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Worms in sheep

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Worms in Sheep . . .

By C. R. TOOP, B.V.Sc., Chief Veterinary Surgeon

THE parasitic worms of sheep are widely distributed throughout Australia and are a source of serious loss to the sheep and wool industry. This results from the loss of condition which occurs in infested animals as well as from the failure of young sheep to thrive and make normal growth, and there is a consequent reduction both in carcass values and in the quantity and quality of wool produced. Furthermore, heavy infestations with worms are frequently responsible for serious mortalities.

In Western Australia on account of the long, dry summer which is unfavourable to the development of worm eggs and larvae, these losses are not so serious as those which occur in parts of Eastern Australia which are favoured by a summer rainfall or an evenly distributed annual rainfall, but they are nevertheless quite considerable.

For the most part, they are sustained during the dry months of summer but are by no means infrequent during winter in the South-West.

Severe losses have often occurred in the late summer and early autumn, especially when the autumn rains are scanty or delayed. In these outbreaks the large-mouthed bowel worm is often seen in large numbers. Outbreaks of "barber's pole worm" infestation have been seen from September to November. Fortunately the nodule worm which flourishes in areas of summer rainfall does not occur in this State.

The majority of sheep harbour some worms, but the effect upon the animal will obviously depend upon the number of parasites present and in addition it will be influenced to a very considerable extent by the nutritional conditions which prevail.

The presence of a few worms is of little consequence and will produce no apparent ill-effect upon the health of the animal. A heavy infestation on the other hand, may set up well-marked symptoms of disease often accompanied by heavy mortality.

AVOIDING WORM INFESTATION

Nutrition is of the utmost importance. A well-nourished sheep is quite often able to resist the effects of an infestation which might prove fatal in the case of an animal in poor condition which is forced to exist upon a much lower level of nutrition. The influence of nutrition is well illustrated in the outbreaks of worm infestation which occur in this State during summer.

The majority of the worms harboured by the sheep are probably picked up from the pastures during late winter and spring when the warm moist conditions which then prevail are favourable to the development of the parasites.

The sheep show no ill-effects while there is an abundance of succulent green feed available but when the feed dries off and its nutritive value is reduced, the effect of the infestation becomes apparent declaring itself in a well marked loss of condition together with the development of other more or less characteristic symptoms.

A series of field trials carried out in recent years in collaboration with C.S.I.R.O. has shown that heavy infestations are often acquired in the late summer and early autumn months, especially with large-mouthed bowel worm and black scour worm. As soon as the autumn feed comes away the sheep tend to rid themselves of the infestation but, if the rains are delayed and the feed does not respond, severe losses from worm infestation may occur.

ATTACK THE WORMS AT ALL POINTS OF THE LIFE-CYCLE.

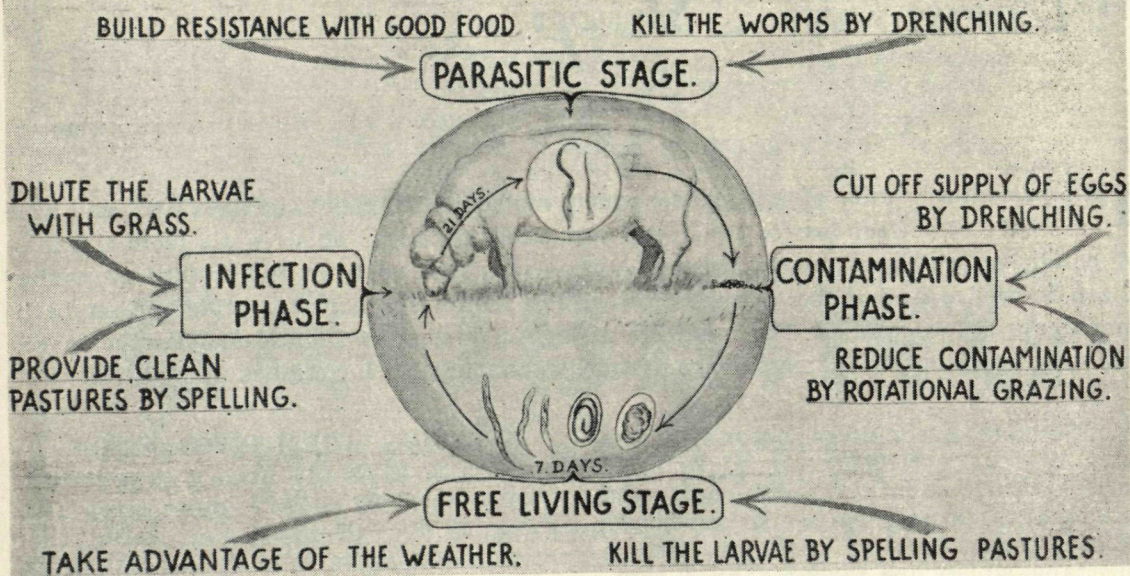


Fig. 1.—A diagram showing the life-cycle of the sheep worms, with suggestions for worm control at all stages.

