed. Unfortunately, in none of these cases are specimens or definite identifications available. Stock men who notice these grubs often wonder if they are not the same as the warble grubs of cattle.

The adult flies are very large and some species measure nearly an inch and constitute the most bulky members of this order of insects occurring in Canada. Some are entirely dark with shining blue-black bodies, while others have yellowish areas on the head, thorax and tip of the abdomen. The grubs when well developed are black and are provided with numerous small spines on the segments. They may attain an inch in length and have a marked resemblance to the grubs of heel flies.

Adults are found during the late spring and summer months, but are not often noted since they have secretive habits and prefer dark places such as outbuildings and the ground burrows of rodents. Little is known of the life-history, or the means by which the larvae enter the host, but the larvae live under the skin in various locations and bore a breathing hole as do the warble grubs of cattle. In some cases they have been known to emasculate squirrels. When fully developed, or on the death of the host, the grubs work their way out, bury themselves, and pupate within two or three days. In the majority of cases we have noted, the larvae reach full development in the late summer and autumn. The pupal period is long and in one case reported, lasted ten months.

Eggs of *C. tenebrosa* are known to be viable for at least two months or more, during which time they hatch intermittently. The newly-hatched larvae will live for over a week without a host. These observations suggest that the eggs are laid in places frequented by rodents. In all cases coming under the observation of officers of the Kamloops, B.C., laboratory, the grubs were found to have no well-defined cysts, but were embedded in the muscles of the host. For this reason, removing the grubs by forceps or other mechanical means is preferable to killing them in the flesh, as is done with cattle warbles, which have strong cysts.

THE SHEEP BOT FLY, *Oestrus ovis* L.

This is a medium-sized, greyish fly, measuring about one-half inch. The thorax is yellow in ground colour, but is covered with small dark nodules and there are four indistinct stripes. The abdomen is velvety with white and dark reflexions, and has a number of irregularly-dispersed black spots. The insect has a slightly hairy appearance. When attacking sheep for the purpose of depositing larvae, it is extremely active and quick on the wing, but otherwise is sluggish in habits.

Distribution is very general, and this fly is known to occur in almost every sheep-raising district in the world. It is found in all parts of the Dominion, and wherever abundant, constitutes one of the major pests of sheep.

The flies first appear in late May, and the period of adult activity may continue until August or even later, although June and July are the months when the flies are most noticeable. They attack sheep mainly during the heat of the day and are quiet in the early mornings and evenings. Eggs hatch in the body of the female fly, and the minute white grubs, measuring only one-twentieth of an inch, are deposited in the nostrils of sheep. One fly has been observed to deposit as many as sixty grubs in the nostrils of a sheep in an hour. Goats are also attacked to some extent and human cases are recorded where

larvae have been deposited in the eye. The larvae, often referred to as sheep nostril maggots, are provided with a pair of black, claw-like hooks at the head end, and there are numerous backward-directed spines on each segment. By the aid of these they move up the nasal passages, causing severe inflammation.



Fig. 47—The sheep bot fly, *Oestrus ovis* L., enlarged and natural size (original).

They finally come to rest in the nasal sinuses above the eyes, where development is completed in about ten months after the larvae are first deposited. They feed on the mucus in the nasal passages and are stated to sometimes attack the tissues. The colour changes from white to yellowish and finally becomes quite dark. On attaining full growth, the grubs, which now measure four-fifths of an inch, return to the nasal passages, and are sneezed out to the ground. They are quite active and seek protection in the earth or under debris. In two or three days they have contracted and hardened into black seed-like objects.

The pupal period ranges from three weeks to two months, but averages about six weeks. The flies mate shortly after emergence and quickly commence depositing larvae. The mouthparts are degenerate and no food is taken by the adults, which are short lived. While the flies are at times extremely swift in flight, they are restricted in their movements and do not spread far from the place of emergence.

Injury is caused to sheep both by the worry occasioned by adult flies and by the effect of the parasitic grubs on the health of the animals. Sheep become terrified when the loud buzzing flies approach them and commence depositing larvae. They bunch tightly together with heads inward and held close to the ground; or they may



Fig. 48—Mature larva of the sheep bot fly, dorsal and ventral views (original).

run frantically to and fro with the head down, and suddenly push their muzzles against the soil. When a fly touches the nostrils sheep often shake the head violently and give vent to their uneasiness by striking with the front feet. The tickling sensation of the larvae on the delicate membrane of the nose causes them to rub that part against their fore feet, on their fellows, or on the ground. This worrying is most noticeable in the heat of the day when the flies are active.

There is considerable variation in the number of grubs found in an animal, but usually from five to ten may mature in the sinuses. Cases have been recorded, however, where more than sixty were noted in the nasal passages and cavities. The grubs with their strong mouth-hooks and spined bodies cause great irritation when moving in the nasal passages. At first there is a clear discharge, but following bacterial infection, this becomes thickened and yellowish and a catarrhal condition, known to sheep men as "snotty nose", soon develops. This interferes with the breathing, which is further complicated by the thickening of the nasal membrane. When the sinuses are invaded, serious irritation and infection are set up in these places. Frequent sneezing and distressed breathing are characteristic symptoms. The eyes become inflamed and the animal may step high and stagger about with the head held in the air. The symptoms of



Fig. 49—Sectional diagram of sheep's head showing the presence of maggots or larvae of the sheep bot fly (adapted from Curtice).

vertigo should not be confused with "gid" caused by the larval stage of a dog tapeworm (*Multiceps multiceps* Leske) on the brain. In the case of grub in the head there is none of the constant circling characteristic of an animal suffering from "gid." The grubs of nostril maggots are unable to penetrate through the bone into the brain in spite of the popular belief to the contrary.

Preventive Measures and Remedies.—Prevention is particularly necessary with this pest since little reliance can be placed on remedial measures, once the nasal passages have become infested with the grubs. "Rapid rotation of pastures is always good policy with sheep and with range flocks; it is often possible to drive them long distances away from the place where the grubs have left them. As it takes some weeks for the grubs to turn into flies the flock may be too far away for them to find" (Hadwen), since the short life and usually sluggish habits of the flies preclude extensive spread. In the mountain sections of British Columbia and Alberta, the moving of sheep to high mountain pastures in late May or early June has a marked effect in reducing trouble from this insect, since the sheep do not return to the winter range until the autumn,

when the period of adult fly activity is over. It has been noted that sheep having access to dense clumps of bush are less affected than are those in open fields, where there is no such protection from the flies; hence, an excellent safeguard for small farm flocks is to provide them with darkened sheds with curtains hung over the doorways to exclude light. The sheep will make for these at the first onset of the flies and will escape a great proportion of the infestation that would occur if such protection were not provided.

Dressings of pine tar on the nose of the sheep to prevent larvae from being deposited is an old method that has much to recommend it. The first application should be made thoroughly by hand at the earliest appearance of the adult flies, usually in late May; in small flocks, weekly applications are generally quite feasible. In the case of larger flocks the sheep can be made to tar themselves if provided with special salting troughs. A series of 3-inch holes should be bored in cedar logs and these should be filled with salt. Pine tar should be smeared around the holes often enough to retain a sticky surface.

Strips of furrows ploughed in a field are of some value as the sheep are able to secure some protection by putting their noses into the soft earth.

Remedies after infestation has occurred are of comparatively little value, especially after the grubs have reached the sinuses. A feather dipped in benzine or turpentine, pushed as far as possible up the nostril and given a quick turn before being drawn out may reach some of the grubs that are still in this location, and the stimulation of mucous secretion and sneezing caused by the substances introduced may dislodge grubs and give a little relief. Such measures at the best, however, are a very poor makeshift for prevention.

Nostril Maggots in Goats.—The sheep nostril maggot affects goats to a certain extent, and in parts of Asia these animals constitute the main hosts for another closely allied, but distinct, species. No information is available to indicate the amount of infestation of goats by these pests in Canada; but in view of the fairly dense goat population in some districts of Vancouver Island, owners of these animals should keep a close watch for symptoms of nostril fly trouble, and, if they are noted, should undertake the preventive measures outlined above.

THE CARIBOU NOSTRIL FLY, *Cephenomyia trompe* L.

This dark bee-like insect constitutes one of the major insect pests of these valuable domestic animals of the northern barren lands. Infestation is very general throughout the range of the caribou in Europe and America. The adult flies are on the wing from June to September. Each female is capable of producing about 500 larvae. The grubs are deposited in the nostrils and work their way back and attach themselves in front of the entrance to the throat. Development is slow until March when it becomes much accelerated, the grubs attaining full growth in May. They drop to the ground and pupate in about six hours. The pupal period is from two weeks to a month.

Injury from this pest is caused by the fear induced in the animals when the flies are depositing grubs; irritation in the nasal passages during the movements of the young larvae (although this is stated to be much less marked than in the case of the sheep nostril maggot), and suffering and annoyance to the host when the grubs are mature or nearing full growth. The animals elevate their heads and continually sniff and cough in an attempt to dislodge the grubs. Death from suffocation sometimes results from heavy infestation, and as many as 130 grubs have been noted in the nasal passages and throat of one animal.

The provision of darkened shelters appears to be a feasible preventive measure, but, as Hadwen states, in the arctic latitudes the insects are at work the greater part of the twenty-four hours, and during the hotter weather the animals might get little chance for feeding. Moving the herds frequently, helps to reduce infestation.

Nose and Throat Maggots of Deer and Elk

Several species of dark bee-like flies affect deer and elk in much the same manner as the caribou nostril maggot affects that animal. The nasal passages and the throat pouches sometimes become infested with large numbers of the maggots and as many as 64 grubs have been noted in one animal. The habits and life-history appear to be very similar to those of the sheep and caribou nostril flies. While identifications have not been made of the species found in Canada, *Cephenomyia pratti* Hunter is in all probability the commonest one. These flies have a very wide distribution and undoubtedly are a serious pest to the large game animals they affect; but since the grubs are large and mainly noticeable during the spring months, and are not so much in evidence during the fall hunting season, information as to the amount of damage caused is somewhat meagre. During the spring of 1930 reports were received from widely-separated points in British Columbia, of deer and elk having been found in a weakened and dying condition from these parasites. Mr. Bryan Williams, Game Commissioner for British Columbia at that time, stated that fatalities among deer from throat maggots had been reported by game wardens and others in both the interior and coastal sections of the province. This pest has also been blamed for the destruction of the majority of about 150 semi-tame deer on one of the small islands off the British Columbian coast. The death, from this cause, of large numbers of deer has been reported from Colorado and elsewhere in the United States.

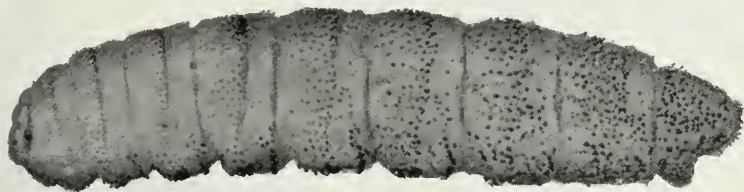


Fig. 50—Throat maggot of deer. *Cephenomyia* sp., much enlarged (original).

It is possible, as suggested to the writer by Dr. S. Hadwen, that other conditions, such as starvation, may have been the primary cause of death in the cases reported, and the presence of the maggots merely incidental, but the game wardens and others making the reports seemed satisfied that the throat maggots were wholly responsible. Dr. E. A. Bruce states that these parasites "perhaps are responsible for more deaths than is generally supposed." Careful investigations would be of interest to ascertain the exact rôle of this pest in the destruction of deer.

Blow-Flies or Screw-Worms

A number of common flies, normally breeding in carrion, will sometimes "strike" living animals if suitable conditions occur and the maggot infestation, known as myiasis, may result in sufficiently severe injury to cause death.

Many of the metallic blue or green blow-flies commonly occurring throughout Canada have been incriminated in other parts of the world, but as a general rule only a very few species cause trouble in this respect in the Dominion. The majority of our dozen or more common species should, however, be regarded with suspicion as potential sources of danger, in view of the change in habits from a scavenging to a parasitic life, which has caused some formerly harmless blow-flies to develop into the worst insect pest known in the Australian sheep industry.

Identification of maggots and reared flies from a number of cases of myiasis in cattle and sheep in Western Canada, indicates that the black blow-fly, *Phormia regina* Meig., a dark metallic-blue species is almost invariably the culprit in many districts. In the East a larger, blacker and more hairy species, *Calliphora vomitoria* L., is stated to be troublesome; and in sub-arctic areas a small dark-blue species, *Protophormia terrae novae* Desv., resembling the black blow-fly, is stated by Hadwen to be a source of injury to the herds of domestic caribou.



Fig. 51—The black blow-fly, *Phormia regina* Mgn., enlarged and natural size (original).

The metallic-green English sheep-wool maggot-fly, *Lucilia sericata* Meig., and another of much the same appearance, *L. caesar* L. are other familiar flies that are liable to cause trouble. Maggots of the grey striped flesh-flies *Sarcophaga* spp., are also occasionally found in wounds, and Dr. E. M. Walker has recorded a number of cases of human myiasis caused by *Wohlfahrtia vigil* Walker, in Ontario. The southern screw-worm *Cochliomyia macellaria* Fabr., occurs in Canada, but fortunately little injury has so far been noted from it in this country, although in parts of south-west Texas it is so formidable a pest to the stock industry that ranchers are stated to be unable to raise calves, and are obliged to import yearlings and older animals for grazing.

There is great similarity in the life-histories of these flies, and that of the black blow-fly will serve as an example. The female fly may lay as many as 500 yellowish-white eggs, these being deposited in clusters of twenty or more in soiled wool or in wounds. Old festering sores especially attract the flies, but we have noted eggs on clean freshly-made cuts. Pus-exuding holes from warble

grubs both in cattle and caribou sometimes become fly-blown, and form the main point of infestation in the latter animals. Maggot injury is particularly liable to follow tick attacks, and in an outbreak recently investigated in British Columbia, over sixty-five steers were "struck" in a herd that was heavily infested with ticks. Tick paralysis was a direct contributory cause, since the steers in struggling and falling had loosened the scabs resulting from dehorning, had squashed engorged ticks, and had so cut and bruised themselves that they became infested with thousands of maggots. In very warm weather the eggs may hatch in less than a day but under colder conditions hatching may be retarded for several days. The elongate, segmented, white maggots are blunt at the hind end, but taper sharply at the head end, which is provided with a pair of small hooks adapted to tearing tissues. They exude a slimy liquid from the mouth which liquefies the flesh and enables them to obtain nourishment for their very rapid development. Growth may be complete in less than a week during warm weather, but may extend to double this period, the entire life-cycle occupying from three weeks to more than a month. Under Canadian conditions there are probably six or more broods in a season. On reaching maturity the maggots drop to the ground, contract and turn into brown, ovoid, barrel-shaped objects. The pupal period is usually longer than the larval period, and may extend from one to three weeks. In the last fall brood the pupal period is much extended, as it is mainly in this stage that the winter is passed, although adults are also known to winter over. Adult flies may live for a month or more, and commence egg-laying about a week after emergence. Experiments undertaken in Australia and elsewhere indicate that blow-flies can spread with ease to a distance of at least ten miles. Unlike the southern screw-worm, the black blow-fly can withstand fairly cold temperature and is on the wing during the first mild weather in spring. Numerous cases of "struck" sheep and cattle have been noted in British Columbia as early as the first week in April, but from late April to June is the main period for this trouble to develop. It is much less apt to occur during hot, dry, summer weather, but may recur towards fall.



Fig. 52—Larvae and pupae of the black blow-fly, *Phormia regina* Mgn., enlarged (original).

Injury, Losses and Symptoms.—Two forms of maggot injury may be recognized. Maggots may infest wounds, or, in the case of sheep, may occur in soiled wool. If wool maggots are not treated promptly, underlying healthy flesh may be invaded. Any operations such as dehorning, castrating, branding, docking and the like may result in maggot infestation if not undertaken at a time when the flies are scarce and inactive. Calving and lambing time constitute particularly dangerous periods, and when sheep are first turned into succulent pasture in the spring, they are apt to develop "scours" and fall victim to maggot infestation. Internal parasitic worms are of some importance in this connection since heavy infestations of these worms often result in severe scours, even if the sheep are on scanty pasture or dry feed. The influence of tick attacks and the presence of pus-exuding warble holes are also important factors. Cuts in shearing, wounds caused by barbed wire, injuries from the horns of other animals or attacks of magpies may all lead to maggot infestation, resulting in permanent injury or even death. Weather conditions have a marked influence on the amount of fly trouble, mild humid days with passing showers being especially conducive to egg-laying. Moisture on sheep is an attraction to blow-flies, and trouble seldom develops during very dry weather, except when the animals scour.

In warm countries, such as Australia and Africa, blow-flies constitute the worst pests affecting the sheep industry and exact a toll amounting to millions

of dollars annually. The losses to the live stock industry in the United States are placed at \$5,000,000 a year. Fortunately, in Canada the financial losses are much less extensive, but are quite serious in some seasons when weather conditions are especially favourable.

“Struck” animals, especially sheep, show rather marked symptoms and evince irritation and uneasiness, stamping the feet and biting the site of infestation. Sheep constantly wag their tails. Later the animals become listless and disinclined to feed, and have a tendency to separate from the flock and hide away in secluded places.



Fig. 53—Sheep with myiasis in hind quarters caused by maggots of the black blow-fly, *Phormia regina* Mgn. (original).

Preventive Measures.—Prevention consists of the following:—

- (1) Reduction of blow-flies liable to cause myiasis by destroying carrion and trapping or poisoning the adult flies.
- (2) Modification of farm practice to reduce the chances of infestation.

(1) All the flies liable to cause myiasis in live stock in Canada are primarily carrion breeders and the destruction of all carrion by burning is a measure of first importance. A narrow trench should be dug and a good wood fire built in this. Carcasses placed on iron bars over the trench can readily be destroyed. It has been estimated that the carcass of one cow can breed 1,000,000 flies, and 42,000 flies have been reared from one sheep. Since one dead animal can provide flies for a radius of at least ten miles, the importance of proper disposal of carrion is self-evident. Burial is not very satisfactory since maggots can ascend several feet through the soil when ready to pupate. If this method must be resorted to, liberal use should be made of quicklime, burial should be deep, and the soil should be well tramped down. If neither of these methods is feasible, the carcass should not be left in a moist or shaded location, but should be dragged to a dry open place, where the action of the sun and wind will dry it and reduce fly breeding. A thorough soaking of the carcass with coal-tar-creosote oil will effectively repel flies from it.

Various types of fly traps have been successfully utilized to reduce the number of blow-flies on stock farms. Bishopp's fly trap mentioned in the section on houseflies (see p. 16) is of considerable value, but the improved African trap made from two gasoline or kerosene tins has proved more efficient than other types. One of these traps caught more than a quarter of a million flies in three months. Construction is fairly simple as will be seen by the accompanying cut. Gut slime from abattoirs, or liver, are good baits, but vermin such as groundhogs may be utilized: they should be split open. One of the best baits consists of dessicated egg powder (as used by bakers) three ounces, and one teaspoonful of baking soda, mixed in a quart of water, to each bait tin.

