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DIVISION OF VETERINARY SCIENCE

Stomach Worms in Sheep and Goats

T. O. WALTON, President

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The stomach worm, a round-worm parasite infesting the fourth stomach of sheep and goats, frequently causes heavy losses in these animals. The females deposit eggs which pass out in the droppings to the ground, where they hatch. The young larvae reach the infestive or mature stage within three or four days after having molted a number of times. In this stage they are very resistant and may live for a year on the vegetation or in the soil. During the presence of a sufficient amount of moisture such as prevails immediately after rains or during heavy dews these larvae migrate onto the grass, where they are taken up by the host while grazing. They are especially active during warm weather. After being taken up by the host the parasite reaches sexual maturity within 9 to 11 days and the mature female begins to lay eggs from the 15th to the 18th day after being taken up.

Young animals suffer more severely from heavy infestation with stomach worms than older animals, although very old animals are sometimes heavily infested. Infestation with stomach worms produces an unthrifty condition of the animal, marked by loss of flesh, emaciation, weakness, sometimes diarrhea, a marked anemia, marked pallor of the skin, whitish, porcelain-like appearance of the conjunctivae, and sometimes an accumulation of serous fluid under the skin between the jaws.

Copper sulphate in 1¾ per cent solution in doses of 100 cc. for adult animals, or the same dose of copper sulphate to which 0.8 cc. of Black Leaf 40 has been added, and tetrachlorethylene in soft gelatine capsules, have been found efficient in killing stomach worms in the host. Tetrachlorethylene treatment is more expensive than either the treatment with copper sulphate alone or copper sulphate plus nicotine sulphate. Treatment should be repeated at intervals of 17 days during the dangerous season.

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STOMACH WORMS IN SHEEP AND GOATS

W. T. HARDY and H. SCHMIDT

Stomach worms have caused heavy losses in sheep and goats in this State in the recent past; even in areas in which they have not been previously suspected. It is not a new trouble and has followed the sheep and goat industry to every part of the world. The importation of breeding animals, the rapid methods of transportation, and the fact that once an animal is infested it will remain so for a long time, have contributed much to the spread of the trouble. Wherever the parasite has appeared men have been actively engaged in finding some method of effectively combating it with the result that numerous treatments have been suggested. Many of these suggestions are rather old and none of them have completely satisfied the flockmasters, so that the search for newer and better remedies is still going on.

The control of stomach worms is a dual problem and must include the control of the infestation in the pasture or field and the control of the infestation in the animal. In order to give intelligent direction to this control, a comprehensive knowledge of the life cycle and habits of the stomach worm and its brood is necessary.

LIFE CYCLE OF THE STOMACH WORM

The life cycle* of the stomach worm consists of two stages, the parasitic stage, or that stage passed within the animal host, and the non-parasitic stage, or that stage passed in and upon the soil and herbage.

The term stomach worm as used in this Bulletin refers to the common stomach worm†, sometmes also called twisted wire worm, *Haemonchus contortus* (Rud.). The sexually mature parasite as encountered in the fourth stomach of sheep and goats (and for that matter cattle also) varies somewhat in size. The males measure 10 to 20 mm. in length and the females 18 to 30 mm. They are about 0.3 to 0.4 mm. thick. This gives them the size of an ordinary pin but they are perhaps not quite so thick. Their color is of a deeper red than the mucous membrane of the fourth stomach, so that the parasite when viewed with the mucous membrane as the background stands out quite prominently. The female has an appearance like a fine white and red thread twisted together lengthwise. The posterior end of the male shows a more or less bell-shaped enlargement consisting of two flaps or folds of the skin, which can be readily seen

*Veglia, F. The Anatomy and Life Cycle of the **Haemonchus contortus** (Rud.). Third and Fourth Report of the Director of Veterinary Research, Union of South Africa, 1915, pp. 350-500.