The importance of maintaining sheep in good condition and hence increasing their resistance, to worm infestation by the provision of improved pastures and hand feeding during the summer months cannot be over-emphasised as a control measure. Under West Australian conditions it is of paramount importance.

The establishment of a heavy worm infestation will depend upon the climatic conditions and the degree to which the pastures are contaminated by worm eggs passed out by infested sheep. Moisture is essential to the development and survival of worm eggs and larvae, and as a consequence serious infestations are more likely to occur in districts which enjoy a favourable rainfall.

Heavy stocking leads to heavy contamination of the pastures. Low-lying areas which remain moist and green during summer and in which the sheep congregate in large numbers, are especially dangerous in this respect.

Because of these factors, worm infestation may become a serious problem in the agricultural districts and particularly in the areas of higher rainfall and high carrying capacity, whereas in the dry, lightly stocked pastoral areas it is a matter of little concern.

The susceptibility of sheep to worm infestation varies considerably. Lambs particularly, and breeding ewes, are especially susceptible and particular attention must be paid to such animals when control measures are receiving consideration.

Older sheep, as the result of previous exposure to infection, develop a well marked resistance to the parasites. In breeding ewes this resistance may be broken down by the additional burden of pregnancy and lactation.

DIAGNOSIS

Sheep suffering from worm infestation exhibit well-marked symptoms of disease. Unthriftiness and loss of condition invariably occur. When these symptoms make their appearance the presence of worms may be suspected. From a consideration of the more or less characteristic symptoms which subsequently develop, it is frequently possible to form an opinion with regard to the identity of the parasite which is actually responsible.

In all cases, however, the diagnosis should be established by the post mortem examination of an affected sheep. An animal showing typical symptoms should be selected for examination. Sheep which

have recently died or which are showing advanced symptoms of disease and are in extremely weak condition are not suitable subjects for examination. In such cases the majority of the worms may have been passed out and the result of the examination may in consequence be misleading. It is important that the species of worm present should be identified since this will determine the type of treatment which must subsequently be adopted.

In this connection it must be recognised that sheep may harbour a considerable variety of parasites. Some of these are capable of producing serious effects. All parasites are capable of causing disease, but some species are of much greater importance than others. Disease depends on the number of worms and the duration of the infestation.

The parasites inhabiting the digestive tract of sheep always occur in the same location and are not normally found elsewhere. The large stomach worm, for

example, is always found in the fourth stomach; the *Trichostrongyles* or hair-worms are confined to the first 15-20 feet of the small intestine.

The digestive tract of a sheep is shown in the accompanying illustration, reference to which will enable the various portions to be recognised.

The stomach of the sheep is large and voluminous, occupying all of the left side and portion of the right side of the abdominal cavity. It is divided into four compartments, viz.,

- (1) the rumen or paunch;
- (2) the reticulum or "honeycomb" which will be recognised because of the honeycomb like structure of its lining membrane;
- (3) the omasum or "bible," so called on account of the numerous longitudinal folds or "leaves" which it contains;
- (4) the abomasum or fourth stomach.