Poisoning is very effective but should be undertaken by methods that eliminate danger to dogs and other animals. A 40-gallon oil drum cut in half lengthwise will make two troughs. Heavy wire



Fig. 54—Blow-flies breed in dead animals and other carrion. As many as a million may develop in the carcass of one cow (original).

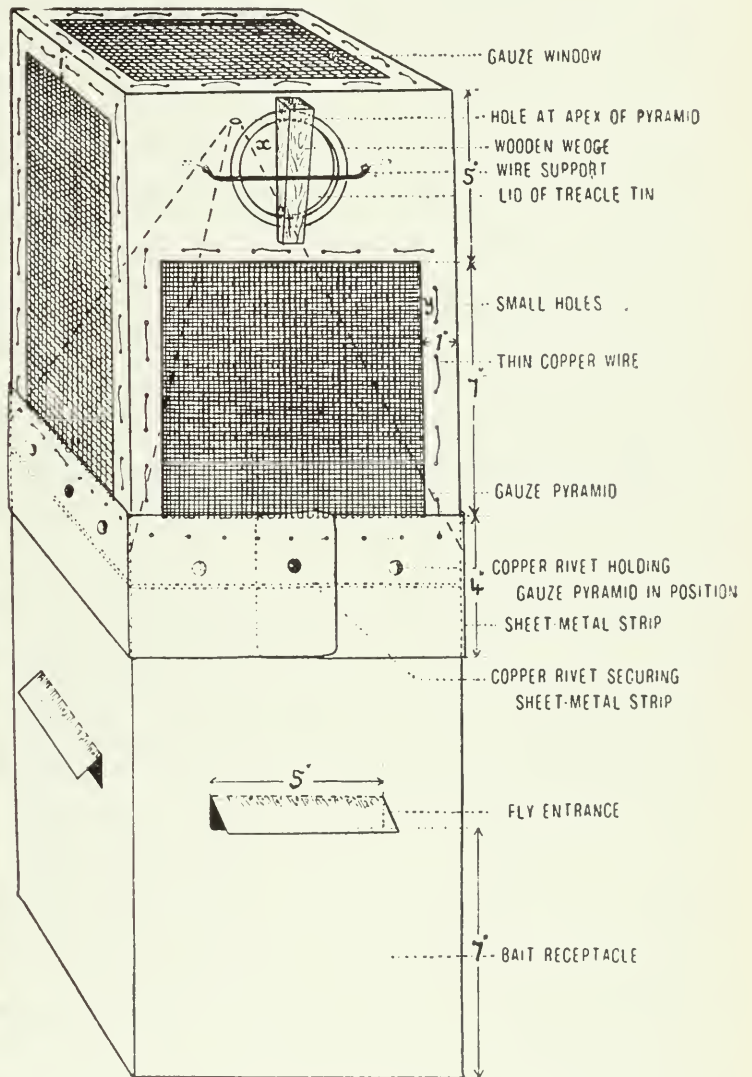


Fig. 55—Improved African fly trap (after Smít).

netting should be tightly fastened over the top of each trough. These are partly filled with a solution of arsenite of soda at a rate of two ounces for each four gallons of water, sweetened with two pounds of cheap sugar. Carrion such as dead sheep and the like are placed on the wire screen and flies are attracted for egg-laying. They almost invariably feed on the sweetened liquid and are poisoned. Maggots developing in the carcass drop into the liquid below and perish.

(2) There are many ways of modifying farm practice to reduce danger of maggot infestation. Operations on animals such as castrating, dehorning and branding should be carried out either very early in the spring or late in the fall. Sheep should be sheared as early as possible and all cuts dressed with repellents

such as oil of pine tar. Care should be taken to keep animals in as clean a condition as possible, and sheep should be crutched early, ewes being especially carefully dealt with prior to or immediately following lambing. The wool and tags should be clipped away to well above the tail on each side of the breech and down the back of the legs to the hocks. Animals should not be given too sudden a change to green succulent feed from dry winter fodder or they may develop scours and be liable to fly attacks. Rough handling should be avoided since small cuts and wounds may assume serious proportions if fly-blown. Measures to reduce ticks and warble grubs are of value in lessening dangers from fly-blow. The health of sheep is an important factor in resistance to blow-fly attack, and control of internal worms is very necessary.

Remedies and Dressings for Struck Animals.—Prompt measures are necessary when animals have become maggot-infested, since permanent injury or even death may ensue in a short time. In the case of sheep, the wool should be removed around the infested area, clipping from the outside towards the centre of infestation to prevent the spread of maggots. If maggots have penetrated deeply, an application of glycerine will bring them to the surface, when they may be killed with benzol. Extensive tests by Parman, involving treatment of 9,000 struck animals, have proved benzine (or benzol) to be a most effective material for killing maggots in wounds. Gasoline, carbon-tetrachloride and chloroform are also fairly efficient. If a wound is very moist it should first be dried with a cloth before the benzine is applied to kill the maggots, which should then be removed with forceps. A mechanic's oil can is of value in applying benzine to very deep wounds. A dressing of oil of pine tar over the wound will aid healing and prevent further fly-blow. In Australia the following mixture is used with much success for this purpose, and is strongly recommended by the Queensland Department of Agriculture:—

Creosote.....	6 parts
Turpentine.....	20 “
Olive or raw linseed oil.....	40 “

Before swabbing the wound with this dressing, it should be thoroughly cleaned out with a solution of lysol. If it is bleeding or very moist, dressing with either of the above repellent mixtures should be preceded with a dusting of tannic acid over the wound.

In Australia, jetting or dipping is also extensively practised as a preventive measure. A strong jet of arsenical solution is forced through a nozzle into the crutch of the sheep, since 90 per cent of infested animals are first struck in this location. The solution used consists of seven pounds of arsenic and seven pounds of carbonate of soda to each 100 gallons of water, pressure being 160 pounds per square inch for sheep carrying heavy wool, and sixty pounds for crutched or sheared animals. Protection lasts three months. Dipping with a solution containing two pounds of arsenic and two pounds of carbonate of soda to 100 gallons of water is also effective, but sheep should not be dipped until at least two weeks after shearing.

For convenient observation and handling, struck animals should be cut out from the flock or herd and enclosed in a small yard near the farm buildings.

Maggots Affecting Nestling Birds

Complaints are sometimes received that nestlings of swallows, bluebirds, sparrows and various other wild birds are attacked and killed by maggots of blow-flies, the larvae hiding in the nests by day and coming out at night to feed upon the blood of the birds. Large numbers of maggots are sometimes observed in the nests, and in a study made by O. E. Plath in California, 61 per cent of 63 nests examined were found infested with an average of 47 maggots to a nest. A metallic-blue fly, *Protocalliphora splendida* Macq., has proved to be the main

culprit in most of the investigations in the United States, where this subject has been given considerable study. Although injury to nestlings by blood-sucking maggots is known to occur in Canada, no detailed study has yet been attempted. It is extremely probable that the above species or closely allied members of the same genus are responsible for the trouble. *Protocalliphora hirudo cuprea* Shann. & Dobr., has a different habit and lives in tumour-like swellings on the birds, much as warble grubs do in cattle. Maggots have been taken from such cysts from the backs of swallows in Eastern Canada. According to Prof. G. J. Spencer, the species affecting swallows is *P. avium* Shann. & Dobr., and maggots taken from baby chicks belong to an unidentified species of the same genus.

Injury to Poultry through Feeding on Maggots and Beetles

A disease of poultry known as "limberneck" sometimes develops when large numbers of fly maggots are eaten by the birds. It has been proved that the disease is caused when such maggots have fed on putrid flesh containing the germs or bacteria of botulism or ptomaine poisoning. A characteristic symptom is paralysis of the neck muscles, making it impossible for the bird to raise its head from the ground. The bright emerald-green or blue-green blow-flies, *Lucilia caesar* L. and *L. sericata* Meigen, are among the species implicated in experimental work, but doubtless maggots of most other flesh-flies may also cause this trouble. It sometimes results from the birds feeding directly on carrion or spoiled canned goods. Proper disposal of all carrion is suggested as a preventive measure. Gallagher states that a purgative such as one-half teaspoonful of Epsom salts, or three or four teaspoonfuls of castor oil for each adult bird is the best treatment, but it must be given very promptly owing to the rapid course of the disease.

The common eastern rose chafer, *Macrodactylus subspinosus* Fab., contains a substance that is very poisonous to young chickens, ducklings, goslings and young turkeys, and it is stated that birds have died after eating only a few of these insects. When the beetles are common and large numbers are eaten, quite heavy losses may occur. Losses on some of the poultry farms in the eastern United States are reported to have run into hundreds and, in one or two instances, into thousands of chickens. Heavy losses have been reported in Eastern Canada, Ross and Hall reporting the death of over 100 chickens from this cause in one place in Ontario. During the rose chafer season it is advisable to enclose young birds in areas which do not contain grapes, roses, daisies, peonies and other vegetation particularly attractive to the beetles. Lampson states that very good success in reducing loss has been obtained on large chicken farms by mowing the ranges just prior to the chafer season. In Ontario adult rose chafers commence to emerge in the first week in June and are usually present in very great numbers by the middle of the month. After about three weeks of abundance they gradually decrease and have usually all disappeared by mid-July. It is not known if the very closely allied western rose chafer, *Macrodactylus uniformis* Horn, is poisonous to poultry.

Other beetles that have been found in the crops of poisoned chickens in the United States are species of the very common leather-winged beetles, *Cantharis* spp. A number of species are common in Canada, but no complaints of poisoning from this source have so far been received.

THE LOUSE-FLIES, *Hippoboscidae*

These are degenerate, flattened flies with a superficial tick-like appearance. Certain of them, such as the tropical species affecting cattle, and others parasitic on birds in Canada, retain their wings. Some, such as the deer louse-flies, snap off their wings after finding a host, but the best known species, the sheep ked, is wingless from birth and is as completely parasitic as the lice.

THE SHEEP TICK OR KED, *Melophagus ovinus* L.

This insect, commonly referred to as the sheep tick, is really a degenerate wingless fly, as mentioned above, and is a true insect not even allied to the ticks. The general use of the term sheep ked would eliminate much of the present misunderstanding and confusion when references are made to this parasite. The ked is very widely distributed in practically all of the sheep raising countries of the world and is a common pest in every part of Canada where sheep farming is undertaken.



Fig. 56—The sheep tick or ked, *Melophagus ovinus* L., enlarged and natural size (original).

The adult insect is reddish-brown to grey in colour, and is about one-quarter of an inch in length. The body is covered with short spines, and the small sunken head is armed with a fairly long sucking beak or proboscis, usually carried to one side. The six legs are stout and terminate in strong claws, well adapted to holding the insect securely in the wool. The body is large and sac-like. The insect, which can move actively, is readily able to pass from one sheep to another. When sucking blood, which it accomplishes by sinking the proboscis deeply into the flesh, it may remain quiescent for a considerable time, but can usually secure a full meal in about twenty-four hours.

Life-history and Habits.—One larva is produced at a time. The eggs hatch in the body of the female insect and the larva is not extruded until fully developed. When born the larva has a whitish appearance from the soft white membrane enveloping it, but within a few hours this darkens and hardens until the puparium becomes shiny, hard, and chestnut-coloured, and, in appearance and size, much resembles a radish seed. When first extruded, the membrane enclosing the larva is sticky and covered with a glue-like substance, which, on drying, fastens the puparium to the wool. The nits or seeds, as the puparia are commonly called, are usually attached at from one-half to one inch from the skin, an important point in connection with shearing. Unlike the prolific true ticks, which lay thousands of eggs, the sheep ked produces only ten to fifteen

larvae during her life of from four to six months. In spite of this, however, the progeny of one pair of keds may total 700 individuals in a year. The period of incubation before the keds emerge from the puparium varies from nineteen to twenty-four days, but may be much extended if this stage is passed away from the host on shorn wool, or on the ground. The newly emerged keds work their way through the wool to the skin where they inset their beaks and commence feeding. Mating occurs in about four or five days, and the first larva is produced about eight to ten days after this, or about two weeks after the emergence of the parent ked from the "egg." Larvae are deposited throughout the life of the female at intervals of from seven to nine days. Sheep, and occasionally goats, are the only animals upon which the ked is able to live, and adults die within a week if they drop from the host or are removed with the wool during shearing. If shearing is undertaken during warm weather a large number are removed since, when not feeding, the insects prefer the outer parts of the fleece. In colder weather they are to be found clustered deep down against the skin. The nits or puparia remain viable if removed from the host in the wool, as a large proportion are apt to be, owing to their location in the fleece. They often become detached when the animal rubs or scratches itself. Emergence of the young keds is then considerably delayed and may not take place for nearly six weeks, an important point with regard to re-infestation. The "eggs" are unable to withstand freezing temperatures if away from the host.

Injury and Economic Importance.—The presence of a small number of keds is not the source of much trouble to sheep, but, in spite of the small number of larvae produced by each female, the steady increase may result in very heavy infestation in a flock during comparatively few months. When infested with large numbers of these parasites, sheep are seriously affected, lose flesh and become unthrifty. Conservative estimates supplied by practical sheep men to the United States Bureau of Animal Industry placed the annual losses at 20 cents per head for mature animals and 25 cents for lambs. After the ewes have been sheared, heavy concentration of keds may occur on the lambs and serious setbacks often result. It is during the winter, when sheep are penned or herded closely together, and the animals have their vitality lowered by cold and often by poor feeding conditions, that the effects of sheep keds are most serious. In addition to the irritation and loss of blood resulting from the feeding of the parasites, the wool is often injured and depreciated in value. Infested animals rub, scratch and bite at the fleece, causing it to become ragged. The wool also becomes soiled and dirty with the excrement of the insects. The presence of empty shells of the nits is objectionable and these have to be removed from the fleece. Keds have not been incriminated in the transmission of any sheep diseases.

Control Measures.—Sheep keds are fortunately rather easy to control and proper co-operation among all sheep owners in a district would result in complete elimination of the pest. Fall dipping with any of the standard commercial preparations sold for this purpose is very effective. Dips are mainly of three kinds: lime-sulphur-insoluble-arsenic, nicotine, and coal-tar-creosote products. Since the hard shiny "eggs" are protected with a glue-like covering, they are very resistant to any of the known dips, except during the first few days after being deposited. Two dippings are therefore essential, the first to kill all adults on the animals, and the second to kill all the young keds that later hatch from the "eggs" present at the time of the first treatment. It is most important that the proper interval should elapse before the second dipping. Studies of the life-history indicate that a 24-day interval is the most satisfactory one to accomplish



Fig. 57—Puparium of sheep tick or ked, enlarged and natural size (original).

this result. Sheep that have been dipped should not come into contact with untreated animals, and pens and fields in which sheep were held prior to treatment should be considered as contaminated for at least six weeks, after which time all young keds hatched from "eggs" on the ground, or on tufts of wool on fences will have died. For the same reason, wool should be stored at least fifty feet away from the sheep. When fall dipping has been neglected and heavy infestation is noted at the time of shearing, it is advisable to treat the animals, giving special attention to the lambs, on which the keds usually concentrate at this time. Any of the commercial dips may be used, or a wash consisting of a 2 or 3 per cent solution of cresol in water may be utilized. In the case of practically all of the standard dips, time should be allowed for all shearing cuts to heal before dipping is attempted or blood poisoning may result. In the winter months when dipping is not feasible, badly infested flocks may be treated with pyrethrum powder blown deeply into the fleece. Complete eradication is not possible by this method and several dustings may be necessary. Since the process is a slow and tedious one, it can hardly be undertaken except in the case of small numbers of valuable animals, and it is best to rely on the double autumn dipping whenever possible. Dipping costs only from 2 to 3 cents per animal and should be undertaken as a general practice by all sheep men, to reduce the injury by and spread of this pest.

THE DEER LOUSE-FLY, *Lipoptena depressa* Say

This peculiar insect is closely allied to, and much resembles, the previous species. Sheep men noting it on deer sometimes mistake it for the ked, although it is somewhat smaller in size and less grey in colour. When they first emerge from the puparia the flies have well developed wings and with these are able to move to new hosts. On settling down to a parasitic life, the wings are shed at the base. These insects



Fig. 58—The deer louse fly, *Lipoptena depressa* Say, enlarged and natural size (original).



Fig. 59—Puparium of deer louse fly (original).

suck blood and produce single fully developed larvae ready to pupate, just as sheep keds do. Little is known of their economic importance, but very heavily infested deer have been noted on a number of occasions in British Columbia.

LOUSE-FLIES OF BIRDS, *Lynchia* and *Ornithoica*

Domestic pigeons and various wild birds, particularly predacious species, are sometimes attacked by large, flat, winged louse-flies, which, however, do not appear to be of any particular economic importance in Canada, but are of interest in that they are fairly closely related to the sheep ked, but have not degenerated to the extent of that species.

FLEAS

Fleas are small, brown, hard-bodied insects devoid of wings, a deficiency partly compensated for by the possession of powerfully developed legs especially adapted for jumping. Unlike most parasites they are very active and nimble and are capable of jumping upwards to a height of seven inches, and horizontally to nearly twice this, a distance that corresponds to a jump of approximately 300 yards for a 6-foot man. The compressed bodies, which are flattened laterally, and the numerous stout, backward-directed spines enable them to move readily through the hair of the host animal. The mouthparts are especially adapted for piercing the skin and sucking blood, which is the only food known to be taken by adult fleas of both sexes. They can subsist for quite long periods without a meal, but blood is apparently essential before mating for the production of eggs.

Fleas have a world-wide distribution and several hundred species are known. In Canada only a few are of importance, although a large number of species occur on wild animals. The commonest kinds affecting man and domestic animals are the cat and dog fleas, *Ctenocephalus felis* Curt. and *C. canis* Bouche. The human flea *Pulex irritans* L., is also troublesome in some places. These species infest cats, dogs, domestic foxes and swine as well as man. The common European chicken flea, *Ceratophyllus gallinae* Schrank, occurs in Eastern Canada, and several other fleas affecting poultry have been noted in various sections of the Dominion. The human flea also sometimes occurs on poultry in British Columbia. With the exception of the hog, none of the larger domestic animals are affected to any extent by fleas. These parasites are often very troublesome pests on fur farms: foxes, rabbits and other fur bearers being particularly liable to heavy infestation under domestic conditions. In addition to the human, dog and cat fleas, rabbits are affected by the true rabbit flea, *Spilopsyllus cuniculi* Dale. Since the life-histories of different fleas much resemble each other, and the general control measures are applicable to most species, it is unnecessary to give more than a very generalized account.