†This stomach worm is not reported from the Pacific northwest but in its place another stomach worm, sometimes called the smaller or lesser stomach worm, belonging to the genus **Ostertagia** is found. It is much smaller than the common stomach worm and readily overlooked in a casual post-mortem examination. Copper sulphate and nicotine sulphate are reported as unsatisfactory for the control of this parasite.

when the parasite is suspended in clear water. This structure is, however, also found in other nematode male parasites living in the intestinal tract of animals.

The sexually mature female deposits a large number of eggs in the stomach of the host, which pass out with the droppings to the ground, where, under favorable conditions of warmth and moisture, they hatch within the next twenty-four hours into tiny larvae. Under favorable conditions these larvae rapidly complete their non-parasitic development and within three days after hatching have reached the stage in which they are infestive for the animal. In this stage the larvae are very resistant to heat, cold, and drouth, the three main climatic conditions upon which one might rely for their destruction.

INFLUENCE OF NATURAL CONDITIONS UPON THE EGGS AND LARVAE

A favorable degree of heat and moisture is necessary for the stomach-worm eggs to hatch and the larvae to thrive. There is enough moisture in the dung for the eggs to hatch provided the air temperature is not too high. The larvae, up to the time they reach the infestive stage, i.e., during the first three days after hatching, thrive best in moist sheep dung, the medium in which nature evidently destined them to begin their delicate life. When this infestive stage is reached, however, the larvae leave the sheep dung and continue their existence on herbage and later enter the soil. The most favorable temperature for the development of the larvae is approximately 20 to 35 degrees centigrade, above and below which their development is less rapid and, when extremes are reached, they indeed will perish. It was found that the eggs after being exposed to a temperature of —2° C. for 5 days or to —9½° C. for several hours would still hatch and the larvae develop to maturity when the temperature again reached a favorable degree. The rapidity of development of the larvae to maturity is, however, retarded at low temperature so that with a minimum of 8° C. the time required for the newly hatched larvae to reach the infestive stage is 10 days. Under such conditions the mortality of the young maturing larvae is fairly high and at 4° C. development is almost brought to a standstill while the mortality may be as much as fifty per cent. Observation definitely shows that our average winter temperature permits the development and maturation of the larvae of the common stomach worm and that infestation of sheep with these larvae in winter is entirely possible especially during a wet season.

With regard to higher temperature it has been found that eggs when on the ground are killed when the temperature of the ground rises to 42° C. or above and remains there for several hours. This condition is not often attained in this State and for that reason reliance can hardly be placed in it for the destruction of the eggs. When the eggs fail to hatch at high temperatures, it is probably not so much the high temperature that destroys the egg as the premature drying out of the same. The mature larvae are much more resistant to high temperature. When kept

at 42° C. for 17 hours eighty-five per cent survived and when kept for 40 hours fifty per cent survived. At 45° C. an exposure for 12 hours was tolerated by fifty per cent of the larvae and 50° C. for 2 hours did not kill all the larvae. These temperatures only hold when sufficient moisture is present and undoubtedly many larvae fail to reach the infestive stage during our hot and dry summers and even the mature (infestive) larvae that have become stranded on blades of dry grass when the temperature reaches 42-45° C. will be killed in 10 days. On the other hand, in the presence of a moderate amount of moisture mature larvae will withstand 42° C. for a month and even 50° C. will be tolerated for a few hours. In either case the action is a double one, that of heat and moisture, and the lack of the latter during our summers is the determining factor.

Regarding moisture, it is known that a small percentage of eggs can hatch in a layer of water more than ½ cm. deep but the freshly hatched larvae die within 12 to 15 hours. Mature larvae, however, live for months in water up to 20 cm. deep. It is, therefore, evident that shallow pools of water on the range are a suitable medium for the preservation of the larvae. In view of the fact that such pools often catch the surface water draining from a considerable area and in view of the further fact that the vicinity of such pools, when used as watering places, frequently constitute a resting place for the sheep for at least a short period during each day and permits a concentration of their droppings and therewith of the stomach-worm eggs, such pools cannot fail to become a hazard for the sheep.