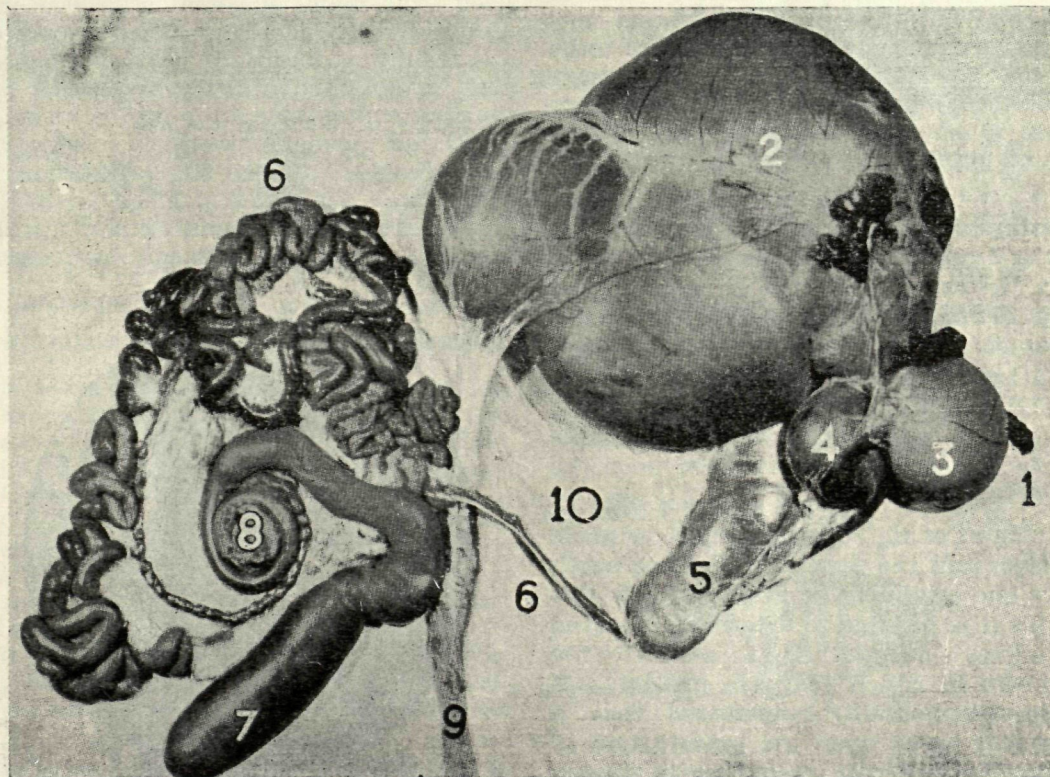


Fig. 2—THE DIGESTIVE TRACT OF A SHEEP—1. Oesophagus (gullet); 2. Rumen (first stomach or paunch); 3. Reticulum (second stomach or honeycomb); 4. Omasum (third stomach or bible); 5. Abomasum (fourth stomach or renet); 6. Small intestine (runners); 7. Caecum (blind gut); 8. Colon (crown); 9. Rectum (hind gut); 10. Omentum (caul).

(After Clunies Ross & Gordon.)

In Western Australia no parasites of any kind occur in the first three stomachs of sheep. The small intestine, popularly known as the "runners," is about 80 feet in length and extends from the fourth stomach to the caecum or blind gut. The caecum in turn passes on to the large intestine which is about 15 feet in length. The first portion is much coiled and is known as the colon or "crown." The terminal portion through which the contents of the bowel are discharged to the exterior is known as the rectum or hind gut.

When conducting an examination the digestive tract should be removed from the body cavity and the intestines should be freed from their attachments. Commencing at the fourth stomach the digestive tract should be laid open with scissors and its contents, together with the lining membrane to which the parasites may be adhering should be examined for the presence of worms. Particular attention should be paid to sections, such as the fourth stomach and the first 20 feet of the small intestine, in which worms capable of producing serious effects are to be found. A conclusion that the symptoms exhibited by the sheep are attributable to worm infestation will only be justified if a large number of parasites are discovered.

An alternative but less reliable method of diagnosis consists of the examination of the droppings for the presence of worm eggs. In order that such an examination may be of value, samples of droppings obtained from a representative number of both healthy and affected sheep must be submitted, and the work must be supervised by a veterinarian who will be able to place a correct interpretation upon the result obtained.

Cultures of the droppings must be made in order that the worm larvae which hatch from the eggs may be identified. By this means it is possible to determine the kind of worms present and to estimate the numbers in which they are present. It must, however, be emphasised that a diagnosis based upon the examination of a single sample of droppings is usually quite unreliable and may in consequence involve the sheep owner in needless worry and expense.

The worms which have been recorded in sheep in this State are described in the succeeding paragraphs. Those which are known to produce serious effects will be dealt with in some detail. The remainder will be mentioned briefly in order that they may be recognised should they be encountered.

THE LARGE STOMACH WORM OR BARBER'S POLE WORM (*Haemonchus contortus*)

This is one of the most serious of the internal parasites found in sheep in Western Australia, chiefly because it increases very rapidly and kills sheep by blood-sucking. It may cause disease in sheep of all ages but is especially important in lambs, weaners and breeding ewes.