Life-history.—The eggs of fleas are minute, white, ovoid objects, just visible to the naked eye. They are usually deposited loosely in the fur of the host, but soon drop off, and may be found in large numbers in places where animals rest. They are particularly abundant in bedding material and nests. Some idea of the great numbers that may be produced even on one animal may be gathered from the fact that a small teaspoonful of them was taken from the lap of a woman who had been fondling a kitten. Each female flea is capable of laying about 450 eggs over a period of several months. The eggs hatch into minute, elongate, white maggots, cylindrical in shape and provided with a number of hairs on each segment. They live in dusty crevices in floors, in carpets or in the bedding of animals, and feed on particles of dust and other debris. The larvae of some species appear to need particles of semi-digested blood voided by the adult fleas. On attaining full growth a cocoon is formed, within which the larva changes to the pupal stage. In many species the completely formed adult fleas in the pupal cases may remain quiescent for an indefinite period, especially

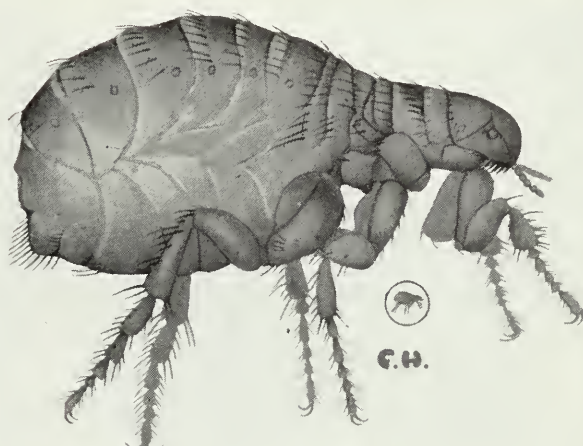


Fig. 60—The dog flea, *Ctenocephalus canis* Curtis, enlarged and natural size (after Gibson and Twinn).

if the temperature is low. Large numbers emerge when disturbed by some movement in their vicinity. They then seek a host, mate, and shortly after commence egg-laying. The entire life-cycle from egg to adult may be completed in as short a time as from 17 to 21 days, but is often much more prolonged. Adult fleas have been known to live in an unfed condition for as long as four months, and under favourable conditions, if able to obtain food, may live for a year and a half or longer. They vary somewhat in their parasitic habits, some species, such as the human flea, remaining off the host except for short intervals, while others, such as the rabbit flea, seldom leave the host animal. Places where much dust and dirt accumulate in floor cracks are especially favourable for flea development, but fleas sometimes also develop in great numbers in the open, particularly in sandy hog lots and piggeries, where moisture conditions are fairly uniform, and there is much humus and vegetable matter to provide food. Fleas often develop extensively under buildings when dogs, cats, hogs and other animals have access to such places.

Injury and Economic Importance.—Heavily infested animals suffer very much from the irritating bites of fleas, and these parasites are of considerable economic importance in connection with the silver fox industry and fur farming in general. Animals constantly worried by fleas continually scratch themselves and cannot be expected to thrive or produce fur of good texture. In addition to the irritation they cause when biting, certain fleas are transmitters of the dreaded bubonic plague, a disease of high fatality affecting various rodents and man. They also form the intermediate hosts of tapeworms, such as the double-pored dog tapeworm, *Dipylidium caninum* L., which is very common in dogs, and occasionally occurs in children. The fleas become infested in their larval stages through swallowing tapeworm eggs present in the trash and dust on which they feed. Infection of the final host, whether it be dog, cat or child, occurs when an adult flea is swallowed, a frequent occurrence in the former animal when one considers the assiduous manner in which dogs hunt out their small persecutors.

Remedies and Control Measures.—In attempting to control a bad infestation of fleas it is very necessary to deal with the breeding places where the early stages of fleas are found, and at the same time to treat infested animals. For the latter, a wash consisting of a weak solution of cresol in water is very satisfactory. The head should be washed first since the fleas congregate there when the animal is submerged. The animal should be held in the bath for several minutes and the solution rubbed well into the fur. For dogs a 3 per cent solution, or about four tablespoonfuls of cresol to a gallon of water is best, but for cats the solution should be weaker and should not exceed 2 per cent. Foxes can safely be treated with a 1 per cent solution. In the case of cats and foxes it is advisable to wash out the material immediately. The washing should not be attempted in cold weather. Most authorities do not advise the dipping of foxes, but prefer the use of powders in view of the nervousness of these animals. When the above treatment is not feasible, spirits of camphor sprayed into the fur and well rubbed in is of some value for foxes and cats, but dusting with pyrethrum or derris powder is probably a more satisfactory method. During treatment the animal should be held over a large sheet of paper and after an interval of from 10 to 15 minutes the powder should be well brushed out, and the paper, together with the stupefied fleas which have dropped on to it, should then be burned. The treatments recommended for lice on hogs also will give these animals some relief from the attacks of fleas.

Kennels and places where dogs, cats, foxes, rabbits and other fur bearers are kept, should be frequently cleaned out and no trash or dirt permitted to accumulate. Special attention should be paid to bedding material, and, for dogs and cats, it is advisable to provide mats or rugs which should be shaken out at frequent intervals. Pyrethrum and derris powders are of value for sprinkling over floors and in the resting places of animals. Good control may

be obtained by spraying floors and woodwork with fuel oil, kerosene, preferably pyrethrum-kerosene spray, creosote oil or any good commercial coal-tar-creosote stock dip. Infested hog lots and hog pens should be cleaned up and sprayed with creosote oil and the same treatment is applicable for poultry houses and runs. Salt is very effective for killing the early stages of fleas, and a good soaking of wooden or earth floors with brine is of value in controlling fleas in poultry houses, pig pens and so forth. It should be kept in mind that salt is poisonous to poultry and bags of salt should not be placed where birds have access to them.

BEDBUGS AS PESTS OF POULTRY

The common bedbug, *Cimex lectularius* L., is usually considered as a pest of man, but this and several allied species are often troublesome to poultry. These parasites are oval, flattened, wingless insects of a reddish-brown colour, and measure about one-quarter of an inch in length. The long sucking beak usually lies folded back under the insect.

The host is sought out only at night when a blood meal is required, the bugs at other times secreting themselves in cracks and crevices. Small, elongate, white eggs are deposited in these hiding places, up to about 200 eggs being laid by each female. The young bugs produced from these eggs are similar in appearance to the adults but are paler in colour. The only food of nymphs and adults is blood. They may live, however, for periods of several months without a meal. The life-cycle from egg to adult may be completed within six weeks, but is often much more prolonged.

One of the simplest and most satisfactory control measures for infested chicken houses is to spray all cracks and crevices in woodwork, roosts, etc., with creosote oil or crude petroleum. If complete eradication is not effected by this treatment, it should be repeated after about ten days.

LICE OF DOMESTIC ANIMALS AND POULTRY

Practically every kind of domesticated and wild animal has one or more species of lice peculiar to it, and few forms of these are able to live if transferred from one kind of host to another. Certain closely related animals, such as horses, asses and mules, may sometimes harbour the same species of both sucking and biting lice. On mammals, sucking lice are primarily of importance, but a more limited number of biting lice also infest this type of host. About a dozen species of Mallophaga, as the biting lice are technically called, are known to occur on domestic animals in North America. Poultry and wild birds are not affected by sucking lice, but by biting lice, which sometimes develop on them so abundantly as to become quite serious pests. The various members of this large group of parasites are almost invariably restricted to particular kinds of wild birds, or the different classes of poultry, although more than one species may infest one kind of bird. For instance, at least a dozen different biting lice have been found on the common hen.

Unlike the fleas, both types of lice are permanent parasites, and the entire life and early stages, including the eggs, are passed on the body of the host animal. Lice are seldom able to live for more than a few days if removed from the host. The young lice have much the same appearance and habits as the adults.

SUCKING LICE

The sucking lice (Anoplura) are soft-bodied, somewhat flattened insects, varying in colour from white to dark blue-grey. Many of them have a rather characteristic crab-like appearance. The comparatively large, ovoid bodies are sparsely haired, and the three pairs of legs terminate in formidable-looking claws.

It is very advisable for stockmen to be able to distinguish between sucking and biting lice since there are some differences in the life-histories and habits which influence control measures. The head of a sucking louse is usually somewhat pointed and is longer than broad, whereas the head of a biting louse is very broad and well rounded in front, and fitted with biting mouthparts. As indicated by their name, sucking lice have mouthparts adapted for piercing the skin and drawing blood, which constitutes their only food. These somewhat sluggish parasites are world-wide in distribution.

THE HOG LOUSE, *Haematopinus suis* L.

The hog louse is probably the best known member of this group of insects. It is the largest species affecting domestic animals and may attain one-quarter of an inch in length. The body is broad and oval, and the stout legs terminate in



Fig. 61—The hog louse, *Haematopinus suis* L., enlarged and natural size (original).

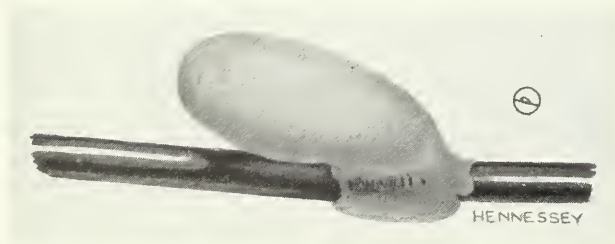


Fig. 62—Egg of the hog louse, enlarged and natural size (original).

large, dark claws well adapted to hold the insect securely when attached to the hairs or moving on the host. These parasites are a dirty grey in colour, with dark brown markings on the head, thorax and around the edge of the body. They congregate mainly in the loose folds of skin at the neck and jowl, at the base and inside of the ear (the latter place being especially favoured by the young lice), along the belly and on the inner side of the legs. The back and upper parts of the sides are much less infested. The above points are of considerable importance and should be kept in mind when control measures are attempted. Eggs are mainly located in a wide band along the lower parts of the body and at the base of the ears. This species is restricted entirely to the hog and is the only kind of louse affecting swine.

Space will not permit a detailed description of the life-history of each kind of louse, but since there is a fairly close resemblance in this respect in the different species, a short account giving a generalized life-history follows the discussion of various economic species. Control measures are outlined following the

section on biting lice, since in many cases similar methods are applicable for both groups.

SUCKING LICE OF CATTLE

Three species of sucking lice affect cattle, one of the most common and troublesome being the short-nosed cattle louse, *Haematopinus eurysternus* Nitzsch, a fairly large louse measuring a little over one-eighth of an inch in length. The colour is bluish-grey. It is somewhat broader than the other two species. The broader, less pointed head makes it fairly easy to differentiate between this and the other most commonly encountered species, the long-nosed cattle louse. Cattle are mainly infested on the shoulders, the upper portion of the

neck, forehead, throat, escutcheon and tail, especially towards the base. The white eggs are attached to the hairs in the places mainly infested by the adults.

The long-nosed cattle louse, *Linognathus vituli* L., is a smaller species than the preceding one, is more slender in build, and is usually considerably darker in colour. The most characteristic feature is the elongate head. When feeding, the louse appears to be standing on its head with the body upright. These parasites are stated to occur more commonly on calves and young stock, but heavy infestations have been observed on mature animals, in various sections of Canada. The withers and parts of the animal mentioned under the preceding species are also the favoured locations for this louse. The eggs differ from those of the short-nosed cattle louse in being nearly black.

Another species of sucking cattle louse, the capillate louse, *Soloneptes capillatus* Enderlein, has been found to occur sufficiently abundantly in the United States to be a serious pest of cattle, and it is undoubtedly the source of trouble in various parts of Canada as well. In appearance it closely resembles the short-nosed cattle louse, but is smaller and not quite so broad. This species is stated to have a tendency to attach itself in dense groups about the head and neck of the host animal. The eggs are pale yellowish.

SUCKING LOUSE OF HORSE, *Haematopinus asini* L.

Of the three lice known to attack horses, asses and mules, the sucking species is the most troublesome. It has a wide distribution in all parts of the world, and sometimes constitutes a serious pest of poorly kept horses throughout Canada, although it is probably more prevalent in western rangelands than elsewhere. While somewhat smaller than the hog louse, it resembles that species in general shape, has a broad body and elongate head and is yellowish-brown in colour. The neck, flanks, and under the jaw are the locations where lice are usually found in greatest numbers, but when an animal is very grossly infested, every part of the body may be invaded.

SUCKING LICE OF SHEEP

Two species of sucking lice occur on sheep, but fortunately they appear to be scarce in most parts of Canada. The sheep foot louse, *Linognathus pedalis* Osborn, is unique among lice in that it has a marked preference for the legs. In moderate infestations it is only found around the feet and on the lower portions of the legs below the true wool. It especially prefers the region of the dew claws, and the eggs are mainly deposited in this location. When infestation is very heavy, however, other parts of the body, more thickly covered with wool, may occasionally be invaded. It was first found on sheep imported into the United States from Canada. This species is somewhat similar in shape to the short-nosed cattle louse, but is not quite so broad and is paler in colour.

The other species of sucking sheep-louse, *Haematopinus ovillus* Neum., may infest any part of the body, but the lice are inclined to cluster in large colonies. Masses of eggs mat the wool together. It is not reported as a particularly common louse, and we have no information as to whether it is prevalent in Canada.

THE SUCKING LOUSE OF GOATS, *Linognathus stenopsis* Burm.

Goats are mainly infested with one species of sucking louse, the common goat louse, *Linognathus stenopsis* Burm. These parasites are stated to occur sometimes in sufficient numbers to cause injury. They have a very wide distribution.

THE SUCKING LOUSE OF DOGS, *Linognathus piliferus* Burm.

The common sucking dog louse, *Linognathus piliferus* Burm., is a small pale yellow to pinkish species occasionally abundant on poorly kept animals in every part of the world. It is also known to affect foxes, but as far as we are aware no trouble from lice has yet been experienced on Canadian fox farms.



Fig. 63—Sucking louse of dog, *Linognathus piliferus* Burm., enlarged and natural size (original).

THE SUCKING LOUSE OF RABBITS,

Haemodopsis ventricosus Denny

This is a broadly oval louse with unusually short legs. It is very widely distributed and infests various kinds of wild rabbits and hares, in addition to sometimes being an important pest in commercial rabbitries. It is known to be capable of spreading tularaemia among wild rabbits.

LICE IN CONNECTION WITH FUR FARMING

Sucking lice apparently seldom cause trouble on fox farms, but since many of the other animals now being raised under domestic conditions harbour lice, owners of fur farms should keep a close watch for these parasites and should apply appropriate remedial measures as soon as lice are noted. Badly infested animals cannot be expected to produce good pelts.

THE LIFE-HISTORY AND HABITS OF SUCKING LICE

These parasites pass their entire life and development on the host animal. The eggs, which in most species are white or yellowish, are stout, barrel-shaped objects, closed with a cap at the upper end. They are attached firmly to the hair close to the skin by means of a glue-like substance. Varying numbers of eggs are laid by the different species, the short-nosed cattle louse, for instance, laying from 35 to 50 eggs, and the hog louse as many as 90 eggs. The young lice, similar in appearance to the adults, emerge by pushing the cap off the top of the eggs. Incubation may take from ten days to two weeks, but if the nits have been scratched off the host on to the ground, it may extend to three weeks or more. The newly hatched lice crawl to the skin, which they pierce and commence feeding on blood. Lice do not gorge themselves with one big meal in the manner of ticks, but feed at frequent intervals. Each time the beak or proboscis is inserted, fresh irritation is caused. Several moults are passed through before the adult stage is reached. In most species mating does not occur until more than a week after the insects are fully developed and until they have obtained a meal of blood; egg-laying takes place very shortly after this, and usually commences about two weeks after the insects have reached the adult stage. A few eggs are laid each day during the life of the female, which in many species averages four or five weeks. A succession of generations follow each other, and it has been estimated, in the case of the hog louse, that there are from nine to twelve generations each year. It will be seen from this that an enormous increase may occur in a short time, and, under favourable conditions, the presence of a very small number of lice may lead to extremely heavy infestation in a few months. Although lice do not often voluntarily leave the host, and succumb fairly quickly if scratched or rubbed off on to the ground, they will spread fairly rapidly from one animal to another of the same kind, through contact, when cattle, horses, hogs, sheep and

so forth are penned and closely crowded together. A few badly infested animals admitted into a clean flock or herd will soon cause general infestation. In the case of these parasites, the condition of the animals themselves is of greater importance than the condition of the stables, bedding and so forth, animals in poor condition being more heavily infested than healthy ones.

INJURY CAUSED AND ECONOMIC IMPORTANCE OF SUCKING LICE

The presence of a few lice is not the source of much inconvenience to animals, but when heavy infestations occur, great irritation is set up and under these conditions lice constitute quite a serious pest. The hog louse, for instance, is, next to hog-cholera, considered to be the worst enemy of swine. Sheep have been known to die from gross infestations of the sheep foot louse, and all classes of stock are liable to become weakened and unthrifty, so that they are less able to withstand diseases and poor feeding conditions. It is doubtful if cattle and horse lice ever cause death directly, but they are certainly important contributory causes under some conditions. The sucking lice, from their habit of piercing the skin and feeding on blood, which they do at frequent intervals, are in general more serious pests than are members of the biting group, although in the case of sheep the biting lice are considered more troublesome. The irritation caused by feeding, and the crawling of the lice on the skin is sometimes so intense that heavily infested animals often bite and scratch at themselves and rub off much hair and even considerable patches of skin. In some instances large scabby patches may be so extensive as to be mistaken for mange. Bleeding sores may be formed and certain species of lice, especially hog lice, have the peculiar habit of congregating and feeding in large numbers around such places and greatly aggravate the condition. Lice are particularly likely to thrive on unthrifty animals, and shortage of feed is often a contributory cause towards heavy infestation.

In the case of horses, cattle, and sheep, as well as of wild animals, lice are mainly troublesome during the late winter months and are seldom very much in evidence during the summer. Because lice are not noted at this time, it should not be considered that the animals are completely free of them. Enough of the parasites persist to give rise to vast numbers when satisfactory conditions for development occur. There are several reasons for this increase which is so noticeable during the winter months. Added protection is provided by the heavier growth of the winter coat; also, dry and often insufficient feed during the winter causes the skin and coat to become dry and less oily than when the animals have ample and succulent summer fodder, and lice thrive best when the coat is dry. Moreover, during the summer, animals are usually less crowded than they are when closely herded in feeding pens, or when continuously stabled during the winter months, and crowding always tends to spread lice.

BITING LICE

The biting lice are very small, wingless, somewhat flattened insects, soft bodied in the early stages, but with a harder covering than the sucking lice when in the adult stage. The head is large in proportion to the body and is broadly rounded in front. The colour varies from white to red-brown in the different species. As their name suggests, biting lice do not suck blood, but possess mouthparts adapted for biting, and feeding on particles of feather, hair, loose scales and other débris on the skin of the host. They are fairly active and move about considerably more than do the sucking lice, and this constant movement may cause great irritation and worry to the host. Several species are of importance on domestic animals, and each of the larger domestic mammals, with the exception of horses and goats, have one kind peculiar to them. Horses

are affected by two species and goats by three or more. Swine are free from these pests. A large number of species occur on poultry, but each kind is generally more or less restricted to one particular host.