Moisture is an important factor in the life of the stomach-worm larvae and they will seek it whenever possible. It frequently happens, however, that sufficient moisture is not available and it now becomes a question of how long the larvae can live with insufficient moisture and what degree of desiccation is required to destroy them. Exposure of feces to the hot sun under field conditions in the summer time when the temperature reaches 40° C. has been found to destroy the eggs and young larvae already hatched. Under our hot and dry summer conditions but few larvae can be expected to hatch and survive, but during the early spring and late fall when temperature and moisture conditions are very favorable a high percentage of survival may be expected. The larvae hatching under these conditions will rapidly reach maturity, crawl up on the grass and here await the arrival of a suitable host to pick them up. The larvae do not remain at the tips of the grass during the day time, but are found to descend to the base of the grass with advancing brightness of light to seek protection from the latter. Observation under artificial conditions has shown that the larvae will begin their ascent as soon as they are placed in the dark and will begin to descend immediately when placed in the light. Under field conditions we would therefore expect a nocturnal upward migration of the larvae at a time when there is dew or moisture from other sources on the grass to be followed by a descent when day comes with its bright light.

This ascending and descending migratory movement of the larvae will continue until they are about 20 to 30 days old. They will then enter the

ground—provided they have not become stranded on the grass by adverse weather conditions—to seek proper protection only to come forth again at the next favorable opportunity. The fact that a crop of mature larvae has entered the soil, however, need not materially influence the severity of an outbreak of infestation with stomach worms in any one season, because the larvae are not all of the same age and for every larvae entering the soil there is probably another taking its place on the grass.

The precise amount of moisture that must necessarily be on the grass to enable the mature larvae to ascend is difficult to determine, but in view of the fact that our sheep and goats frequently pick up an infestation under our average summer conditions, too much reliance should not be placed upon moderate drouthy conditions in the control of stomach worms, especially since many of the larvae will remain coiled up on the grass at a place either selected by them to pass the day or where they were overtaken by the premature disappearance of the amount of moisture required to enable them to migrate. The most that could be expected is that such conditions will assist in keeping down heavy infestation. It must be kept in mind that only such larvae are most likely to be destroyed by the hot sun as happened to become stranded upon the grass in an exposed position upon the arrival of day and the rapid disappearance of the moisture from the grass. The majority will again reach their safe retreat at the base of the grass or in the ground to await the arrival of the next favorable opportunity. During favorable weather, however, many live larvae may be found on the grass throughout the day. Since the larvae show a marked tendency to collect at the base of the grass during the daytime, it is obvious that they are most likely to be picked up by the animal on short grass so that very close grazing favors the stomach-worm larvae in gaining access to the host and completing their life cycle. The migratory movements are influenced by the atmospheric temperature and are more rapid and active during warm weather, while low temperature will slow up such movements but does not necessarily check them completely except during rather cold weather. They cease at 40 to 42° C. and above, are much reduced in speed at 9-10° C. and cease with temperatures approaching zero.

LARVAE MAY LIVE OVER IN THE SOIL

Under favorable conditions of moisture mature larvae have been found to penetrate into the soil to a depth of as much as 10 to 15 cm., where they can live for a period usually stated to be about a year. Undoubtedly many will perish before this time has elapsed but it is known that many will live that long. At such a depth they are well protected against extremes of temperature and drying out. It must be assumed that larvae follow their natural instinct when descending into the soil to such a depth and for this reason it must also be assumed that they can again reach the surface of the soil when the proper time arrives. If this be so, then it follows that the larvae are not only able to protect themselves during most unfavorable conditions, but that other means resorted to by man

aiming at their destruction, such as plowing the land or burning the grass, cannot be depended upon to control the pest. Burning the vegetation could at the most destroy only those larvae which at the time are upon the vegetation; the practice, however, is not feasible, for other economic reasons.

