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## STOMACH WORMS (*HEMONCHUS CONTORTUS*) IN SHEEP.

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The stomach worm of sheep, known to zoologists as *Hæmonchus contortus*, is generally recognized as one of the most serious pests with which the sheep raiser has to contend. Sheep of all ages are subject to infection, and cattle and goats as well as various wild ruminants may also harbor the parasite. The most serious effects of stomach-worm infection are seen in lambs, while full-grown sheep, although heavily infested, may show no apparent symptoms of disease. It is from these, however, through the medium of the pasture, that the lambs become infected.

### SYMPTOMS AND DIAGNOSIS.

Among the symptoms which have been described for stomach-worm disease probably the most frequent are anemia, loss of flesh, general weakness, dullness, capricious appetite, thirst, and diarrhea. The anemic condition is seen in the paleness of the skin and mucous membranes of the mouth and eye, and in the watery swellings which often develop under the lower jaw. A more certain diagnosis may be made by killing one of the flock and opening the fourth stomach. The contents of the fourth stomach are allowed to settle gently, and by carefully watching the liquid the parasites, if present in any considerable numbers, will be seen actively wriggling about like little snakes from one-half to  $1\frac{1}{4}$  inches long and about as thick as an ordinary pin.

### LIFE HISTORY OF THE STOMACH WORM.<sup>a</sup>

The worms in the stomach produce eggs of microscopic size, which pass out of the body in the droppings and are thus scattered broadcast

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<sup>a</sup> Some of the details in the life history of this parasite are treated more at length in Circular No. 93 of the Bureau of Animal Industry.

over the pasture. If the temperature is above  $40^{\circ}$  to  $50^{\circ}$  F. the eggs hatch out, requiring from a few hours to two weeks, according as the temperature is high or low. When the temperature is below  $40^{\circ}$  F. the eggs remain dormant, and in this condition may retain their vitality for two or three months, afterwards hatching out if the weather becomes warmer. Freezing or drying soon kills the unhatched eggs. The tiny worm which hatches from the egg feeds upon the organic matter in the manure, and grows until it is nearly one-thirtieth of an inch in length. Further development then ceases until the worm is swallowed by a sheep or other ruminant, after which it again begins to grow, and reaches maturity in the fourth stomach of its host in two to three weeks. The chances of the young worms being swallowed are greatly increased by the fact that they crawl up blades of grass whenever sufficient moisture—such as dew, rain, or fog—is present, provided also that the temperature is above  $40^{\circ}$  F. When the temperature is below  $40^{\circ}$  F. the worms are inactive.

The young worms which have reached the stage when they are ready to be taken into the body are greatly resistant to cold and dryness; they will stand repeated freezing, and have been kept in a dried condition for thirty-five days, afterwards reviving when moisture was added. At a temperature of about  $70^{\circ}$  F. young worms have been kept alive for as long as six months, and the infection in inclosures (near Washington, D. C.) which had been pastured by infested sheep did not die out in over seven months, including the winter, the inclosures having been left vacant from October 25 to June 16. It is uncertain whether infection in fields from which sheep have been removed will die out more rapidly during warm weather or during cold weather; experiments on this point are under way, but have not been sufficiently completed for definite statements to be made. It is, however, safe to say that a field which has had no sheep, cattle, or goats upon it for a year will be practically free from infection, and fields which have had no sheep or other ruminants upon them following cultivation may also be safely used. The time required for a clean pasture to become infectious after infested sheep are placed upon it depends upon the temperature; that is, the field does not become infectious until the eggs of the parasites contained in the droppings of the sheep have hatched out and the young worms have developed to the final larval stage, and the rapidity of this development depends upon the temperature. It may be stated here that neither the eggs nor the newly hatched worms are infectious, and only those worms which have reached the final larval stage are able to continue their development when swallowed. This final larval stage is reached in three to four days after the eggs have passed out of the body of the host if the temperature remains constantly at about  $95^{\circ}$  F. At  $70^{\circ}$  F., six to fourteen days are required, and at  $46^{\circ}$  to

57° F., averaging about 50° F., three to four weeks are necessary for the eggs to hatch and the young worms to develop to the infectious stage. At temperatures below 40° F., as already stated, the eggs remain dormant.

#### METHODS OF PREVENTING INFECTION.

It is evident from the foregoing statements that in the northern part of the United States, under usual climatic conditions, infested and noninfested sheep may be placed together in clean fields the last of October or first of November and kept there until March or even later, according to the weather, with little or no danger of the noninfested sheep becoming infected. If moved then to another clean field they may remain there nearly the entire month of April before there is danger of infection. From the 1st of May on through the summer the pastures become infectious much more quickly after infested sheep are placed upon them, and during May it would be necessary to move the sheep at the end of every two weeks, in June at the end of every ten days, and in July and August at the end of each week, in order to prevent the noninfested sheep from becoming infected from the worms present in the rest of the flock. After the 1st of September the period may again be lengthened. This method of preventing infection in lambs would require a considerable number of small pastures or subdivisions of large pastures, and in many instances could not be profitably employed, but in cases where it could be used it would undoubtedly prove very effective. By the time the next lamb crop appeared the pastures used the year before would have remained vacant long enough for the infection to have disappeared, and would consequently again be ready for use. By continuing this rotation from year to year, not only would each crop of lambs be protected from infection, but as reinfection of the infested ewe flock is prevented at the same time, the parasite would in a few years be entirely eradicated from the flock and pastures.