CATTLE BITING LOUSE, *Bovicola bovis* L.*

Stock men often refer to this as the little red louse in distinguishing between it and the larger, blue, sucking lice. It is a compactly built, rather short louse, measuring about one-thirteenth of an inch in length. The head is red in colour, and the yellowish-white body is marked with a number of conspicuous dark bands. The lice may be general over the body, but usually congregate in extensive groups around the base of the tail and on the withers and neck. The intense irritation resulting from their presence may cause infested animals to rub the hair off the affected parts, and large lesions, resembling scab or ringworm, are frequently produced.



Fig. 64—Cattle biting louse, *Bovicola bovis* enlarged and natural size (original).

are the parts of the horse usually most heavily infested, but when very numerous, lice may be found all over the body.

The common chicken louse, *Menopon gallinae* L., will occasionally attack horses stabled near chicken runs.

BITING LOUSE OF SHEEP, *Trichodectes ovis* L.

Sheep men often refer to this minute insect as the red-headed sheep louse. The body is pale brownish and the large rounded head is conspicuously red in colour. This is a very small louse measuring only one-twentieth of an inch in length. In spite of its minute size, and unlike most other biting lice of animals, this species is often more injurious than the sucking lice. In addition to the intense irritation caused by countless numbers of these parasites crawling on an animal, further injury results from the lice biting through the wool fibre. Infested animals constantly rub against fence posts and the like, and scratch and bite at themselves. This causes the strands of wool that have been cut by the lice to be pulled loose, giving the animal a very "taggy" appearance. When such loose tags of wool are noted in the outer part of the fleece, the animals should always be closely examined for lice, which will usually be located on or very near the skin. While reported from various parts of Canada, and probably generally distributed in all provinces, sheep biting lice do not appear to be

HORSE BITING LICE, *Trichodectes* spp.

Two kinds of biting lice, *Trichodectes pilosus* Giebel, and *T. equi* L.†, which affect horses, asses and mules, resemble each other in appearance and are much like the cattle biting louse. The fore parts are reddish or chestnut brown in colour, but the body is yellowish, except for a number of dusky crossbands. They are a little larger than the cattle biting louse and measure about one-tenth of an inch in length. The region of the neck, especially along the mane, and the base of the tail

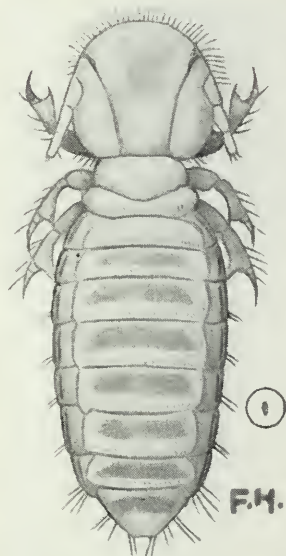


Fig. 65—Horse biting louse, *Trichodectes equi* L., enlarged and natural size (original).

* *Trichodectes scalaris* Nitzsch.

† *T. parumpilosus* Piaget.

particularly prevalent. In Australia, New Zealand and various other sheep raising countries they are a common and serious pest.

BITING LICE OF GOATS

Goats sometimes harbour remarkably large numbers of several species of biting lice. One of the commonest and most widely distributed is the common goat louse, *Trichodectes caprae* Gurlt. In appearance these lice are very much like the various other species described above. Heavy infestations in Angora goats are particularly troublesome since the valuable mohair may be seriously damaged.

BITING LICE OF DOGS AND CATS

The common biting louse of the dog, *Trichodectes canis* De Geer, is a small, very broad species, measuring about one-sixteenth of an inch, and is clear yellow in colour. As in most other biting lice the body bears a series of dusky bands. It is world-wide in distribution, and, while comparatively uncommon in Canada among properly cared for dogs, it may develop in very large numbers on poorly kept animals. Under the latter conditions it is a serious pest and a constant source of worry. Puppies are said to be especially affected. This louse is known to transmit tapeworms to dogs.

Cats are not often troubled by lice, but one species, the cat louse, *Trichodectes subrostratus* Nitzsch, sometimes occurs on them. It is about the size of the last mentioned species, but differs from most biting lice by possessing a somewhat pointed head.

BITING LICE OF POULTRY

This group of lice constitutes one of the worst enemies of all classes of domestic poultry, and is all too often the unrecognized cause of poor condition in hens and other birds of the farmyard. Owners of large commercial chicken farms usually realize that neglect in controlling these parasites may bring failure to their enterprises, but many small farm and backyard flocks do not receive the attention that they should and become extremely badly infested. Under such conditions hens appear "dopey" and listless and egg production falls off.

About a dozen species of biting lice are known from the hen, but in Canada only three or four are serious pests, since many of the others mainly stay on the feathers where irritation from them is limited.

One of the most generally distributed and probably the most injurious species is the chicken body louse, *Menopon stramineum* Nitzsch, which measures about one-tenth of an inch, and is yellowish in colour. On account of its size, and the fact that it lives on or very near the skin, it causes great irritation when abundant.

Another species found very commonly in all parts of Canada is the common chicken louse, *Menopon gallinae* L. It is only about one-half the length of the former species, but is almost equally broad. It is pale straw-coloured. The lice crawl actively over all parts of the body, but both this and the last-named species are usually most numerous in the vicinity of the vent and under the wings.

The chicken head louse, *Lipeurus heterographus* Nitzsch, is credited by many poultry



Fig. 66—Chicken body louse, *Menopon stramineum* Nitzsch, enlarged and natural size (original).

men as being a particularly injurious louse owing to its preference for the head. It has been stated that young chickens succumb quickly when heavily infested. This has not been substantiated, however.

The variable hen louse, *Lipeurus variabilis* Nitzsch, is an easily recognized species measuring one-sixteenth of an inch. It is a long, slender, pale louse with black markings. The feathers of the wings and tails of the birds are mainly infested.

Other species of minor importance, such as the lesser chicken louse, *Goniocotes hologaster* Nitzsch, and several closely allied forms may be recognized by their remarkable width. Some are comparatively large, but the one named is only one-twentieth of an inch in length. Fluff louse is another common name for it.

All the other classes of poultry, such as ducks, geese, turkeys, pigeons, etc. are similarly attacked by different species of biting lice, but the hen has a greater variety of these pests than is the case with other fowl.

LIFE-HISTORY AND HABITS OF BITING LICE

The biting lice lead a completely parasitic existence and only leave the host animal or bird when transferring to another of the same kind. The eggs, which are whitish and oval, resemble those of the sucking lice, and are attached to the hairs or feathers of the hosts. In the case of the common chicken louse they can often be noted in large clusters around the base of feathers in the vicinity of the vent. In this, and some other species, the eggs are quite striking objects with a glistening rosette of spines at the upper end. Eggs hatch in from five to ten days, the incubation period varying according to the coldness of the weather, protection afforded the hosts and so forth. When the eggs are rubbed off the host, this period may extend to as long as three weeks. The newly hatched lice resemble the adults except in size. Like them, they feed only on particles of hair, feathers, flakes of skin, etc. and after passing through a number of moults attain maturity in from eleven days to two weeks. The biting lice are hardier than the sucking species and when removed from the host may live for as long as ten days, but usually succumb within a week.

CONTROL OF SUCKING AND BITING LICE ON ANIMALS

Fall dipping has proved the most effective method of controlling both kinds of lice on cattle, horses, sheep and goats. Standard commercial arsenical or coal-tar-creosote dips are very satisfactory and should be employed in strict accordance with the directions supplied with them. The various nicotine dips are also of value. None of the known dips can be relied on to rid animals of all lice at one treatment, since many eggs survive, and the young lice that hatch from them must be killed before they attain maturity and become capable of egg-laying. A second dipping after an interval of two weeks will ensure complete freedom from lice. Where only a few animals are involved, hand spraying is a satisfactory alternative for dipping, but care should be taken to thoroughly wet every part of the body. Any of the commercial cattle dips can be used for spraying, but kerosene emulsion is a very cheap and efficient homemade remedy. The ingredients are as follows—

Soft soap.....	1	quart
Hard soap.....	$\frac{1}{4}$	pound
Kerosene (coal oil).....	1	pint
Water (soft).....	2	quarts

Mix the soft soap and finely shaved hard soap with two quarts of hot water to completely dissolve them. Add the kerosene and stir and churn vigorously until a creamy emulsion is produced. Before using add a gallon of water. If

free kerosene is present, burning may result and careful mixing by stirring before application is, therefore, essential. This mixture can be applied as a spray or with a brush.

The sheep foot-louse is fairly easy to control owing to its preference for the lower part of the legs below the long wool. Sheep affected by it should be made to walk through shallow vats containing some standard dip. This only needs to be deep enough to reach up to the body without wetting the wool. If the flock is small, hand washing with a suitable dip solution or with kerosene emulsion is quite feasible.

Raw linseed oil, applied with a brush or cloth, is a useful remedy in the case of horses, cattle and hogs, and will not cause burning. It is best, however, to avoid exposing the animals to direct sunlight or overheating them for some hours after treatment; the late afternoon is the best time for the application. Volck, a bland mineral oil, has also proved of great value in killing both types of lice, and is harmless to stock in proper dilutions. Whenever possible it is advisable, as a preliminary to treatment, to clip horses and cattle and thoroughly brush the coat. This is, of course, not feasible in very cold weather.

Powders used for the destruction of lice on live stock are, at best, only rather poor makeshifts but are of use when fall dipping has been neglected and severe infestation with lice is noted during very cold weather. With the exception of derris, most powders have little effect on sucking lice. If only biting lice are found to be present, sodium fluoride can be used to kill them. For horses and cattle the raw linseed oil treatment mentioned above is preferable even under fairly cold weather conditions. Dusting has proved of some use in the case of small flocks of valuable sheep, but is not feasible when large numbers of animals are concerned. It can best be accomplished by use of hand powder-guns of the barrel and plunger type. One-half ounce of sodium fluoride is sufficient for each animal. Derris powder in dilutions of up to ten parts of an inert carrier, such as cornstarch, is fairly effective against both types of lice on all classes of live stock. If some of the dusting powders containing naphthalene or pyrethrum are used on horses and cattle it is best to strap a horse blanket on to the animal immediately after the dust is applied, to retain the fumes.

Since lice spread readily by contact, especially when animals are crowded together, the greatest of care should be exercised to prevent herds and flocks that have been treated and freed of lice, from becoming contaminated by infested animals. One or two lousy animals brought into a herd will soon cause general infestation. It has been noted that louse eggs off the host may hatch during a period of three weeks; with this in view, premises that have been occupied by infested animals cannot be considered as clean for nearly a month. All hair clipped from lousy animals should be burned. Litter and manure should be removed from infested premises and coal-tar-creosote dip used freely to kill any lice that may be present on the floor and woodwork of the stalls.

Some of the general treatments mentioned above are applicable for the control of hog lice, but the most effective and cheapest control is by crude petroleum. Where there are only a few animals, thorough application can be made by means of a long-handled brush or mop, particular attention being paid to the creases in the neck and jowl, inner sides of the legs and the other parts of the animal where the lice are most abundant. A medicated wallow as described below is more satisfactory, and is necessary where large numbers of animals are to be treated. The wallow, which is best made of concrete, should be in a shaded place, and should be of sufficient depth for the animals to become well covered when they roll; in general three to four inches of liquid are sufficient and the wallow need only be about five feet square. It is better to allow the hogs to become thoroughly used to the wallow with water alone, and then to add crude petroleum oil to the water at a rate of from one to two pints for each animal, according to size. If the oil is added towards evening and plenty of shade is

provided for the animals there is practically no danger of blistering the skin. After the oil has been in place for a day or two, the wallow should be drained and filled with clean water. A second application of oil is necessary in two weeks, and further treatments with the same interval may be needed until the lice are completely eliminated.

Homemade or commercial oiling posts are employed extensively in some districts for control of hog lice, but the best of them are not really very efficient and lice cannot be properly checked by their use, since the oil fails to reach the place where the parasites are most abundant.

Irrespective of the treatment employed, it is inadvisable to return the animals to the pens and premises previously occupied, until a thorough clean-up is undertaken, all manure and litter removed, and liberal use made of a good insecticide such as coal-tar-creosote dip, to kill any stray lice that may have dropped off the host. If possible, it is best to give the yard or pen a three weeks' rest, by which time all lice will have died.

Lice on cats and dogs may be controlled by the use of the weak cresol washes mentioned in the section on fleas. Derris powder is also effective.

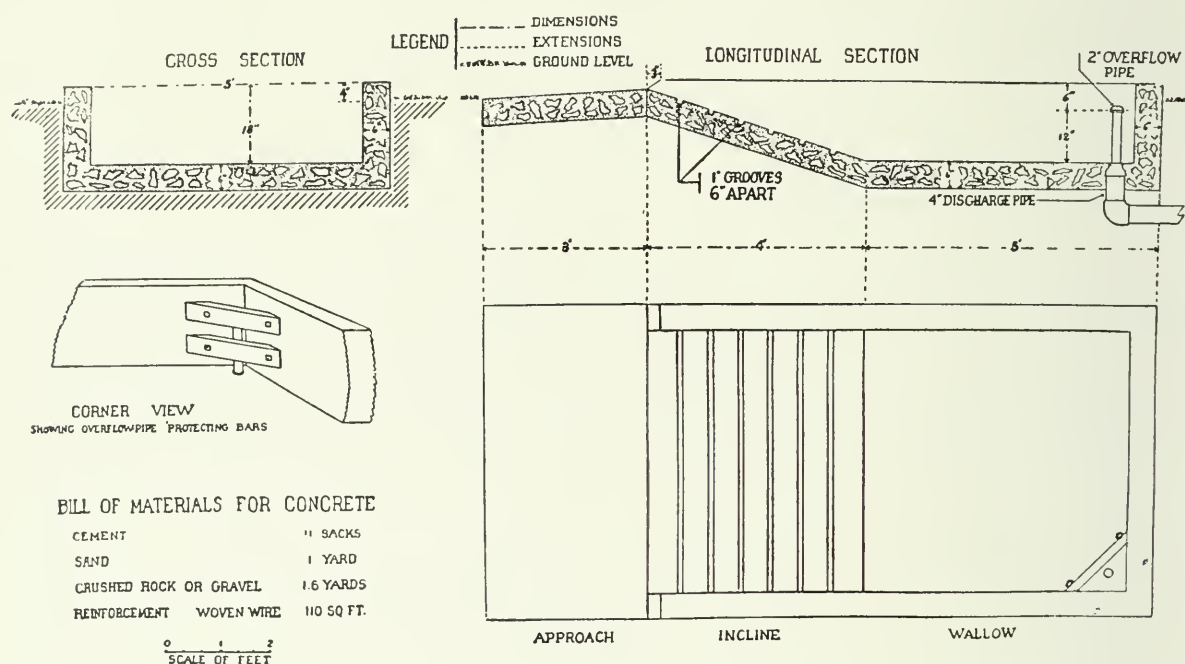


Fig. 67—Plan of hog wallow—concrete construction (after Imes).

Control of Biting Lice Affecting Poultry.—Sodium fluoride dusted into the feathers of hens or other louse-infested poultry will give very satisfactory results, since only biting lice affect birds, and the material is particularly fatal to these parasites. Bishopp and Woods state that one thorough application to all fowls on a given premises will completely destroy all lice present. The powder persists in the feathers for some time and the young lice are killed as soon as they hatch and commence feeding. The "pinch" method is simple and economical. The bird is held over a shallow pan and a small pinch of the powder applied at each of the following places: head, neck, along the back, breast, below the vent, on the tail, on each thigh, and one pinch scattered on the underside of each wing when spread. While this method is undoubtedly effective, it is also laborious, and dipping the birds in a solution containing one ounce of sodium fluoride to a gallon of tepid water is quicker, but can only be undertaken in warm weather. Many poultrymen are averse to wetting their hens, but if birds are given sufficient time to dry before evening and the dipping is undertaken properly during warm weather, no ill effects will ensue.

The method which has most to recommend it, however, in view of its simplicity, saving of time, and effectiveness, consists of painting the roosts occupied by the birds with a very thin coating of nicotine sulphate (40 per cent strength). The fumes given off by this insecticide, when the birds are on the roosts, kills the lice present on the body, and unlike sodium fluoride affords protection against mites and other parasites. Independent tests conducted at Ottawa by C. R. Twinn, and in British Columbia by the writer, indicated that very high mortality occurred and that lice can be completely eliminated by this method. The directions supplied by the makers of this insecticide should be followed.

Warning should be given against another type of proprietary alleged louse and mite destroyer, namely, certain powders and tablets for use in drinking water. As advertised, these powders or tablets, supplied to the birds in drinking water are supposed to completely rid them of lice. Tests have proved them to be worthless.

In starting new poultry establishments it is quite possible to avoid all trouble from lice if simple precautions are taken. If incubator chicks only are used, no lice will be introduced, and if all cockerels or other birds subsequently purchased are treated for lice before coming into contact with the remainder of the flock, complete freedom from lice can be maintained, as long as the birds are not in too close proximity to other flocks.

MITES OF DOMESTIC ANIMALS AND POULTRY

MANGE AND SCAB MITES

These minute, white parasites are so small that they are scarcely visible without the aid of a microscope. Most forms measure from one-fortieth to one-sixtieth of an inch, are spherical, ovoid or flattened, and have eight short stubby legs. The hair follicle mites are very different in appearance, being elongate, worm-like, and even smaller in size. About two dozen species or varieties of species, are known to infest domestic animals, and among them are some of the most serious pests of live stock. So serious are the losses that may occur from sheep scab, and mange of horses, cattle and domestic foxes, that under the Animal Contagious Diseases Act, severe penalties may be incurred for failure to report cases. Fortunately quarantine measures and stringent regulations energetically enforced by the Dominion Health of Animals Branch have done much to remove the danger from these pests in Canada, and no cases of sheep scab have been reported for several years, and mange in horses and cattle has been reduced to a very low point and is well on the way to eradication. If mange is suspected it is best to immediately notify the nearest government veterinarian, since microscopic examinations of scrapings from skin under the scabs are usually needed for definite diagnosis, and especially since several skin afflictions, including the irritation caused by cattle and horse lice, may look much like mange.

While many of the mites are so similar in appearance that even experts have difficulty in differentiating between them, they vary considerably in habits and in the injury and effects produced on the host. The females of the true mange mites, *Sarcoptes* spp., for instance, burrow into the skin and lay a number of eggs in the minute tunnels formed; the scab mites, *Psoroptes* and *Chorioptes* spp., live on the surface of the skin, where the irritation and secretions from their sucking mouthparts cause the formation of extensive scabby areas. Psoroptic scab may spread over the body, but the chorioptic form is usually restricted to the base of the tail, feet and legs of animals, and shows little tendency towards spreading. The follicle mites, *Demodex* spp., live deep down in the skin in the hair follicles, and some, such as the very troublesome red mange

mite of dogs, cause severe irritation and bacterial infection which results in falling of the hair, hardening of the skin and general poisoning of the system. Another form of mite infests the ears of cats, dogs and foxes and may result in deafness or even death. Many of the mites affecting domestic animals show such slight anatomical differences that they are considered as merely varieties of two or three species, but while they may be capable of temporarily infesting hosts other than the preferred one, such infestations usually do not persist, but die out fairly quickly.