THE PARASITE IN THE HOST

The host takes up the mature infestive larvae with the food and water, whereupon such larvae continue their development into the sexually mature parasite, *Haemonchus contortus*. This process requires 9 to 11 days but during this time the larvae are already attached to and feed upon the mucous membrane of the fourth stomach and rapidly increase in size. When sexual maturity is reached, the male measures about 5 mm. long and the female 6½ to 8 mm. They now quickly increase in length so that on the 15th day the male measures 9 to 10 mm. in length and the female 12 to 14 mm. (Fig. 1). On this day some worms are already laying eggs. By the 18th day many females are laying eggs and on this day passage of the eggs with the droppings is entirely possible.

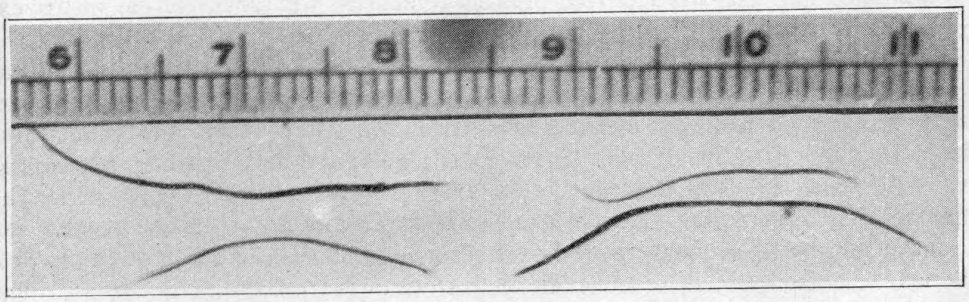

Figure 1. Mature stomach worms magnified about two times. As indicated on rule, the larger or female is about 2½ centimeters in length.

SUSCEPTIBILITY

Lambs and kids are more susceptible to infestation with stomach worms than older animals, though very old animals are sometimes found very heavily infested. It is especially during late summer and fall that heavy losses are likely to be encountered in lambs, but other seasons of the year are nevertheless dangerous for them. It is obvious that lambs will begin to take up the infestation as soon as they begin grazing and for this reason they should be treated with the remainder of the flock as soon as they are old enough to graze. Heavy infestation and losses have been observed in lambs three months old.

SYMPTOMS

The symptoms in light cases of infestation are not distinct enough to permit a diagnosis by physical examination. As the infestation increases, however, symptoms become more marked and as time goes on become so apparent that even the layman should have no difficulty in

recognizing them. The worms gradually sap the vitality of the animal leading to a marked anemic condition, which to the degree that it develops brings about a gradual weakening of the animal and often a diarrhea. The development of a marked anemia also brings on loss of flesh and other marked tissue changes, especially an accumulation of colorless, serous fluid in the space between the jaws, throughout the connective tissue in the muscles, the omentum, and around the heart. The anemia manifests itself most markedly by the pallor of the skin and the conjunctivae. The skin loses its pink color and becomes colorless; the blood vessels of the conjunctivae no longer stand out as red lines but the whole of the mucosa presents a whitish porcelain-like appearance. In advanced cases showing loss of flesh, weakness, and frequently diarrhea, this anemic condition of the skin and eyes is always apparent. On the other hand the accumulation of fluid beneath the skin between the jaws, the so-called bottle jaw, is less frequently encountered and is frequently absent even in heavily infested animals.

The weaker animals will soon succumb to the infestation and an examination of the fourth stomach, that is, that part of the four compartments of the stomach leading into the small intestines, will reveal the trouble.