If such frequent rotation is not possible or practicable, a smaller number of pastures may be utilized, after the ewe flock has been treated with vermifuges. The treatment may be given either before or after the birth of the lambs. If before, the ewes should be treated before pregnancy is too far advanced, in order to avoid possible bad results from the handling necessary in treatment. Probably the best time for treatment is late in the fall or early in the winter. The treated sheep should be placed immediately on clean pasture in order to avoid reinfection. The object of treating the ewes is to get rid of the worms with which they are infested, and thus remove the source from which the pasture becomes contaminated. If it were possible by treatment to free the old sheep entirely from stomach worms, it is evident that the lambs would remain free from infection, provided, of

course, that the flock were afterwards kept on clean pasture. Unfortunately, there is no vermifuge known which can always be depended upon to remove all of the worms, but it is possible to get rid of most of them and thus greatly reduce the amount of infection to which the lambs will be exposed.

Two other methods may be suggested by which lambs can be kept free from infection with stomach worms.

1. It is assumed that a large pasture is available which has had no sheep, goats, or cattle upon it for a year, if a permanent pasture, or since cultivation, if a seeded pasture. This pasture is subdivided into two by a double line of fence, and a drainage ditch is run along the alley between the two fences. At one end of the alley between the two subdivisions a small yard is constructed, communicating with each of the subdivisions by means of a gate. When the lambs are born they are placed in one of the subdivisions and the ewes are placed in the other. The small yard should be kept free of vegetation and must not drain into the lamb pasture. As often as necessary the lambs are allowed in the small yard with the ewes for suckling. The rest of the time the lambs and ewes are kept separate in their respective pastures. By this arrangement the lambs are exposed to infection only while they are in the small yard, where they may become infected either by embryos of the stomach worm present on the manure-soiled skin of the infested ewes, or by embryos picked up from the ground which has been contaminated by the droppings of the ewes. The chances of infection from the skin of the ewe are so slight that in practice this source of infection need not be considered. The danger of infection from the ground may be avoided by frequently removing the manure from the yard and keeping the surface sprinkled with lime and salt. The lambs and ewes will soon learn the way to their proper pastures, and after a few days little difficulty will be experienced in separating them each time after the lambs are through suckling.

2. Another plan which may be followed where the climatic conditions are suitable—that is, in regions where there is a cold winter season—is that of having the lambs born at a time of year when there will be no danger of their becoming infected during the suckling period, and weaning and separating them from the rest of the flock before the advent of warm weather. Under the usual climatic conditions of the State of Ohio, for instance, if the lambs are born in the latter part of October or the first of November they may remain with the ewes on fields which have not been previously occupied by sheep, goats, or cattle within a year—or, if cultivated fields, since cultivation—until the following March without danger of becoming infected, since the eggs in the droppings of the infested ewes will not hatch out during this time of year because of the cold weather. The use of

fields not previously occupied by sheep, goats, or cattle within a year, or since cultivation, is necessary, since otherwise the fields would be already infected with young worms which had hatched out and reached the infectious stage before the beginning of cold weather, and the lambs would consequently be liable to infection from picking up these young worms, which are not killed by cold weather after they have reached the final stage of larval development. When they are weaned the lambs must, of course, be placed on clean pasture, if they are to continue free from infection. With this method only two clean pastures are necessary, one in which the ewes and lambs are placed in the fall, and another for the lambs when they are weaned in March.

Unfortunately for this scheme, it is not always possible to have lambs born at the beginning of the winter season; but with additional clean pastures a modification of the foregoing method may be used in the case of lambs born toward the end of the winter or in the spring. In the northern United States lambs born the first of February, for example, may be kept with their mothers in a clean field or pasture until the last of March, as in the case of those born at the beginning of winter, but unlike the latter they will not then be old enough to wean. Accordingly they are not separated from the rest of the flock, but the ewes and lambs are moved together to a second clean pasture April 1. May 1 they are moved to a third clean pasture, May 15 they are moved again, and finally the lambs are weaned June 1 at the age of four months, and moved by themselves to a clean pasture. In the case of lambs born the first of March and weaned the first of July three additional clean pastures would be required for use during the month of June, and with later lambs a still greater number of pastures would be necessary.

#### TREATMENT FOR STOMACH WORMS.

Among the remedies which may be used to remove stomach worms may be mentioned coal-tar creosote, bluestone, and gasoline.