Nearly all types of mange in live stock are "worst in cold weather, when the animals have become weakened by lack of good food and through the hardships of winter. As soon as the grass comes back in the spring there is an immediate amelioration in the condition of the animals, the skin becomes normal again and the disease disappears, but the cure is only apparent" (Hadwen) and mange will flare up once more when suitable conditions recur. A few mites almost invariably survive and these multiply with rapidity under favourable conditions. These factors are of considerable importance in connection with control and eradication. The intense irritation resulting from mange is not caused by the movement of the parasites, but is due to poisonous substances secreted by them.

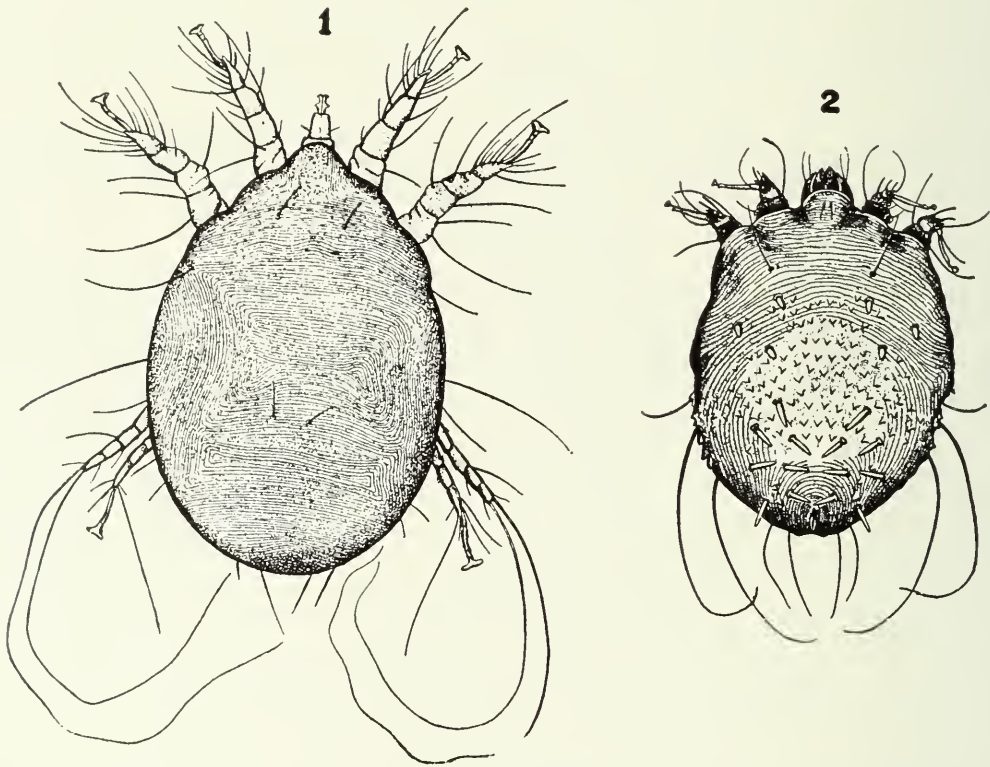


Fig. 68—1, Psoroptic mange mite; 2, sarcoptic mange mite (after Hilton).

In view of the difference in seriousness of infestation caused by the various mites, the different types occurring in various domestic animals are briefly outlined, giving the most noticeable symptoms and characteristics by which, at least in the early stages, the diseases can usually be fairly readily differentiated. Verification can be obtained by examination of scrapings from the edges of the scabs.

MANGE AND SCAB OF CATTLE

Four kinds of mange affect cattle, the most prevalent being common scab, caused by *Psoroptes communis bovis* Hering, a species that does not burrow but lives on the surface of the skin. Infestation may start on any part of the body thickly clothed with hair, but the withers, neck and root of the tail are usually first attacked, the mites spreading from these places until almost the entire

body is invaded. In the earlier stages of scab, marked symptoms are not very noticeable, the initial infestation with a few mites causing little scabbing. Even lightly infested animals, however, exhibit a tendency to scratch and rub at the affected parts, and the disarranged condition of the hair will give an indication of the trouble. If small papules exuding serum with red moist areas around them are noted, scrapings should be made with a dull knife, and examination with a strong lens or microscope will usually reveal the minute, white mites. They are best seen if slightly warmed and placed against a black background. The numbers of mites increase enormously within a few weeks, and on spreading, cause large areas to lose hair and become covered with serum oozing from the places where the mites have fed. This dries, and yellowish crusts or scabs become increasingly noticeable, and the intense itching causes the animal to scratch and rub in a vain attempt to obtain relief. The skin becomes hardened, and wrinkled with corrugations, and if the progress of the disease is not checked, the animal may become very emaciated and finally die.

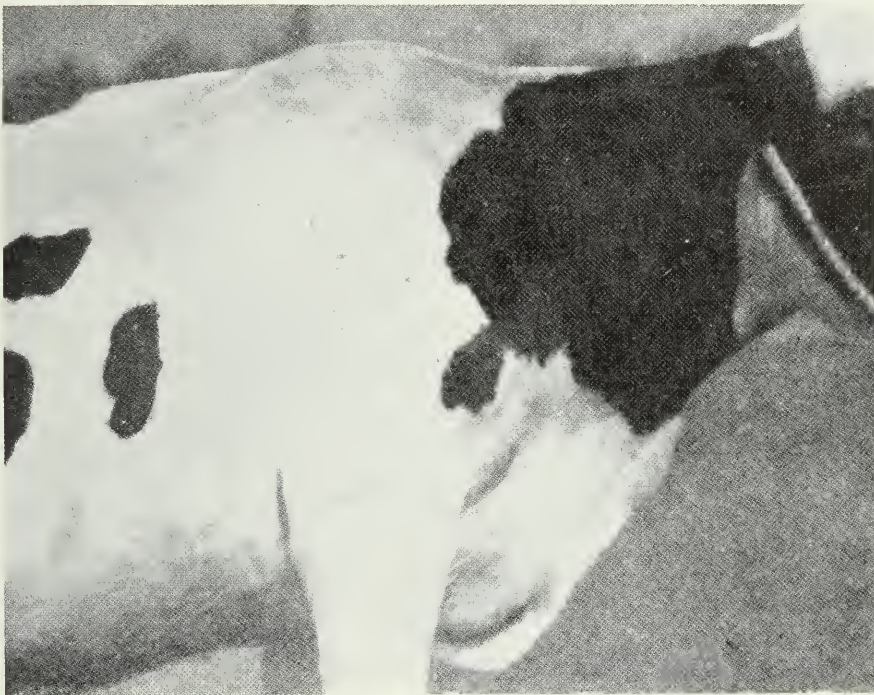


Fig. 69—Follicular mange in cow; note spotting over shoulders (after Hadwen).

Cattle mange caused by *Sarcoptes scabiei bovis* Robin is much less common, but is stated to be more troublesome and difficult to control than psoroptic scab owing to the fact that the mite burrows into the skin and passes much of its time protected in minute tunnels where the eggs are laid. Unlike the psoroptic form, it usually occurs on parts of the body where the hair is short, such as the inner surface of the thighs, the brisket and in the creases around the base of the tail. Once established, however, all parts of the body may be invaded. Little papules or cones of skin become noticeable, and these are capped with small yellow granules of dried serum. In later stages, a dry, scurfy appearance is given to the skin. Constant rubbing and scratching may cause large scabs to form, and it is then not easy to distinguish between common scab and sarcoptic mange without examination of the mites.

Tail mange, resulting from infestation with *Chorioptes bovis* Gerlach, is of comparatively rare occurrence in cattle. The mites live on the surface of the skin and have characteristics in common with the common scab mite, but the disease usually remains localized on the tail or legs.

Follicular mange is the rarest form and is not very often encountered. The very minute, worm-like mites, *Demodex follicularum bovis* Stiles, enter the hair follicles and live deep down in the skin. Small round lumps are formed,

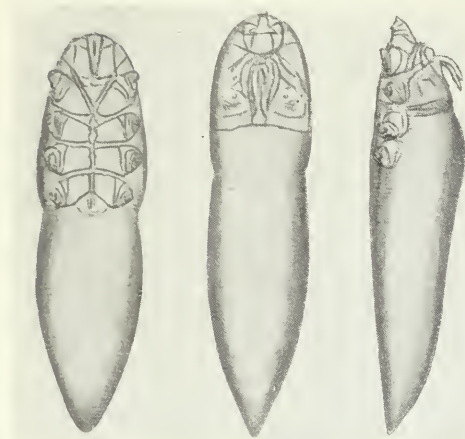


Fig. 70—Follicular mange mite, *Demodex bovis* Stiles, greatly enlarged (after Hirst).

varying in size from a millet seed to a pea, and these are filled with cheese-like matter. The lumps are usually first noted on the shoulder and neck. Warble grubs when first appearing may form rather similar minute papules, but these, of course, are not in the locations mentioned. This type of mange may cause such injury to the skin as to greatly reduce its value for tanning purposes. The disease is considered to be practically incurable, although regular dipping will do much to retard its progress. Fortunately, development is slow and the danger of spread from one animal to another is considerably less than in the other types of mange. It is advisable, however, to get rid of badly infested animals. This type of mange is not included as a notifiable disease under the Animal Contagious Diseases Act.

MANGE IN HORSES

No serious outbreaks of mange in horses have occurred in Canada for some time, and the disease is stated to have at no time been prevalent in the more advanced farming districts, where horses receive proper attention and are kept in good condition. Bands of half wild range animals which sometimes get into very poor condition due to shortage of winter feed are more likely to become seriously affected with mange, than are animals that are well looked after and adequately fed.

Three types of the disease occur in horses, asses and mules, but the sarcoptic type or dry mange, caused by *Sarcoptes scabiei equi* Gerlach, is the most troublesome and injurious form. The neck, shoulders and head are usually the parts first attacked, and while the disease spreads slowly in the earliest stages, it may later spread fairly rapidly in irregular patches until almost the entire body surface may be affected. Small vesicles are formed and the serum discharged from these results in small dry scabs. Constant rubbing increases these until large, blood-stained scabs may cover extensive areas. The skin becomes dry, scurfy and leathery and the affected parts become partly denuded. A fatal termination is not unusual when the disease is allowed to run unchecked.

Psoroptic mange, resulting from infestation with *Psoroptes communis equi* Hering, while less troublesome than the former kind, is a very serious disease. Any of the more densely haired parts of the body may be the initial points of infection, but it usually first appears at the base of the mane, on the head under the foretop or at the base of the tail. The rubbed or broken appearance of the hair at these places is usually the first noticeable sign of trouble. There is an eruption of small pimples containing liquid, and the crusts that develop remain moist and in this respect are unlike the dry scabs formed in sarcoptic mange. Unless treated, the disease spreads to all parts of the body, and the skin becomes thickened, wrinkled and denuded of hair in patches.

Tail mange or foot mange caused by *Chorioptes bovis equi* (Hering)* is confined to the tail and legs. It is stated that heavy horses, such as clydesdales, which have a plentiful growth of hair the "feather," low on the hind legs, are more liable to infestation than are lighter breeds. The disease is one of comparative rarity in Canada. Infested animals stamp and rub their legs together. The habits of the mites and the lesions produced are much as in those of the psoroptic scab mite, but the disease remains localized and is comparatively easy to control.

**Chorioptes equi* Gerlach.

SHEEP SCAB

This is the most serious of the diseases caused by the mange and scab mites and the mortality is very high unless suitable treatment is given. The few serious outbreaks that have occurred have been effectively stamped out, and Canada has been completely free from sheep scab for some years. It is stated that wild mountain sheep (Rocky Mountain bighorn) have occasionally become infested with this disease through using the same ranges as affected domestic sheep. The disease is caused by the sheep scab mite, *Psoroptes communis ovis* Hering, a species which lives on the surface of the skin. The first symptom is seldom noted owing to the heavy fleece, but consists of a reddened and inflamed area from which blood and then serum exudes. The upper and middle parts of the body on the withers and back are usually first attacked. Itchiness of the affected part is indicated by the scratching and rubbing of the host, and any sign of this and a broken appearance in the wool should always be considered a



Fig. 71—Sheep affected with sheep scab mite, *Psoroptes communis ovis* Hering (after Imes).

cause for investigation. The exuded serum dries, forming small scabs which extend in later stages and cover large areas. Constant biting and rubbing of the sheep in efforts to allay irritation cause large areas to become completely denuded of wool and the skin is thickened and shows numerous scabby sores.

The other two types of mange in sheep, head or sarcoptic mange, and foot mange, are not very often encountered and are of far less importance than sheep scab. The former is caused by a burrowing mite, *Sarcoptes scabiei ovis* Megnin, which attacks the head, usually in the portions not clothed with wool, and causes the formation of hard nodules which later scab over. "Black muzzle" is a name sheep men give to this condition. Foot mange caused by *Chorioptes communis* Verh. var *ovis*, a surface mite, is restricted to the lower parts of the legs below the wool. It causes great irritation, but does not spread much through a flock and is very easily controlled.

MANGE AND SCAB IN GOATS

Four different types of mange are known to occur on goats, but so far little trouble from these diseases has developed in goat-raising districts in Canada. The commonest form is sarcoptic mange caused by *Sarcoptes scabiei caprae* Fürstenburg. The head and ears are usually the initial point of infection but the disease is not restricted to this location, as in the case of the similar type of mange in sheep, but extends back over the body and limbs. Dry crusts are formed and the skin becomes thickened, wrinkled and denuded. There is intense irritation and animals become weakened and may die. The psoroptic type of mange, *Psoroptes communis caprae*, restricted to the inside of the ear, is fairly rare and sometimes appears to cause little injury. It may, however, result in deafness. W. Dwight Pierce reporting on milk goat problems in California, stated that 50 per cent of the animals examined during his survey were infested and that in many cases the ears were swarming with mites.* Chorioptic mange, *Chorioptes caprae* Gerv. and Benedin, is stated to start at the side of the neck and withers and may spread over the body. It is comparatively uncommon. In some of the goat-raising countries of Europe, follicular mange, *Demodex caprae* Railliet, is stated to be fairly prevalent and is mentioned on account of the difficulty in detecting it in the early stages and the possibility of its being introduced on imported animals. Rounded lumps about the size of a pea, containing grey matter, occur beneath the skin and seriously injure the hide for tanning purposes. The disease is practically incurable.

HOG MANGE

Sarcoptic mange caused by the mite, *Sarcoptes scabiei suis* Gerlach, is the only type of common occurrence and importance in hogs, although follicular mange, *Demodex phylloides* Csokor, occasionally affects these animals. Common mange usually starts on the head in the vicinity of the eyes, nose or ears, but spreads from here over the neck and shoulder and may ultimately cover the entire body. The parasites make burrows in the skin, and early symptoms consist of minute pimples capped with granules of dried serum. The hair stands erect and, in later stages, large areas of skin become bare. Affected parts have a dry, scurfy, blue-grey appearance at first, but owing to constant rubbing and scratching by the animal, lesions may later become broken down and the scabs remain moist. In advanced cases the skin is usually much wrinkled and hardened. The disease is one of considerable severity and may result in a very unthrifty condition in badly infested animals.

MANGE AFFECTING DOGS, FOXES AND CATS

Dogs and foxes are subject to infestation by several mange mites which cause very similar effects on both hosts. Sarcoptic mange, caused in the dog by *Sarcoptes scabiei canis* Gerlach and in the fox by *Sarcoptes scabiei vulpis* Railliet, usually commences on the head, but may spread over the entire body in the course of a month. The mites burrow in the skin and small red points are produced. Serum oozes from these and scabs are formed. The intense itchiness results in the infected animal constantly rubbing and scratching itself, and the skin may become denuded and covered with extensive scabby sores. If the disease is unchecked death usually ensues in about three months. While not uncommon in dogs, mange is of very rare occurrence on Canadian fox farms, which is fortunate on account of the ruinous effect on the pelts of these valuable animals.

Ear mange in dogs, foxes and cats is caused by *Otodectes cynotis* Hering, a mite slightly larger than most species, which lives on the surface of the skin on the inside of the ears. The minute punctures resulting from feeding cause

* State of California, Dept. Agr., Spec. Pub. 22, p. 10, 1922.

considerable irritation, although moderate infestations appear sometimes to be unnoticed. With heavy infestation, marked irritation is evinced and the animals rub and scratch their ears, and when the middle ear is invaded, very marked symptoms of trouble may develop, the head becoming twisted to one side and the animal moving in circles. Following bacterial infection, deafness, or even convulsions and death may result. The disease is said to be quite prevalent on Canadian fox ranches but, fortunately, is easily controlled by simple remedies.

Follicular mange caused by *Demodex canis* Leydig, and commonly referred to as "red mange" is a most serious disease of dogs, but is not known to occur on foxes. The elongate, worm-like mites live deep in the skin. The first symptoms are usually hairless, reddened spots about the eyes or elbows or hocks. The hairless areas become more extensive and the skin later appears deadened and greyish. Less irritation is noticeable than in the case of sarcoptic mange, but intermittent scratching may occur. This almost invariably results in bacterial infection and the formation of pustular pockets. The skin becomes thickened and the animal gradually weakens and dies. The course of the disease is not rapid and may run for a year or more. Most veterinarians refuse to undertake treatment, and it is best to destroy affected animals rather than be disappointed by the uncertainty of cure.

Cats are sometimes affected by a head mange caused by a mite known as *Notoedres minor* Fürst. var. *cati* Hering. Infestation often starts at the neck and extends to the ears, forehead and vicinity of the eyes, the body seldom being affected. Characteristic grey crusts and wrinkling of the skin are noticeable in the later stages.

MANGE OF RABBITS

Four varieties of mange affect rabbits, two caused by surface mites *Psoroptes cuniculi* Delafond and *Chorioptes cuniculi* Zürn., occurring in the ears, and two developing on the face and body. The latter are caused by burrowing mites, *Sarcoptes scabiei cuniculi* Gerlach, and *Notoedres minor cuniculi* Railliet. Ear mange is generally confined to the inner surface of the ears, and brownish crusts are formed in this location. The affected animals flap their ears and scratch at them with the hind feet. In advanced cases where the middle and inner ears are invaded, the head may become twisted to one side. Young animals sometimes develop convulsions and die.

The two other varieties of mange are very similar and, in both, the mites burrow into the skin. The region of the nose is usually first infected, but the chin, forehead, ears and legs soon become invaded, and the disease may later spread to any part of the body. Characteristic scabs appear on the infested parts and constant scratching and rubbing may result in the formation of open sores.