SUGGESTED CONTROL MEASURES

The losses from infestation with stomach worms vary with the degree of infestation of the animals and the latter may vary not only from season to season, but also from flock to flock. Since the infestation of the animal may fluctuate rapidly and markedly from negative to positive, no flockmaster can know what is in store for him in the immediate future. In practice, many flockmasters are prone to be content if actual death losses from infestation do not occur. The injurious effects from such infestations are frequently very much underestimated because losses from reduced thriftiness, reduced wool and meat production, retarded development or even underdevelopment, are either not always apparent or ascribed to some other cause. It follows, therefore, that complete eradication is very desirable. This is possible; it is recognized, however, that the attainment of this goal is greatly influenced by the persistence and determination of the flockmaster. Where determined and intelligent efforts are made, the expended efforts can not but yield a return, for even though complete and permanently maintained eradication may not be attained, yet the reduced infestation will materially reduce the injurious effects therefrom.

In practicing control of stomach worms one must not overlook any measures that might in any way assist in destroying the stomach worm or its brood. The destruction of stomach-worm larvae depends entirely upon preventing them from reaching their host. The greatest contribution that man can make toward this prevention is to keep the host animal off infested premises for a length of time required for all larvae to starve. This time is usually placed at one year. Not many flockmasters will be in position, however, to carry through with such a plan and for that reason changes must be undertaken which will not too seriously interfere with the results to be accomplished. In the first place rotation of pastures

may be practiced, in which rotation cultivated land must play a major role even though we do not expect all larvae to be destroyed by plowing under. Furthermore the burning of the vegetation whenever feasible to destroy the larvae thereon and the grazing of known dangerous areas only during protracted dry hot periods, the use of known dangerous areas for animals other than ruminants, a reduction of the stocking rate so that the animals will not graze so frequently over the same area, the elimination of standing surface water, the periodically repeated treatment of all sheep or goats with a reliable remedy, will all contribute their share to the control of stomach worms. Since losses from infestation with stomach worms are most severe during late summer and early fall, the shifting of the lambing season so as to have the lambs ready for market before this critical time arrives will also help to reduce the losses from stomach worms. In making use of any or all of these means one must adapt the procedure to the life cycle of the stomach worm, as otherwise one will meet with disappointment. The same is true in treating animals for this parasite.

When heavily infested animals are treated, it cannot be expected that all will recover, but some of them will probably continue to lose strength and die even though all worms were killed at the first treatment. Even those that do recover will require a comparatively long time before improvement becomes apparent. An animal whose vitality has been so markedly reduced can not be expected to make a rapid recovery as soon as the stomach worms are removed from it. If losses should, therefore, continue after the administration of an effective remedy, the owner should not immediately become discouraged and condemn the treatment.

In determining the number of times an animal should be treated for stomach worms it must be borne in mind that low damp places offer especially favorable conditions for the thriving of the stomach-worm larvae and that they are prone to be especially active for some days after a rain and during the time that heavy dews prevail. It is, therefore, essential that animals in known infested pastures be treated soon after such favorable weather conditions have prevailed. In order to keep down and eventually reduce the infestation of the pasture, animals must be treated sufficiently often to prevent the maturation of stomach worms in the animals and thus prevent their reproduction. The period between treatments should therefore be not more than 17 days. The number of times a flock should be treated during the dangerous season depends greatly upon the degree of infestation on the range, the weather conditions, and the effectiveness of the treatment used. On account of the uncertainty of a complete effectiveness of a treatment it is advisable to treat heavily infested flocks at least twice and preferably three times at intervals of not more than 17 days and preferably 15 days even though hot dry weather prevails. When, after such treatments, weather conditions again become favorable for the activity of the larvae, the treatment must be repeated. The flockmaster should carefully watch his flock for any signs of the return of an infestation with stomach worms during this time, for the suggested number of treatments constitutes the minimum rather than the

optimum. It is obvious from facts related above that only after such treatment has been intelligently practiced for a year, at intervals of 17 days or less, may one expect to have materially reduced the infestation of the range. It is essential to remember that even though the animals may be only lightly infested they may, as time goes on, heavily infest the pasture. One should, therefore, be ever on guard against any future sudden heavy outbreak of the trouble in the flock. He must furthermore keep in mind that after he has cleaned his animals of stomach worms and has sent them back into the infested pasture, they will soon again become infested and need another treatment.