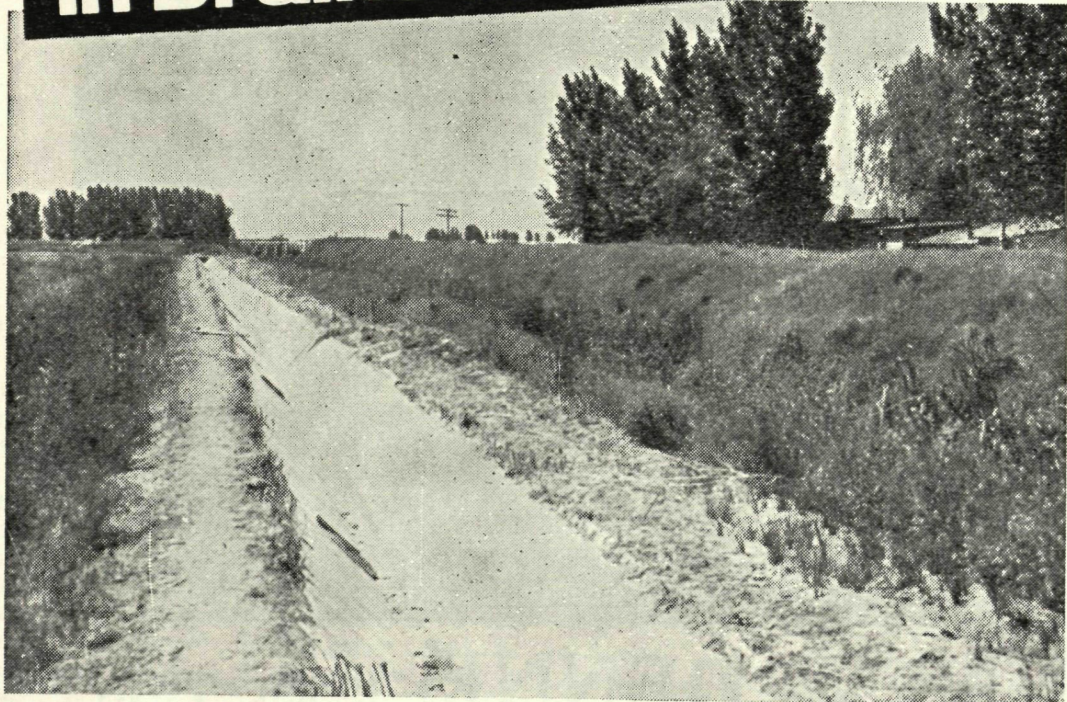
It occurs in the abomasum or fourth stomach. The female worm is about $1\frac{1}{4}$ inches in length and shows a red and white spiral striping from which the popular name "barber's pole" worm is derived. The males are smaller in size and uniformly red in colour. These parasites are readily visible and at post mortem may be observed moving freely in the stomach contents or adhering to its wall. The large stomach worm is a vigorous blood sucker. When the infestation is heavy large quantities of blood are withdrawn from the animal which consequently becomes affected by severe anaemia.



Fig. 3.—LARGE STOMACH WORM (*Haemonchus contortus*)—natural size. The female worm shows a red and white spiral striping and is popularly known as the "barber's pole worm."

(After F. H. S. Roberts.)

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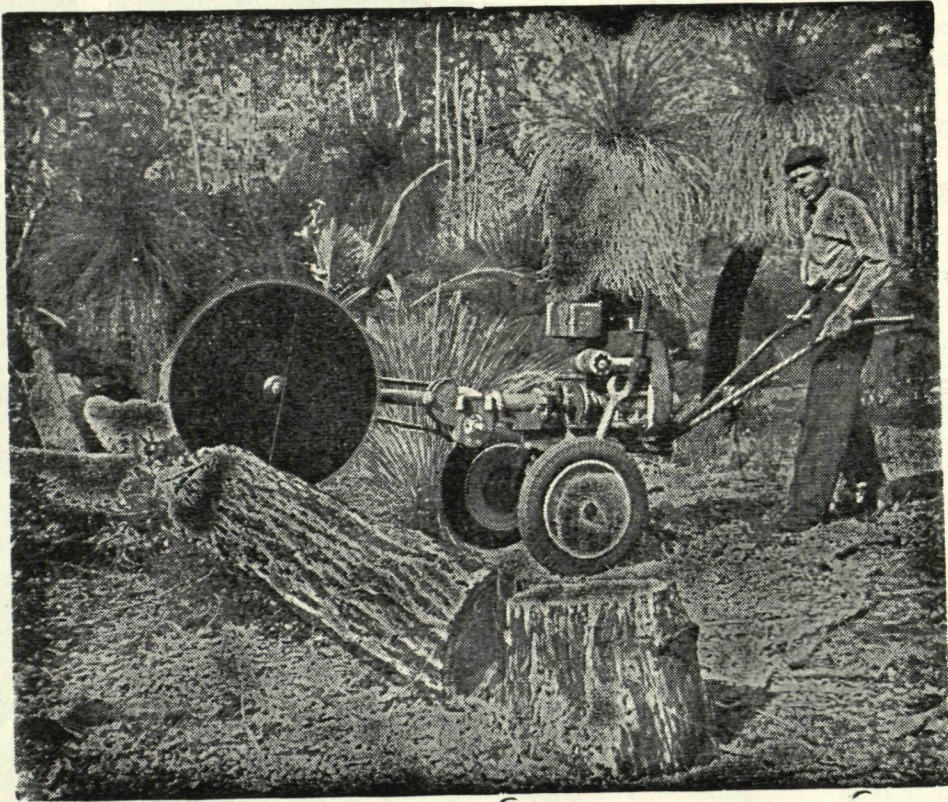