MANGE CONDITIONS IN POULTRY

Scaly Leg.—A fairly common condition in hens and some other domestic and wild fowl such as turkeys and grouse, is known as scaly leg, from the peculiar scabby enlargements and encrustations which involve the feet. This disease is the result of infestation of an almost round, flattened, burrowing mite, *Cnemidocoptes mutans* Robin, much like the various *Sarcoptes* mites previously referred to. Birds become lame and the health is seriously affected, and death may result if the disease is not



Fig. 72—Scaly leg of poultry caused by the mite, *Cnemidocoptes mutans* Robin (after Storrs).

checked. It is stated that the comb and neck are sometimes affected as well as the feet.

Depluming Mite.—These small, oval mites, *Cnemidocoptes gallinae* Railliet, attack the skin of the bird near the base of the feathers. The resulting irritation is so intense that the birds pluck out the feathers so that the skin is denuded in patches. The vicinity of the tail is usually first attacked but other parts later become infested. While known to occur in Canada, very little trouble from this parasite has so far been noted.

LIFE-HISTORY AND HABITS OF MANGE AND SCAB MITES

In outlining the life-history of these parasites, it will only be necessary to give a typical example of one of the burrowing kinds and one of the surface living forms, since most of the species within each of these two groups are fairly closely allied and have rather similar life-histories. The hair follicular mites have somewhat different habits and life-histories, but are of much less importance, and space will not permit a detailed discussion of them. In practically all of the mange mites the life cycle from egg to adult is completed in a very short period under favourable conditions. One generation follows another at fairly rapid intervals, and it has been estimated that the progeny of one pair of mites could total 1,500,000 in three months. This extraordinary ability for increasing indicates the necessity for thoroughness when measures of control are being attempted.

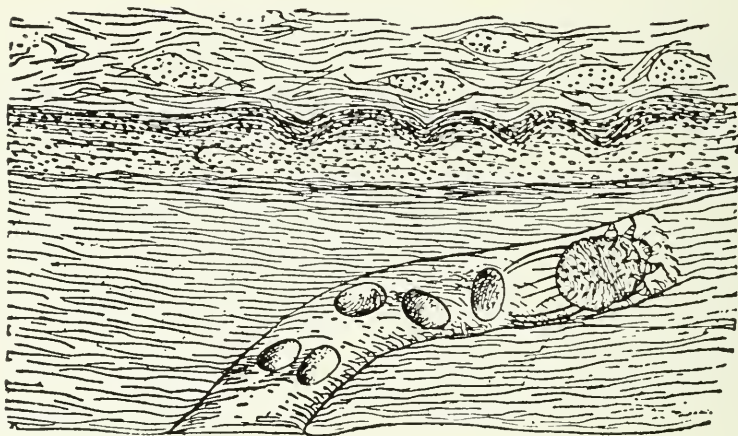


Fig. 73—Diagrammatic sketch of tunnels burrowed in skin by a sarcoptic mite (after Hirst).

Typical burrowing form.—The hog mange mite, *Sarcoptes scabiei suis* Gerlach. Fertilized females burrow into the superficial layers of the skin, making tortuous tunnels or galleries. The less hairy portions of the body are preferred. Toxic secretions of an extremely irritating nature are produced by the mites, and discharge of serum occurs at the mouth of the burrow. Oval eggs, that appear rather large for the size of the mite, are laid singly or in groups at short intervals in the burrows, during a period of about two weeks. The mite dies at the blind end of the burrow after from ten to twenty eggs have been deposited. The eggs hatch into six-legged larval mites after from three to ten days, and these pass through several moults before they reach maturity. They then escape from the burrows, wander about on the surface of the skin, mate, and the females commence new burrows in which they start egg-laying in about ten days. The males are comparatively short lived. New generations are thus produced at intervals of about two weeks.

The burrowing forms of mites do not spread quite so quickly from one animal to another as do the surface forms, but are fairly contagious when animals are

closely crowded. The first lesions are noticeable in from two to four weeks from infection. The active stages of the mites do not usually live long when away from the host animal, but eggs can remain for a week or more before hatching.

Surface type.—The sheep scab mite, *Psoroptes communis ovis* Hering. Mites in this group (*Psoroptes*, *Chorioptes*) never penetrate into the skin, but live on the surface or under the scabs formed. They prefer the parts of the body well protected with hair. When feeding, the skin is pierced by the short mouth parts and a poisonous and very irritating substance is introduced into the puncture. The resulting serum that exudes forms a scab, which is small at first, but gradually spreads owing to the preference the mites have for healthy skin. Apart from this, individual mites migrate and start fresh foci of infection on different parts of the body. Eggs are laid a few at a time in little bunches on the skin or at the base of the wool fibres, from fifteen to twenty-four eggs being laid during the life of each female. Hatching takes place in about four days, the newly hatched mites possessing only three pairs of legs. Maturity is attained in about a week, after several moults. Mating takes place and egg-laying commences in three or four days. The interval from one generation to another is about two weeks. The mites cannot propagate or increase away from the host, but have more vitality under such conditions than the sarcoptic species, and may survive for two or three weeks. Under laboratory conditions they have occasionally been kept alive for as long as two months off the host. This, of course, has an important bearing on the possibility of re-infestation from pastures and pens that have been contaminated by affected animals.

CONTROL OF MANGE AND SCAB IN DOMESTIC ANIMALS AND POULTRY

It will be seen from the varying life-histories and habits in the main groups of mange mites that some kinds will be much more difficult to control than others. The same general principles of control apply, however, to all groups, and in every case thoroughness to the extent of killing the last mite is essential for success. Dipping so that the animal is completely immersed in a suitable medicated solution is the only practical method of eradicating most mange diseases. One treatment is seldom sufficient and in some types of mange a succession of dips at proper intervals is necessary. Since mange mites thrive best on unthrifty animals, it is usually advisable to augment active control methods with liberal feeding.

Control of Mange in Horses, Cattle, Sheep and Coats.—Any of the standard lime-sulphur, nicotine or coal-tar-creosote dips are efficient against mange and scab mites if properly used. Where large numbers of animals are involved, lime-sulphur dip is probably the cheapest material. Home-made mixtures can be prepared by using the following quantities:—

Flowers of sulphur.....	24 pounds
Fresh unslaked lime.....	10 pounds
Water.....	100 gallons

The lime is slaked and made into a paste and the sulphur then added and thoroughly mixed in, all lumps being broken up. This paste is added to thirty gallons of boiling water and boiled for two hours, during which time it must be frequently stirred. The mixture should be allowed to stand overnight, and the liquid portion then syphoned off without disturbing the sediment at the bottom. Water should be added to the liquid to make up to 100 gallons and the solution is then ready for use in the dipping vat. It should be warm, the temperature being maintained at from 105° F. to 110° F. during the dipping operations. Care should be exercised to avoid any of the sediment getting into the dipping solution.

Commercial lime-sulphur, and other commercial dips mentioned above, should be used in strict accordance with the manufacturers' directions. What-

ever material is utilized, it is necessary to loosen all scabs and crusts with a stiff brush while the animals are in the solution, so that the liquid can penetrate into every crevice harbouring mites. Animals should be held in the dip for two minutes and immersed twice.

Two dippings are usually sufficient to control psoroptic or chorioptic scab, but four or more may be needed for the more resistant sarcoptic mange. The intervals between dips should be from ten to fourteen days in the former two types of mange, but should be from six to ten days in the latter.

Clipping the hair from horses and cattle is advisable if possible, before treatment is employed; dipping is most effective and is best accomplished when sheep have been sheared. Even if only a few cases of mange or scab are noted in a flock or herd, it is necessary to treat all the animals, since any contacts, even if they do not at the time show symptoms of the trouble, may harbour a few mites and develop mange unless they are treated.

In the case of well-broken animals, where only a comparatively small number are involved, the hand treatment method can be used. The hair should be clipped, the skin washed with soap and the following mixture well rubbed in:—

Flowers of sulphur.....	2 pounds
Oil of pine tar.....	8 ounces
Raw linseed oil.....	1 gallon

The mixture is heated, but not boiled, and should be applied hot. It should be left on for ten days, then washed off and the application repeated. It is useful also for killing lice.

Foot mange is readily controlled by driving affected animals through shallow wading troughs filled with dipping solution, or the animals may be treated with the above ointment, which is also effective for "black face" or sarcoptic mange in sheep. It is very useful for goats, which are refractory animals and difficult to dip.

A very important part of any attempt to eradicate mange is the cleaning-up of premises that have housed infested animals. It has been indicated that re-infestation is possible from such premises and also from fields in which mangy animals have been pasturing. These fields should be considered as dangerous and animals should not have access to them for a month or two. All litter should be removed from stables and other premises and burned at the time of the first dipping, and manure should be cleared out and placed where animals cannot have access to it. Following this general clean-up it is advisable to use a strong disinfectant or suitable dip solution on the floors or woodwork. A very good method is to mix a suitable disinfectant and insecticide with lime wash and apply this to woodwork as a spray. Carbolic acid in dilution to 5 per cent, or cresol in dilution to 2 per cent are useful in this connection, and there are also many good commercial products on the market which should be used in the dilution recommended by the manufacturers.

Control of Hog Mange.—Mange in hogs can be controlled by the treatment recommended for hog lice, or by the dipping and other methods mentioned for horses and cattle. Crude-oil dip is cheap and effective, and one dipping is usually sufficient for mange. If lime-sulphur dip is used, four dippings are needed with intervals between them of about a week. The temperature should be maintained at from 95° F. to 100° F. and animals should be held in the dip for three minutes. Lime-sulphur is stated to be ineffective against hog lice. Premises should be cleaned up and disinfected as described in the last section, and pens that have been occupied by mangy swine should not be used again for at least six weeks.

Control of Mange in Dogs, Foxes, Cats and Rabbits.—It is always important in attempting to control mange conditions in these animals, to pay especial

attention to the diet, and to keep the animals in as good physical condition as possible. Methods of control, for cases of body and head mange, consist of clipping the hair and washing with warm water and green soap, the scabs and crusts being removed with a brush. The following day a medicated ointment is applied to one-quarter of the animal, another part being treated on the succeeding day and so forth, until the entire skin surface has been covered. Nothing further is done for three or four days, after which the animal is again washed with soap and water, and the treatment repeated until the skin becomes completely healed and itchiness disappears. One of the simplest and most effective ointments consists of the following:—

Flowers of sulphur.....	1 part
Lard.....	8 parts
Balsam of Peru.....	1 dram

Foxes will respond to the above treatment, but on account of the danger of spreading this serious disease, it is advisable, if only a few animals are affected, to destroy them and burn the carcasses, following this with a thorough cleaning and disinfecting of the premises. The enclosures occupied by the infested animals should not be used again for at least four months. If it is decided to attempt to save particularly valuable foxes, control measures should be left in the hands of a competent veterinarian.

If follicular mange in dogs is at all far advanced, it is considered best not to attempt treatment but to destroy the animals. However, if a dog is very valuable and treatment is decided on, it is best to leave this to a veterinary practitioner.

Ear mange is not difficult to control in any of these animals if the procedure suggested below is carefully followed, using 1 per cent cresol, 1 per cent carbolic acid or creosote, added to glycerine. For foxes equal parts of tincture of iodine and glycerine are recommended. For ear mites in goats an ointment of flowers of sulphur in sweet oil is economical and effective. In all cases, the inside of the ear is swabbed with a cotton pledget held with forceps and moistened with the prescribed solution. Care should be taken not to injure the ear drums. The matter and detritus in the ear are then carefully cleaned out with a swab and the solution once more applied. The treatment should be repeated in seven days to kill any mites that may have hatched from eggs present at the time of the first treatment. Pens and premises occupied by affected animals should be thoroughly cleaned up and washed with hot coal-tar-creosote dip or other suitable insecticide, to prevent re-infestation from these sources.

Poultry.—A simple control for “scaly leg” in hens and other poultry is to dip the legs into crude petroleum or a mixture of equal proportions of kerosene and raw linseed oil. Kerosene alone is not so effective. Care should be taken not to get oil on the fleshy parts or on the feathers. Some poultrymen consider the above treatment rather drastic, and prefer the more laborious method of soaking the feet in warm soap-suds to loosen the scales and encrustations, and then applying an ointment consisting of one part of sulphur and nine parts of lard. Caraway oil mixed with lard in the proportion of one part of the oil to four parts of the lard is stated by some authorities to be the best remedy. To prevent contamination, the diseased birds should be isolated from the healthy ones, and the roosts in the hen house should be sprayed with crude oil or one of the commercial emulsified coal-tar disinfectants.

For the depluming mite dipping is effective, two ounces of flowers of sulphur and one-half ounce of laundry soap being added to a gallon of water. If lice are present, three-quarters of an ounce (one heaped tablespoonful) of sodium fluoride should be added to the preceding mixture. The treatment is also suitable for the northern fowl mite mentioned later. Dipping should be carried out in the same manner and with the same precautions as mentioned under control of biting lice of poultry by dipping in sodium fluoride solution.

THE CHICKEN MITE, *Dermanyssus gallinae* L.

This is without question the worst pest affecting poultry in Canada, and is so generally distributed that almost everyone who has kept hens will be familiar with it. When abundant, the specks of excrement from the mites give a "pepper and salt" appearance to boards in the poultry house. The mite, which secretes itself in crevices during daylight, is a small greyish or red object, about the size of a head of a pin when fully fed. It has four pairs of moderately long legs. When in an unfed condition the colour is greyish, but, after feeding on blood, the colour changes to dark red. The minute, elliptical eggs are white and glistening. Unlike the mange mites, this species is not a permanent parasite, but lives away from the host for much of the time, and only visits the bird for the purpose of obtaining a blood meal by means of its piercing and sucking mouth parts. It is essentially nocturnal and during the daytime hides away in

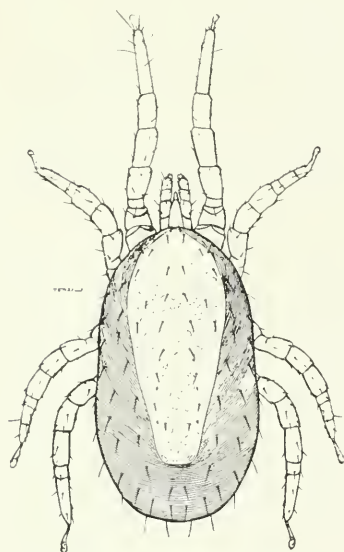


Fig. 74—The chicken mite, *Dermanyssus gallinae* L., (after Hirst).

cracks and crevices, where its eggs are laid. Within one-half to two days after obtaining a blood meal, from three to seven eggs are laid, and further egg-laying is repeated at intervals after feeding until two or three dozen eggs have been deposited. These hatch in two days into pale-coloured mites which feed on blood between each moult. Development is rapid and the life cycle may be completed during warm weather in as short a time as one week. The mites thrive best in very hot summer weather and are particularly troublesome in drier parts of the country. Severe injury may be caused to fowls when the mites are abundant, and an unusual drop in egg-laying may often be attributed to them. Chickens that are constantly worried and fed upon by these parasites become "dopey" and listless, and loss of blood is indicated by the pale appearance of the comb. It is not unusual for sitting hens to be killed outright by the effects of particularly heavy attacks. An important point in control is the remarkable longevity of these mites, even if they have no opportunity to obtain food; cases are known where

disused poultry houses remained infested for four months.

The nicotine sulphate (40 per cent strength) treatment recommended for poultry lice is stated to be of value as a protection against mites, but since these are parasites of the habitat rather than of the host, attention should be paid to controlling them in their hiding places in crevices of poultry houses. This is best accomplished by thoroughly spraying the premises with oily substances. For small houses a whitewash brush may be used. Many commercial mixtures are sold for this purpose, but one of the cheapest substances consists of a cupful of creosote mixed with a gallon of crankcase drainings. The best materials, however, for killing the mites, are stated to be certain commercial wood preservatives containing anthracene oil. The action of these mixtures persists for several months and lessens the chance of re-infestation. Before spraying operations are commenced, it is advisable to remove all loose boards, manure, and debris, and to take out all roosts and scrape them. These and nesting boxes should never be firmly nailed down but should be removable. Cracks and crevices in the building should be reduced as far as possible, since it is in these that the mites find protection. It is of advantage to have the buildings well lighted. Some poultrymen suspend their roosts by means of wires from the roof, and this affords much protection from the mites. When poultry houses are free of mites it is advisable to exercise care in preventing re-infestation through crates in which purchased birds have been received.

OTHER KINDS OF POULTRY MITES

Several other kinds of blood-sucking mites such as the northern fowl mite, *Liponyssus sylviarum* C. & F., and another species known as *Liponyssus canadensis* Banks, occasionally occur on fowl in Canada, but so far have not proved of serious importance. The former is rather generally distributed and is of particular interest on account of its difference of habits in comparison with the common chicken mite. It is a permanent parasite passing its entire life on the body of the host, the eggs being deposited and hatching among the feathers. In appearance it is very like the poultry mite only much smaller. Control consists of dipping in a wash of sulphur, soap and water as recommended for the depluming mite.

The air sac mite, *Cytoleichus nudus* Vizioli, is quite common in Canada and is found in the air passages, lungs and so forth. No control is known and affected birds should be killed and burned.

The connective tissue mite, *Laminosioptes cysticola* (Vizioli) is a peculiar form inhabiting tissues and, when dead, forming calcareous, white granules in the connective tissue beneath the skin of birds. The presence of these mites is apparently quite harmless to the host, but they are of interest in that the granules are sometimes confused with the symptoms of tuberculosis.

TICKS

Eighteen different kinds of ticks are known to occur in Canada, and further research will undoubtedly lead to the discovery of others. Fortunately few are of economic importance in this country, and only five require consideration as pests of live stock. A sixth, however, is briefly discussed, since it is the most abundant and widely-distributed species and is a factor in the spread of disease.

Adult ticks are eight-legged creatures, measuring a little less than one-quarter of an inch when unfed. They are flattened and bear a superficial resemblance to the common bedbug. The sexes are dissimilar in that the males have the entire back covered with a hard plate, whereas this is much reduced in the female and covers less than one-half of the front end. Fully-fed female ticks assume a very different appearance and become greatly distended and ovoid, resembling bluish-grey beans about half an inch or more in length. Both sexes anchor themselves to the skin by means of "a barbed sort of dart", the hypostome, through which they imbibe the blood of the host. Blood of mammals, birds and reptiles constitutes the only food of ticks, and without it they cannot complete their development. Many forms are extraordinarily hardy, however, and can survive two years or more without feeding. There is remarkable variation in the complicated life-histories of the different species. All agree, however, in having four stages: the egg, six-legged seed or larval tick stage, nymph, and adult; the latter two somewhat resemble each other and possess eight legs. In many cases three separate hosts are needed to complete development, the tick dropping off between each blood meal in order to transform to the next stage; such species are known as three-host ticks. In at least one of our commonest species the ticks do not drop to moult, but remain on the original host from the seed to the adult stage; this type is known as a one-host tick. All ticks leave the host animal to lay their eggs. Many species have a decided preference for one kind of animal, some attack only certain large animals in all their stages, while others, which in the seed and nymph stage restrict their attacks to small animals, prefer, when adult, the larger domestic and wild mammals. A few species appear to be less selective and are found on a wide variety of hosts. In tropical regions ticks are extremely numerous and constitute a very serious pest, but even in such temperate countries as Canada they are of considerable economic importance. Heavily-infested animals become weakened and emaciated and may even die from tick poverty. It has been

found that there is a shrinkage of one quart of milk a day in the case of dairy cattle carrying very large numbers of ticks. Several species are also known to transmit serious diseases of man and domestic animals.