TREATMENT

Given an effective treatment the number of times to apply it during the dangerous season and the interval between the different treatments for the successful control of the stomach worm depends upon the degree of infestation of the premises and the rate of stocking. The greater the animal population for a given area the more rapidly will the infestation of that area reach the danger point. On heavily infested premises treatments should be repeated at least every 17 days during the dangerous season, that is, during the time that the stomach-worm larvae are most active. We have seen above that this is during the warm season of the year. The owner should also be guided by the condition of his flock. A flock in which infestation with stomach worms is manifestly not very heavy and in which gross manifestations of infestation are not apparent will not need to be treated as frequently as one in which losses from an infestation with stomach worms are occurring. He should, however, take every opportunity to examine for an infestation with stomach worms every animal that he may slaughter for meat or that succumbs to some other trouble. Only in this way can he determine just how heavy the infestation in his flock may be.

There are a number of drugs that can be used in removing stomach worms from sheep and goats but all are not equally effective. The choice of the drug depends somewhat upon the condition of the animals and the degree of infestation.

The discrepancy in the effectiveness as it appears in the results still to be detailed herein, is evidently due to physiological conditions beyond control in the administration of the medicine. It is probable that in those animals in which a very low efficiency is obtained the greater part of the medicine lingers in the rumen and is too much diluted before entering the fourth stomach. The fact that in many cases of our experiments a one hundred per cent kill of stomach worms could be demonstrated some 12 to 15 hours after the administration of the medicine is proof that the medicine as administered is effective and that the lower percentage of kill of stomach worms in other cases must be explained upon some other basis. This is true of all medicines used as a drench. Unless the medicine reaches the fourth stomach in the dose and concentration required to destroy the stomach worms it cannot be expected to be effective. As the dose chosen by us for the treatment of animals against stomach worms is the highest

effective safe dose, this condition cannot be remedied by increasing the amount of medicine given.

The technic used in all tests at this Station to determine the efficiency of treatments for stomach worms follows: The animal was deprived of food and water the desired length of time before administering the treatment and was not allowed food and water thereafter. Some 12 to 15 hours (in some of the tetrachlorethylene experiments, 6 hours) after the administration of the drug the animal was destroyed and the 4th stomach as well as the entire intestinal tract carefully searched for live and dead stomach worms.

Copper Sulphate

This Station has found copper sulphate alone in one and three-fourths per cent solution, copper sulphate plus nicotine sulphate (Black Leaf 40), and tetrachlorethylene satisfactory in controlling stomach worms. Of these three treatments the copper sulphate treatment alone has proven effective and safe enough in our hands to be satisfactory when administered monthly throughout the year in flocks showing a moderate degree of infestation. We have used it in one flock of sheep every 30 days for 4 years without causing copper sulphate poisoning. Neither did it show any detrimental effect upon pregnant animals nor was it found to produce ill effects in any other way. We have given it to nursing ewes and to lambs as soon as they begin grazing. This Station has determined the efficiency of copper sulphate as a treatment for stomach worms. In a group of 14 animals in which a one and three-fourths per cent solution in a dose of 100 cc. was used, an average efficiency of 98.4% was obtained in 9 animals, while an average of only 1% efficiency was obtained in the other 6 animals. In another group of 29 animals a 2% solution in a dose of 100 cc. was used. Here an average efficiency of 91.2% was obtained in 26 animals, while the average efficiency in the other 3 animals was 1.6%.

Athough death losses from the administration of a 2% solution did not occur in our experiments up to the time they were destroyed some 15 hours later, yet a few animals died from its effect in flocks where the 2% solution was given a trial. It is for this reason that we prefer the 1¾% solution.