The animals to be treated should be deprived of feed for twelve to sixteen or even twenty-four hours before they are dosed, and in case bluestone is used should receive no water on the day they are dosed, either before or after dosing. In drenching, a long-necked bottle or a drenching tube may be used. In case a bottle is used the dose to be given may be first measured off, poured into the bottle, and the point marked on the outside of the bottle with a file, so that subsequent doses may be measured in the bottle itself. A simple form of drenching tube consists of a piece of rubber tubing about 3 feet long and one-half inch in diameter, with an ordinary tin funnel inserted in one end and a piece of brass or iron tubing 4 to 6 inches long and of suitable diameter inserted in the other end. In use the metal tube is placed in the animal's mouth between the back teeth, and the dose is poured into the funnel, which is either held by an assistant or fastened

to a post. The flow of liquid through the tube is controlled by pinching the rubber tubing near the point of union with the metal tube. It is important not to raise the animal's head too high on account of the danger of the dose entering the lungs. The nose should not be raised higher than the level of the eyes. The animal may be dosed either standing on all fours or set upon its haunches. It has been found by experiment that if the dose is taken quietly most of it will pass directly to the fourth stomach when the animal is dosed in a standing position, and that when the animal is placed on its haunches only a part of the dose passes immediately to the fourth stomach. From this it is evident that the position on all fours is preferable, as more of the dose passes to the place where its action is required.

Great care should be used not only in dosing to avoid the entrance of the liquid into the lungs, but also in the preparation and administration of the remedy so that the solution may not be too strong or the dose too large.

#### COAL-TAR CREOSOTE.

Good results have been obtained from a single dose of a 1 per cent solution of coal-tar creosote. This solution is made by shaking together 1 ounce of coal-tar creosote and 99 ounces (6 pints 3 ounces) of water. The doses of this 1 per cent mixture recommended by Stiles are as follows:

Lambs 4 to 12 months old.....	2 to 4 ounces.
Yearling sheep and above.....	3 to 5 ounces.
Calves 3 to 8 months old.....	5 to 10 ounces.
Yearling steers.....	1 pint.
Two-year-olds and above.....	1 quart.

Serious objections to the use of coal-tar creosote have been found in that the substance known by this name varies considerably in composition and in that some trouble is often experienced in obtaining it in many parts of the country. Complaints have been made that the substance dispensed by some druggists as coal-tar creosote has failed to give satisfactory results.

#### BLUESTONE.

Bluestone, or copper sulfate, has been extensively used in South Africa in the treatment of sheep for stomach worms and is recommended by the colonial veterinary surgeon of the Cape Colony as the best and safest remedy. His directions are to take 1 pound avoirdupois of pure bluestone, powder it fine, and dissolve in 42 whisky-bottlefuls ( $9\frac{1}{2}$  United States gallons) of warm water. It is better to first dissolve the bluestone in 2 to 4 bottlefuls of boiling water, then add the remaining quantity in cold water, and mix thoroughly. This solution is given in the following-sized doses:

Lambs 3 months old.....	$\frac{3}{4}$ ounce.
Lambs 6 months old.....	$1\frac{1}{2}$ ounces.
Sheep 12 months old.....	$2\frac{1}{2}$ ounces.
Sheep 18 months old.....	3 ounces.
Sheep 24 months old.....	$3\frac{1}{2}$ ounces.

In making up the solution only clear blue crystals of bluestone should be used. Bluestone with white patches or crusts should be rejected. It is especially important that the bluestone and water be accurately weighed and measured, and that the size of the dose be graduated according to the age of the sheep.

#### GASOLINE.

Gasoline is one of the most popular remedies for stomach worms which has been used in this country and has the particular advantage of being readily obtained. It is important to repeat the dose if the gasoline treatment is employed, and it is usual to administer the treatment on three successive days, as follows:

The evening before the first treatment is to be given the animals are shut up without feed or water and are dosed about 10 o'clock the next morning. Three hours later they are allowed feed and water, and at night they are again shut up without feed or water. The next morning the second dose is given, and the third morning the third dose, the treatment before and after dosing being the same in each case.

The sizes of the doses are as follows:

Lambs .....	$\frac{1}{4}$ ounce.
Sheep .....	$\frac{1}{2}$ ounce.
Calves .....	$\frac{1}{2}$ ounce.
Yearling steers .....	1 ounce.

The dose for each animal is measured and mixed separately in linseed oil, milk, or flaxseed tea, and administered by means of a bottle or drenching tube. Gasoline should not be given in water.

#### OTHER REMEDIES.

Many other remedies in addition to those mentioned here have been used in the treatment of stomach-worm disease with more or less success. Several of the coal-tar dips on the market are recommended by the manufacturers for the treatment of worms, and the action of some of them is much the same as that of coal-tar creosote.

It is not the policy of the Department to recommend the use of any particular proprietary remedy, and as the action of some such agents is very uncertain it is suggested that, if it is desired to use them, they be used with caution and only in accordance with the printed directions on the package. Whatever remedy is used, it is wise to test it on two or three animals before the entire flock is dosed.

Approved:

JAMES WILSON,  
*Secretary of Agriculture.*

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