THE PARALYSIS TICK, *Dermacentor andersoni* Stiles*

This species is also known as the Rocky Mountain spotted fever tick, and is very generally spoken of as the wood tick, a name that is misleading, since it is also applied to entirely different ticks in other districts, and also erroneously implies that this tick is restricted to woodlands. Actually, it is seldom an inhabitant of densely forested places, and is often quite abundant in open sage brush areas devoid of trees. It is common in willow brush and scrub-covered areas. With one doubtful exception, no other kind of tick has been implicated in tick paralysis of man or domestic animals on this continent, and it is this



Fig. 75—The paralysis tick, *Dermacentor andersoni* Stiles, female, enlarged and natural size (original).

species which most commonly attacks man in western North America. The body, head and legs of the female ticks are dark brownish red in colour, the shield being white with small curved red markings each side of the centre. Males are greyish white, with a number of irregular dark, blue-grey markings.

Life-history and Habits.—Winter is passed in the unfed nymphal stage, and as unfed adults, both sexes hibernating. The first warm days of early spring (usually in the latter part of March) induce activity, and the ticks crawl from the hiding places in which they have been concealed during the period of dormancy, and climb to suitable vantage points on dead twigs and other

* *D. venustus* Panks (synonym).

vegetation where they wait for the passing of an animal. If unsuccessful early in the season they may remain waiting until June, but the advent of hot summer weather causes those which are adult to again seek shelter, from which they do not emerge until the following spring. In some cases they have been known to repeat this proceeding for four years. When waiting on vegetation the adult ticks evince considerable excitement at the least disturbance, and stand with most of the legs extended ready to seize on any large animal that might brush past. With this accomplished, they usually crawl to the back, mainly attaching along each side of the backbone, or at the back of the head. They may, however, occasionally be found on the dewlap and brisket on cattle, and are quite commonly numerous on the belly and between the hind legs on horses. Mating takes place on the host, to which the female ticks remain attached from one to two weeks, before becoming fully engorged. It is during the latter part of engorgement when the tick is feeding very rapidly that paralysis may be induced



Fig. 76—Sheep on spring pasturage on typical rough hillside where ticks are abundant (original).

in the host animal. When full-fed, the females drop to the ground and seek protection under stones or debris, where about 6,500 eggs are laid by each tick. Since the engorged female is sluggish and does not move from her shelter, all the eggs are laid in a mass in one place. Egg-laying commences from two weeks to more than a month after the females drop, and extends over a period of several weeks, since only two or three hundred eggs can be laid each day. The female has an increasingly shrivelled appearance as egg-laying proceeds and dies shortly after her complement of eggs has been deposited. The eggs are brown and ovoid and covered with a sticky substance which holds them together and prevents drying. Hatching commences in from four to six weeks and may continue over a period of two weeks or more. Seed ticks usually begin to appear in June, shortly after the end of the adult tick season, and are particularly numerous on rodents during July. The young seed ticks (which have only three pairs of legs) ascend grass and other herbage and then attach themselves to the first rodent or other small animal that passes by them. They are not so hardy as adults or nymphs and, under natural conditions, seldom live for more than two

and a half months, if unfed. When successful in obtaining a host, engorgement is accomplished in about six days. They then drop off and, after a period of quiescence that may extend from one to four weeks, moult into the eight-legged nymphal stage. The advent of hot weather now, usually causes the nymphs to seek a sheltered place in which they remain until the following spring. Nymphal ticks are hardy and are capable of living for nearly a year. On emergence from hibernation at the commencement of warm spring weather, the nymphal ticks wait on vegetation for the passing of a small animal such as a



Fig. 77—Type of country infested by the paralysis tick in southern British Columbia (original).

groundhog or squirrel, and after engorging for about a week, drop off and remain quiescent on the ground for a period of from six to ten weeks. They then change to the adult stage, this being usually reached during the summer or early fall. The hot dry weather at this time causes the ticks of both sexes to seek sheltered places from which they do not emerge until the following spring. All summer they remain in an unfed, flat condition, since no attempt is made to feed during the hot summer months, and even if placed on an animal they will usually crawl off immediately.

It will be seen from the above that two years are needed to complete the normal life-cycle, but that this may sometimes be extended to three or even four years. There is much overlapping, nymphs of one brood and adults of another emerging from winter quarters at about the same time in the spring, the former to feed on rodents and other small animals, and the latter to engorge on the larger domestic and wild mammals. When the season for adult and nymphal ticks is over, and the summer weather has commenced, the seed or larval ticks can be found in numbers on small wild rodents.

Economic Importance.—The paralysis tick is the most injurious tick in Canada, and it constitutes a menace on account of the possibility of disease transmission. In the western United States, adjacent to the Rocky Mountains, it is the vector or carrier of a dreaded disease known as Rocky Mountain spotted fever, and also transmits tularaemia, a widely distributed plague-like disease of rodents, occasionally contracted by man and some domestic animals. Cases

of Rocky Mountain spotted fever have been reported in Western Canada in recent years. A fatal case developed at Manyberries, Alberta, in 1935, and one fatal and one non-fatal in 1936. In British Columbia, a suspected case at Pender Harbour, and two possible cases at Hedley were reported in 1936. During 1930, tularaemia for the first time was demonstrated with certainty as occurring in Canada, human cases being noted in Alberta and Ontario, and rodents being found infected in British Columbia. The disease may affect cattle and sheep, and the loss of 5,000 head of sheep in one year, in Idaho, in one locality alone, has been attributed to it by Dr. R. R. Parker.

A condition known as tick paralysis, which sometimes develops when this species is feeding rapidly is the most serious injury attributed to it in this country. As an index of the wide distribution of this trouble in British Columbia, incomplete returns from medical practitioners indicated that nearly 150 human cases had been noted in the province, these occurring in almost every district inhabited by this tick. Cases in sheep have been particularly numerous, and many deaths have resulted. Cattle are usually less susceptible, but trouble from tick paralysis has been noted from time to time, and in the spring of 1930 a



Fig. 78—Steer paralysed on the range by the paralysis tick (original).

serious outbreak in steers was investigated in one of the dry belt ranges of British Columbia: over 100 paralysis cases, sixty of them fatal, being noted in one herd. We know of only one equine case. In sheep districts, where this trouble is prevalent, flock masters are obliged to examine their animals frequently for the purpose of removing the offending ticks from sheep showing symptoms of weakness or staggers. This necessitates much lost time during a very busy period. In addition to being a factor in the disease conditions mentioned above, heavy tick infestation in itself reduces the vitality of the animals owing to the irritation and the amount of blood withdrawn. Domestic animals, deer, elk and Rocky Mountain goats are sometimes seriously affected in the spring months. The presence of ticks on animals may also attract blow flies. Hides punctured by numerous tick bites make inferior leather. Outbreaks of "poll evil" and "fistulous withers" that commonly occur in the spring months in unbroken range horses are probably, at least in part, due to tick infestation. Bad ulcers may form in man or animal as a result of tick bite.

Distribution.—Fortunately this tick has a somewhat restricted distribution in Canada. It is abundant in dry belt areas of British Columbia and south-

west Alberta, as far east as Medicine Hat. Its range extends from the United States boundary to at least 100 miles north of Kamloops, and it appears to be most numerous in the Kootenay district, but is apparently absent from the wet coastal belt, except when occasionally introduced on imported animals. It does not occur at all in Eastern Canada, but there is an isolated record from Manitoba.



Fig. 79—Characteristic attitudes of steers paralysed by the paralysis tick (original).

Control and Remedies.—Ticks, especially three-host species, are difficult to control, but the following methods have proved to be of value. Dipping of live stock three times, at ten-day intervals, commencing at the time the ticks first appear in the spring is very effective. The most satisfactory dip is compounded of sal soda crystals twenty-four pounds, white arsenic eight pounds, and pine tar one gallon, to every 500 gallons of water. While home manufacture is quite feasible, reliable proprietary products are available and their use is recommended. The manufacturers' directions should be scrupulously followed, as these materials are dangerous poisons. Where dipping vats are not available, the liquid may be applied by means of sprayers. Hand-picking can be resorted to for dairy cattle. When animals become paralysed, all ticks showing engorge-

ment should immediately be removed; in searching for them special attention should be paid to the back of the head, the region of the spine and along the neck, since this is where they mainly become attached. A dressing consisting of about three parts of raw cottonseed oil, or raw linseed oil, mixed with one part of oil of pine tar, applied from the back of the head along the neck and over the peak of the shoulders to half-way along the back, will usually kill the majority of the attached ticks in cattle. In horses, ticks often attach themselves under the jaw and between the front and hind legs. It is usually advisable to clip the mane before applying the dressing, since ticks are sometimes found in numbers hidden under the long hair. In addition to killing the attached ticks, the dressing will act as a repellent and prevent fresh infestation for some time. The dressing serves a useful purpose in preventing the attacks of blow-flies that frequently occur at the site of tick bites. Wherever it is possible, cattle and other stock should be confined in fenced tick-free pastures, during the period of tick activity in the spring months. Sheep, while very susceptible to tick trouble, have been claimed by some writers to be of value in destroying ticks. The long wool picks up numerous ticks, some of which undoubtedly perish from contact with the abundant oil in the fleece. It is no unusual thing to see numbers of such dead ticks at shearing time; Dr. R. A. Cooley, however, in a letter, expressed strong doubts of the value of sheep as tick destroyers, and stated that sufficient ticks feed upon sheep to maintain or even increase the tick population in the area grazed by the animals. He considers that sheep will feed more ticks than will horses and cattle. It is noticeable that the paralysis tick becomes excessively abundant in places where sheep bed down, and Dr. Cooley stated that Rocky Mountain spotted fever in Idaho is principally a disease among sheep-herders.

Another method of controlling the paralysis tick consists of the reduction of the rodent hosts, which are essential to the development of the early stages. The systematic killing-off of columbia ground squirrels and other small animals has had a marked effect in reducing the tick population in parts of Montana, where it has been undertaken for a number of years. It is, however, a rather costly procedure, although a good agricultural practice in view of the great damage done by rodents, apart from their influence on tick abundance. A number of rodents serve as tick hosts, but groundhogs and the columbia and other ground squirrels (gophers) appear to be the main hosts in Canada, and action should largely be directed against them. Poisoning is a most effective way of dealing with them. The following is a satisfactory rodent poison: dissolve one teaspoonful of saccharine in one pint of water and after adding half a pound of gloss starch, heat and stir until the mixture is thick, then add one pint of stock molasses. Now stir in one ounce of very finely powdered strychnine alkaloid, and pour the mixture over eight quarts of crushed oats, so that the grain is thoroughly covered, and then mix rapidly with the hands. The poisoned grain mixture can be spread on canvas or muslin racks to facilitate drying, the racks being put in some place not accessible to children or animals. It should then be most carefully labelled and stored to avoid any danger from poisoning. About a teaspoonful of the poisoned grain, when dried, should be scattered thinly over an area of about ten square inches around the mouth of each gopher burrow. For groundhogs, the addition of a little cracklings makes the bait more attractive. The very dangerous nature of strychnine should always be kept in mind, and the material should be used with care. Rubber gloves should be worn when mixing the bait and the hands should afterwards be very carefully washed. Another formula recommended by the British Columbia Department of Agriculture and tried out with considerable success in field experiments by our officers is as follows:—

Oats (clean, heavy).....	4½ bushels
Strychnine alkaloid.....	20 ounces
Baking soda.....	1 pound
Syrup.....	2 quarts

Petrolatum oil (clear, heavy, tasteless).....	1 quart
Saccharine.....	2 ounces
Borax.....	2 pounds
Starch (laundry).....	8 ounces
Salt (fine).....	2 pounds
Boiling water.....	5 quarts

1. Place oats on a smooth floor.
2. Mix syrup and petrolatum in a large pan.
3. Mix strychnine and soda by crushing finely.
4. Mix saccharine and borax into the boiling water.
5. Dissolve the starch in a pint of cold water. Stir this slowly into the boiling water. Boil and stir until a clear, fairly thick paste is formed, taking care not to allow the paste to scorch.
6. Add the starch paste to the poison mixture and stir thoroughly until a smooth, creamy mass is formed.
7. Pour the mixture over the oats and mix rapidly with a wide shovel, using care to prevent the paste from running to the floor before it is taken up by the grain. Mix well until no dry kernels remain.
8. Sift the salt over the wet bait and mix again.

The same precautions in preparing and using this poisoned bait as outlined in connection with the preceding formula should be carefully observed.

Calcium cyanide is also of value in killing rodents and is safer in sheep and hog pastures, where it may be inconvenient to move these animals during poisoning operations. The manufacturers' directions should be closely followed, since this also is a very poisonous material.

Of late years much attention has been paid to the use of natural parasites as an aid in tick control. Several minute bee-like insects parasitize and destroy ticks, and in Montana these have been bred in a special laboratory and liberated in very large numbers. It is hoped that they may prove a valuable factor in the control of the paralysis tick.

THE ELK TICK OR WINTER TICK, *Dermacentor albipictus* Packard

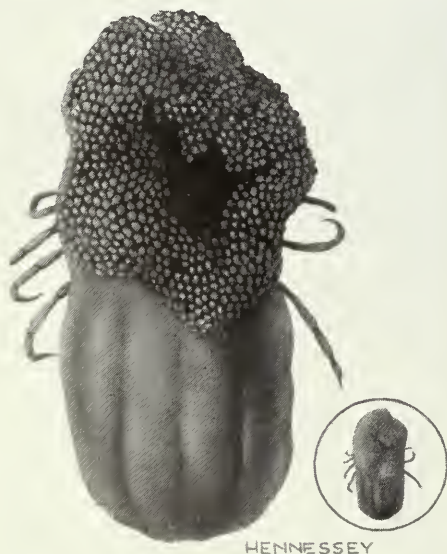


Fig. 80—The elk or winter tick, *Dermacentor albipictus* Pack., shrivelled female with mass of eggs; enlarged and natural size (original).

Elk tick, moose tick and horse tick are among the common names for this species since it is found very abundantly on these hosts. It is by no means restricted to the moose or elk, but attacks a variety of large domestic and big game animals.

The adult female ticks when flat are usually slightly larger than the females of the paralysis tick, and are noticeably more sluggish in movement. The body, legs, and head are paler red-brown in colour, and the white shield has a long central red line in addition to the two lateral ones. When fully engorged, the females are bean-like and resemble the former species. The shield covering the entire back of the male is whitish and the numerous irregular markings are salmon coloured.

Life-history and Habits.—The life-cycle of this species differs markedly from that of the paralysis tick. Seed ticks, which have remained torpid and bunched tightly together from the time of hatching, are wakened to activity by the first cold weather of the fall, when they take up a waiting position on vegetation in order to secure a host. In British Columbia they have first been noticed attaching in numbers about mid-October, but in northern Saskatchewan they probably commence to seek hosts in late September. They are active throughout the late fall, winter and early spring. Unlike the paralysis tick, only one host is needed in this species, and moulting takes place on the original host animal, following each blood meal. The larva or seed tick moults about ten days after attachment, and the nymph after two weeks. Adult females usually become fully engorged and drop from the host about six weeks after the seed ticks first become attached. Egg-laying in the case of females dropped in the spring may commence in less than two weeks, but it may be delayed for four months or more in the case of females that have left the host during the winter. Egg-laying activity is therefore mainly restricted to the spring months, in March, April and early May. The eggs are laid in a large mass over a period of several weeks, about 200 being laid each day until a total of 4,000 or more have been deposited. Hatching takes place in approximately six weeks, most of the eggs in one batch hatching at about the same time. The seed ticks bunch together tightly, as a protection against drying-out during the hot summer weather, and remain torpid until the first cold days of autumn. They have remarkable vitality and have been known to live for over a year without food.

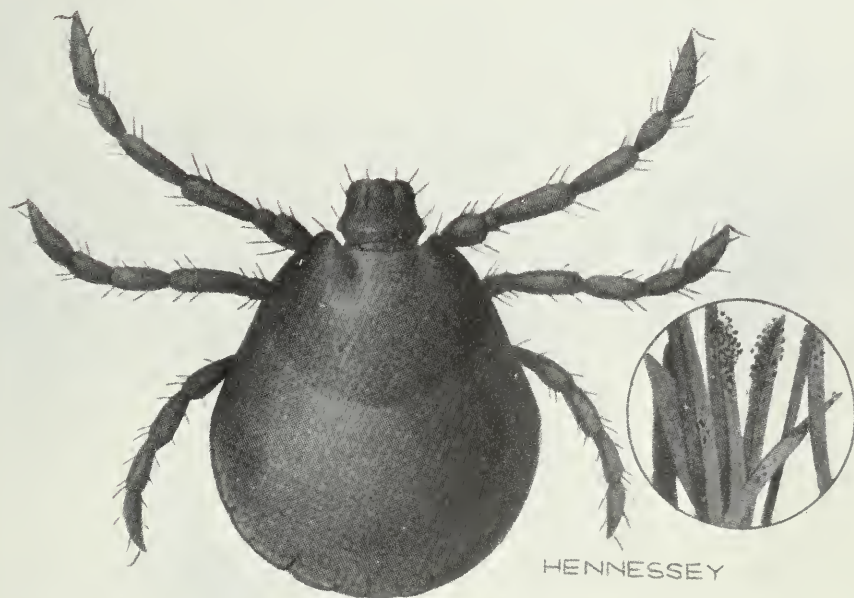


Fig. 81—The elk or winter tick: larval or seed ticks on grass waiting for host, enlarged and natural size (original).