Copper Sulphate Plus Black Leaf 40

The mixture of copper sulphate plus nicotine sulphate as recommended here has been used on some 80,000 animals this year with satisfactory results. It must be borne in mind, however, that this mixture is a very drastic treatment for very weak animals and for such animals we do not recommend it. For weak animals tetrachlorethylene may safely be used, as it is equally efficient and less drastic. One need not hesitate to use this drug on weak animals and we would recommend that before treatment is commenced in a heavily infested flock the weak animals be tailed out and treated with tetrachlorethylene while the remaining animals may be treated with copper sulphate alone or with copper sulphate plus nicotine sulphate. The mixture is not only efficient against stomach worms but also against the common broad tapeworms which are found on many of

our ranges. It is also much cheaper than tetrachlorethylene and can be more easily and more rapidly administered. At this time we have no definite information as to the effect of a mixture of copper sulphate plus nicotine sulphate upon pregnant animals, but it is likely that it will not cause abortion. Its efficiency as determined by this Station in a group of 18 animals in which 100 cc. of a mixture of 1¾% copper sulphate and 0.8% Black Leaf 40 was used was as follows: In 13 animals of the group 94.7% of all stomach worms found were killed, in 2 animals 39% of the stomach worms found were killed, while in 3 other animals only 4% were killed. This is indeed a high efficiency and may well be relied upon for the control of stomach worms under range conditions.

Tetrachlorethylene

Tetrachlorethylene must be administered in a vehicle that prevents the escape of its fumes, for these would readily strangle the animal. For this reason it is, at the present time, administered in soft gelatine capsules. These can be bought on the market under various trade names. It has been administered by this Station in full doses to goats at monthly intervals until 12 to 14 doses were given without showing grossly apparent lesions on post mortem.

Tetrachlorethylene has proven very effective against stomach worms in our hands. Its efficiency was determined by us in a group of 140 animals. In 123 of these animals an average of 97.2% kill of all stomach worms found was obtained while in the other 17 animals an average of only 1.5% kill was obtained.

Preparing The Drench

In making up a solution in which copper sulphate is used, one must take care that only pure blue crystals be used. Those showing a white covering should be discarded. It is important that soft water be used. Distilled water or rain water is entirely satisfactory. It is important that a clear blue solution be obtained with the water that is to be used. In case it becomes necessary that hard water be used, then one must add some acid in order to prevent the formation of a precipitate. For this purpose either diluted sulphuric acid or vinegar can be used. One should add only enough of either to prevent a precipitation in the solution. The solution should be made up in earthenware, enamelware, or glass vessels. The copper sulphate can readily be dissolved in a small quantity of boiling water and then diluted to the proper strength. To make up a one and three-fourths per cent solution, dissolve twenty-two and one-fourth ounces of copper sulphate in one gallon of soft water. This will make the stock solution and must be diluted at the rate of one part of the stock solution to nine parts of water, thus making ten gallons of a one and three-fourths per cent solution, which is now ready to use. The solution should be handled in wooden buckets, glassware, enamelware buckets or crocks, because copper sulphate will corrode metal.

For making up the combined copper sulphate plus nicotine sulphate

mixture we use the same proportions as above and add to this solution Black Leaf 40 at the rate of ten ounces by measure to ten gallons of one and three-fourths per cent copper sulphate solution.

This solution can be used during hot weather without fear that the animals will become intoxicated and collaspe. If this happens, the animal should be placed in a shady place and left alone. On extremely hot days it may be advisable to drench in the early morning or late evening, or even at night.