Economic Importance.—The elk or winter tick is often sufficiently abundant to cause serious losses. Heavy infestation of horses, cattle, moose, elk and deer may result in death from “tick poverty” due to the drain on the vitality of the infested animals. In this respect, it is the most important species occurring in Canada, since it attacks animals during the period when feeding conditions are at their worst, and is an especially serious pest during hard winters when the resistance of animals is lowered through food shortage. The death of horses, deer and other large game animals has been reported from time to time in British

Columbia, northern Alberta and northern Saskatchewan. In some seasons moose are stated to have been seriously depleted in parts of Saskatchewan and, in one outbreak in the northern part of this province, one farmer lost 107 horses and cattle out of a total of 150 head. Reports indicate that moose are also killed in numbers in New Brunswick and Nova Scotia during some winters. The Chief Forester for the latter province estimated that in the winter of 1930 the elk tick caused a loss of at least 20 per cent of the moose population. Rangers reported that heavily-infested animals were found dead or dying, and that others were weak and thin. In many cases the withers were raw and blood-stains were noted where moose had rested. The naturalist, Thompson-Seton, states that ticks are among the four most serious pests of moose in Manitoba. The winter tick has a much wider range than the paralysis tick, and occurs throughout Canada, from the Pacific to the Atlantic coast. In the Prairie Provinces it is mainly confined to wooded northern sections, and is essentially a tick of the uncultivated rougher ranges and bush areas.

Control.—Where possible, cattle and horses should be confined in fenced tick-free pastures from September until May, as they will then escape attack. If infestation has occurred prior to rounding them up from the ranges, dipping is advisable, if this can be accomplished before the weather becomes too cold. Oily dressings are useful for the removal of attached ticks, as previously mentioned, but should be used sparingly. Ploughing is a most effective measure for destroying ticks in an infested field. It should be carried out in May after all the ticks have dropped; engorged females and eggs will be buried and will cause no further trouble.

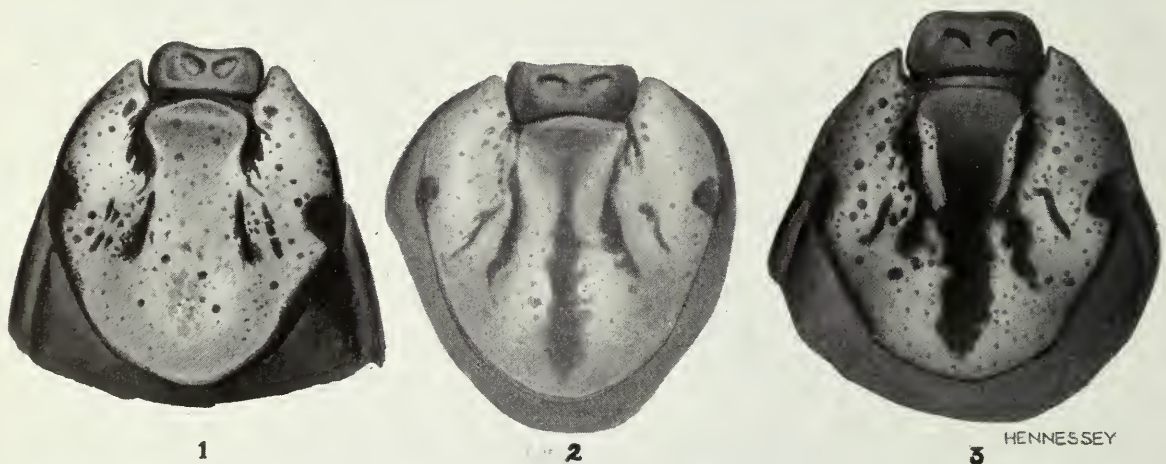


Fig. 82—A comparison of the shield and typical markings of: 1, the paralysis tick; 2, the elk or winter tick; 3, the American dog tick, all much enlarged (original).

THE AMERICAN DOG TICK, *Dermacentor variabilis* Say

This is an eastern tick which is particularly abundant in Manitoba, parts of Saskatchewan and a few districts in Ontario. It closely resembles the paralysis tick of the west in appearance, habits and life-history, but can be distinguished by the larger area of red on the white shield of the female, there being a broad central marking of this colour. The adults are particularly numerous and troublesome just after the snow leaves in the spring, and are seldom noticeable except during the spring months. Three hosts are required, and the entire life cycle may occupy two or more years. Dogs and cattle appear to be the preferred hosts for adults, but various other animals are attacked, including man. It has been demonstrated experimentally that both tularaemia and Rocky Mountain

spotted fever can be transmitted by this tick and it should therefore be considered as a potentially dangerous species. Cases of both diseases have been reported in places in the United States where this is the most common tick and where the paralysis tick is not known to occur. Apart from this, it is not a species of serious economic importance, although it may be troublesome when abundant. The bite may result in suppuration and irritating sores that may persist for months. It is advisable to cover attached ticks with an oily substance, to remove them carefully and to disinfect the site of the puncture.

THE CASTOR BEAN TICK, *Ixodes ricinus* L.

This is a greyish species with a red-brown shield. When fully engorged, adult females resemble castor bean seeds. In Canada, it is found most commonly in British Columbia, and attacks deer, sheep, cattle, man and a number of different wild animals. It has a cosmopolitan distribution, having been found in Europe, Asia and Africa, as well as throughout America. At the present time it does not appear to be a species of much economic importance in Canada, but is of interest in that it transmits several diseases of domestic animals in other countries. In Great Britain it is the main vector of "red water" of cattle; and possibly of "looping ill," a disease causing paralysis in sheep. There is evidence that other little understood diseases may be carried by it, but so far, no trouble in this connection has been experienced in Canada. This is another three-host tick. The larvae engorge in less than a week, and drop to the ground to moult about three weeks later. Following attachment to a new host, the nymphs engorge for about the same length of time, drop, and change to adults after a somewhat longer interval. Adult females feed from one to two weeks, and begin depositing eggs about two weeks after dropping and seeking shelter. Hatching usually commences in about six weeks but may take much longer. There is remarkable vitality in all stages, larvae and nymphs having been kept alive without a meal for a year and a half, and adults for over two years. Since very bad sores may result from the rough removal of an attached tick, it is advisable to apply an oily substance before this is attempted. If this, or the application of a heated wire to the rear end fails to make it relinquish its hold, the tick may be gently pulled up and a small piece of skin, with the embedded mouthparts, snipped off with a sharp pair of scissors.

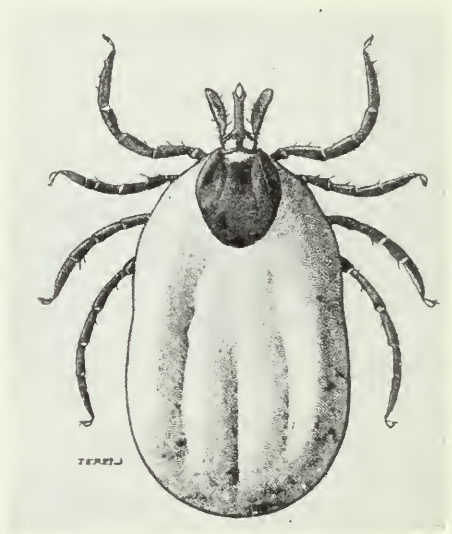


Fig. 83—The castor bean tick, *Ixodes ricinus* L., engorged female (after Hirst).

THE BIRD TICK, *Haemaphysalis cinnabarina* Koch.

The bird tick is rather a uniform brown in colour, and, in common with others of the *Haemaphysalis* group, has mouthparts resembling a little arrow-head, owing to the palpi (feelers) being expanded sideways at the base. It is a three-host tick and attacks a wide variety of animals, both domestic and wild, game birds, and poultry. The hosts vary in size from cattle to quail. It is referred to as the "bird tick" owing to its frequent occurrence on birds. In Canada it has been recorded mainly from Manitoba, although it is known also from Alberta and British Columbia, and probably occurs in the eastern provinces as well. Seymour Hadwen has informed us that he has noted it on turkeys at Flfros, Saskatchewan. The life-history is somewhat similar to that of the castor bean tick, but adults have usually been found on cattle in the late summer

months. Comparatively few complaints have been received about this tick, but it may at some future time cause trouble if its numbers increase. Experiments in Great Britain indicate that this species (or a very close ally of it) is capable of transmitting "red water" disease of cattle. The only known case of tick paralysis in Canada, due to a species other than *Dermacentor andersoni* Stiles, was attributed to a specimen of the bird tick found attached to the patient. There is a possibility, of course, that a paralysis tick was also attached and escaped notice. The case ended fatally. The bird tick is known to cause serious losses in turkeys, which from their habits are particularly liable to become infested. The death of turkeys in Alberta has definitely been traced to *H. cinnabarina*, and complaints received from time to time from other parts of Canada are doubtless due to infestation by the same species. It is common on blue grouse and pheasants in the dry belt of British Columbia, and is suspected of causing the death of the former in certain parts of that province. When cattle become heavily infested, the application of a small quantity of oily dressing is advisable. Too liberal use of oil is dangerous, and even in bad infestations four ounces per animal is sufficient. In the case of turkeys, hand-picking should be resorted to, since the ticks are usually to be found only on the neck and head.

THE RABBIT TICK, *Haemaphysalis leporis-palustris* Packard

These small, dark-brown ticks principally attack rabbits and are more widely distributed than any other species occurring in Canada. The mouth-parts and palpi present a characteristic arrow-shaped appearance. Three hosts are required for development, but larvae, nymphs and adults may all be found on an animal at the same time. In addition to rabbits, ground-birds such as grouse and meadow-larks are affected, but to a lesser extent. Rabbits often become infested with several hundred ticks and such heavy parasitism results in extreme weakness and emaciation. The tick is mainly of interest as an indirect factor in the spread of tularaemia and Rocky Mountain spotted fever. Rabbits form the most important reservoir of tularaemia, and the rabbit tick is the chief means by which it is spread from one animal to another.

OTHER CANADIAN SPECIES OF TICKS

Wild animals harbour various other kinds of ticks, which are of little economic importance except as they may affect fur-bearers. Two injurious southern live stock ticks, the lone star tick, *Amblyomma americana* L., and the spinose ear tick, *Ornithodoros megnini* Duges, have been taken in Canada, but probably were introduced on imported animals, and fortunately do not appear to have become established. The latter species was not found on cattle, but was taken on jack-rabbits in southern Alberta. A species of *Dermacentor*, the identity of which is at present unknown, has been the subject of a number of complaints from Vancouver Island.

MONTHLY PROGRAM OF LIVE STOCK INSECT AND ARTHROPOD CONTROL

For easy reference the major pests affecting live stock during each month of the year are outlined below, with suggestions for a control program. This outline is of necessity very generalized owing to the different conditions occurring in various parts of the country.

January.—Examine cattle for grubs of the common heel fly that are first noticeable about the middle of the month, squeeze them out or arrange with neighbours for a co-operative control campaign (see page 46). Look over horses,

cattle and sheep for presence of lice which increase greatly and are abundant from mid- to late winter; if only biting lice are present dust with sodium fluoride, if both sucking and biting lice are noted use raw linseed oil on horses and cattle (see page 75); for foot lice on sheep wash their feet with a dip (see page 75). If mange is present it will be noticeable by now, and, if so, notify a veterinary inspector (see page 77). In large flocks this is a good time to crutch pregnant ewes which may be difficult to handle in April (see page 60).

February.—About the middle of the month (in British Columbia) apply the first derris wash for community warble fly control, or squeeze out grubs. Examine horses and cattle for the winter tick; they will be large and noticeable by this time; if numerous, apply raw linseed oil with a little oil of pine tar (see page 98). If sheep ked is numerous, dust small flocks of valuable sheep with pyrethrum powder (see page 64).

March.—About the 11th of the month (in British Columbia) apply the second derris wash for co-operative warble fly control, or squeeze out the grubs. In the Prairie Provinces and Eastern Canada apply the first wash about the third week of the month. If winter ticks are abundant on horses and cattle, and dropping for egg-laying, treat with raw linseed oil. From late March to May, restrict sheep and other stock in the dry belt of British Columbia, to low valley pastures free of the paralysis tick, avoiding brushy side hills (see page 95). When dehorning apply raw linseed oil and oil of pine tar, from the base of the skull along the backs of cattle, so as to kill or prevent attacks of paralysis tick (see page 95). Burn all old straw stacks and later plough under, to prevent breeding of stable flies (see page 17). Scatter manure accumulated during the winter thinly over the fields, and clean up all places that may breed house-flies (see page 10).

April.—About April 11th (in British Columbia) apply the third derris wash to kill warbles; if adults of the common warble or heel fly start to worry cattle, provide darkened shelters. In other provinces apply the second derris wash about mid-April. In dry belt areas where the paralysis tick is abundant, remove all engorged ticks immediately sheep or cattle show "staggers"; if possible dip cattle three times at ten-day intervals in worst areas (see page 94), or apply raw linseed oil and oil of pine tar along the backs; start systematic strychnine poisoning, shooting and trapping to reduce ground hogs, "gophers" and other rodent hosts of immature stages of the paralysis tick (see page 95). Clean up sheep early in the month by careful crutching. If pregnant ewes were not crutched earlier they should be dealt with now, but should be held with a halter and not placed on their backs. If maternity pens are utilized crutching can conveniently be undertaken immediately following lambing. Avoid a sudden change to succulent feed which results in scours, as blow-flies commence to be troublesome the latter part of the month (see page 57). In late April control mosquitoes by oiling pools formed from melting snow (see page 21). Treat sitting hens with sodium fluoride by pinch method, to kill all lice before hatching of chicks (see page 76).

May.—About mid-May, apply the fourth derris wash in British Columbia, and the third in other provinces, for warble fly control; adult heel flies are active and shelters are needed for cattle. Blow-fly trouble is at its worst if the weather is showery, so burn all carcasses and carrion and use poison traps for flies; treat all brands and cuts and shearing wounds on sheep, with oil of pine tar as a repellent (see page 59). Dip lambs after ewes have been sheared, to prevent sheep keds from concentrating on them (see page 64). Sheep bot fly commences to worry sheep towards the end of the month, therefore tar their noses or provide tarred salting-logs (see page 54). Plough under fields badly infested with winter tick; this will kill eggs and seed ticks, and the field will be clean the following autumn (see page 98). In the West, shoot and trap ground hogs, gophers and

other rodents to reduce hosts of the paralysis tick. Draw out and scatter manure thinly on the fields to prevent breeding of house flies, or utilize manure rack and maggot trap (see page 11). Oil all snow and rain pools where mosquitoes are breeding.

June.—About June 17th, apply the fifth (fourth in colder sections) derris wash for community warble fly control; the large warble fly is on the wing from the end of the month until August; provide shelters for live stock as protection against warble flies, nose flies and horse flies. The biting-fly season starts in early June; horse flies, mosquitoes and blackflies become troublesome. In Saskatchewan guard against swarms of blackflies that may kill cattle; provide smoke smudges whenever these appear (see page 28). Horn flies will be abundant, scatter cow droppings in the pasture twice a week to dry these out and prevent the flies from developing. Do not let manure accumulate in barn yards to breed flies. Watch for first appearance of nose bot flies and provide fringe protectors for horses (see page 34). In paralysis tick districts early June is a good time for a second drive against ground hogs and other rodent tick hosts; plan a systematic community campaign of poisoning. Watch the river freshets and oil mosquito breeding floodwaters and pools (see page 21). Chicken mites begin to be most troublesome at advent of hot weather; clean up poultry houses and spray thoroughly with crude oil (see page 88). Apply 40 per cent nicotine sulphate to roosts in poultry houses to control hen lice and mites (see page 77). In Eastern Canada, the rose chafer commences to appear in early June and lasts until July, protect chickens from poisoning by confining them in areas devoid of vegetation attractive to the beetles; mow chicken ranges on large poultry farms about June 1.

July.—This is the worst month for biting-flies: horse flies, blackflies, mosquitoes and horn flies, some are on the increase; nose and throat bot flies are at their worst on horses, and the large warble fly is apt to stampede cattle. Unless it has been attended to before, protection against these pests should not be neglected during this month. Provide darkened brush shelters, or house animals, during the daytime, when this is at all feasible; see that smoke smudges are ready at the first sign of blackfly swarms in Saskatchewan and elsewhere. If horse flies are very abundant use fly-nets on work horses. Provide approved protectors to prevent egg-laying on horses by the nose and throat bot flies. House flies may start to become numerous, so scatter manure to prevent breeding, and provide fly traps in dairy buildings and barns (see page 16). A second spraying for poultry mites may be needed; examine chicken houses to see if last spraying was effective.

August.—On high mountain sheep-ranges blood-sucking flies such as horse flies and biting snipe flies are at their worst during early August; pack horses may require some protection, especially against the latter; a repellent mixture may give some protection; smoke smudges are often necessary. In some places blackflies are particularly bad now; as a protection against the ear-infesting species provide horses with linen ear bags (see page 29). The latter part of August is a good time to dip farm flocks for the sheep tick or ked; a second dipping will be needed after twenty-four days interval. Treat household pets and the premises on which they are kept for fleas (see page 66). House flies are often extremely numerous; continue proper disposal of manure, use properly-baited fly traps in dairy buildings and around barns, and utilize pyrethrum-kerosene spray for destruction of flies on the wing in such places (see page 16). Watch sheep for blow-fly trouble.

September.—This is the last month for safe dipping in colder sections, as in the Prairie Provinces, Start your stock into winter, protected against lice, mange, and other external parasites, by systematic dipping of all horses and cattle; two dips should be given with an interval of about two weeks (see pages

74, 85). Range sheep should be dipped for sheep ked and other external parasites, as soon as they are brought down from mountain pastures, since two dippings are necessary and there should be an interval of twenty-four days between them: usually there are sufficient warm days to accomplish this (see page 63): dipping is unsafe in cold weather. Hogs should be cleared of lice and other external parasites by use of medicated wallow, if this was not attended to before; give treatment before start of cold weather (see page 75). Where winter tick is abundant bring in horses and cattle from rough brushy ranges before the advent of cold weather, when seed ticks become active and commence to infest animals; horses and cattle should be wintered in tick-free pastures until May (see page 98). Another application of 40 per cent nicotine sulphate to roosts in poultry houses is advisable, as a protection against lice and other external parasites.

October.—Whenever possible it is advisable to breed ewes not later than October, to produce lambs in March, in order to avoid blow-fly trouble; even earlier breeding is preferable where feasible. Black flies may still be very troublesome in some sections and horses should be given the protection of ear-bags against species that prefer that part.

November.—This is the time to put all buildings and animal sheds in good sanitary condition for the winter; use disinfectant lime wash (see page 85), which will destroy any mites, lice and other parasites that may be harbouring in crevices and woodwork. Arrange with a competent veterinarian to treat your horses with carbon bisulphide for bots, at the same time wipe the legs and other places where eggs are laid with 2 per cent coal-tar-creosote dip to destroy any unhatched eggs of the common bot fly; arrange with neighbours for a systematic treatment of all horses in the district. In the case of large range flocks in the interior sections of British Columbia, and in colder parts of the Dominion, flock masters find that November is the most convenient time to breed their ewes so that lambs are dropped in April. In view of blow-fly trouble, breeding should be as early as possible.

December.—Treatment of horses for bots should be completed by mid-December, if this is at all possible. Watch the animals for signs of lice or mange.

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PRINTED BY
J. O. PATENAUDE, I.S.O., KING'S PRINTER
OTTAWA, CANADA