Administration And Dose

The amount of the copper sulphate alone or of the copper sulphate plus nicotine sulphate mixture to be given an animal is 3½ to 4 ounces for adult animals and a correspondingly smaller dose for smaller animals; thus, about one cubic centimeter per pound body weight is satisfactory for lambs. After the lambs get a little older and heavier, that is, to the size of feeder lambs, this amount may be increased a little so that a lamb weighing about 75 lbs. would receive about three ounces of the mixture. Keeping in mind that the animal should receive the maximum amount that it will tolerate one will soon learn to gauge this amount properly. Before the treatment is given the animals should be deprived of food and water for at least 24 hours and this starvation continued for about 6 hours after the administration of the medicine. Keeping in mind the difficulty of finding all animals on the range, especially when the pastures are very large, it is a good plan to paint-mark all animals that have been treated. In this way those animals that have escaped treatment can be easily recognized and treated later. For this purpose it may be well to have the riders carry some tetrachlorethylene capsules and administer them as they find the stragglers around the watering places. In case such stragglers are too numerous it will, of course, be necessary to take them to the corrals.

Tetrachlorethylene is put up in 2½-cc. and 5-cc. soft gelatine capsules. The larger size is the dose for an adult and the smaller size for a lamb. We have found this drug quite effective without a preliminary starvation but our recommendation would be to follow the directions on the package.

Regarding the method of administration but little need be said. An ordinary dose syringe with a heavy 6-inch nozzle and delivering three and one-half to four ounces is entirely satisfactory for this purpose. An experienced person can dose some four thousand sheep a day with such a syringe without strangling the animals. While one man holds the sheep with both hands by the head the drencher fills the syringe with the desired solution, inserts the nozzle full length into the mouth with the right hand, grabs the animal with the left hand around the mouth with the thumb above and the extended fingers below, and empties the syringe into the animal's mouth. At the same time the left hand is slipped slightly forward and pressure exerted so as to cut off the air for the animal. During this operation, slight traction is exerted with the left hand so as to extend the animal's neck a little and prevent it from compressing its own pharynx, which would make swallowing more difficult. In this way no difficulty

will be experienced in getting the animal to readily swallow the solution. In case of young lambs and kids it is advisable to use a fairly stiff but soft rubber tube on the end of the syringe. This tube is passed down the oesophagus of the young animal for delivery of the dose. The rubber tube is slipped over the 6-inch nozzle and allowed to project some 10 inches. The mouth of the young animal is opened and the end of the rubber tube pushed on in. With a little practice no difficulty will be experienced in drenching the youngsters in this way. It is probably advisable to employ an experienced person to do the drenching. It is practical to herd the animals into a chute about three feet wide and as long as desired. The doser and two men to catch the sheep will enter the chute at one end and start dosing and allow the sheep to pass by as they are treated. One man should carry the bucket with the medicine and keep it handy for the doser to fill the syringes. In this way 4,000 to 5,000 sheep can be dosed per day without difficulty.

SUMMARY AND CONCLUSIONS

1. Stomach worms [*Haemonchus contortus* (Rud.)] may cause heavy losses in sheep and goats.
2. Infested animals spread the stomach-worm eggs wherever their droppings happen to fall. The greater the number of animals on a given area, the more heavily and more rapidly such areas will become infested.
3. The eggs contained in the droppings hatch and reach the infestive stage by the fourth day under favorable conditions of temperature and moisture. Clean pastures into which infested animals are placed may therefore become dangerous as early as the fourth day after placing such animals therein.
4. Infested pastures will remain dangerous for at least 12 months after all animals have been removed therefrom.
5. The infestive larvae crawl up on the grass and other vegetation under favorable conditions of temperature and moisture. At night they ascend to the tips of the grass blades and with the coming of day descend to the base of the grass for protection from light and heat.
6. After a migratory period of 20 to 30 days the infestive larvae enter the soil, where they may survive for a year.
7. Continued dry hot weather, as well as cold weather, materially slows up the activity of the infestive larvae.
8. An animal heretofore clean will pass stomach-worm eggs in its droppings as early as the 18th day after taking up infestive stomach-worm larvae.
9. Copper sulphate alone, copper sulphate plus nicotine sulphate, and tetrachlorethylene have been found effective and safe in destroying stomach worms in the host.
10. Treatment should be repeated every 17 days during the dangerous season for effective control.

Stomach worms in sheep and goats / by W.T. Hardy and H. Schmidt.

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