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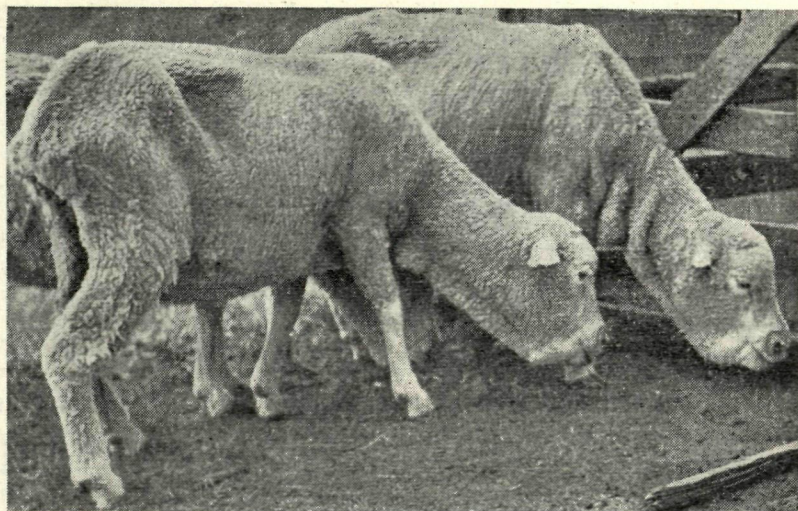
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Fig. 4.—These sheep are heavily infested with the large stomach worm or "barber's pole worm." Note the typical soft swelling under the jaw ("bottle-jaw"). In a heavy infestation, the worms may take up to three-quarters of a pint of blood from the sheep every day, producing an anaemic condition. The milk supply of the ewes can be considerably reduced.



Symptoms.

The effects of infestation with the large stomach worm are in general most serious in young sheep and breeding ewes. All types of sheep may, however, become affected. The symptoms usually make their appearance during the summer months; less often in early winter. Affected sheep steadily lose condition, becoming poor, unthrifty and often "pot-bellied" in appearance. Such sheep become weak and sluggish, do not move about the paddocks freely and spend less time in feeding. They are usually difficult to drive and may fall to the ground from weakness after proceeding a short distance. Upon examination the skin and mucous membranes of the mouth and eyes will be found to be extremely pale in colour. In advanced cases there may be a well-marked break in the wool. Later a soft swelling appears beneath the lower jaw ("bottle jaw"). This symptom is characteristic of stomach worm infestation. Affected sheep become progressively poorer and weaker in condition and without treatment will usually succumb. Sometimes as the result of a massive and rapidly acquired infection, mortality may occur amongst sheep in fat condition, death being due to the sudden and heavy loss of blood which is withdrawn by the parasites.

Post Mortem Appearances.

The blood is reduced in quantity and watery in appearance, The carcass is light

and emaciated, the fat being replaced by gelatinous material.

In heavy infestations sheep may be "bled to death" before there has been time for them to lose condition and deaths have been seen in fat lambs and ewes.

The abdominal cavity usually contains a quantity of clear fluid. In severe cases the liver may appear fatty and pale yellow in colour. Upon opening the fourth stomach the worms will be found in large numbers in the stomach contents and adhering to the stomach wall. It is estimated that the presence of 500 large stomach worms is necessary to produce symptoms of disease, but this will be influenced by the nutritional conditions.

Treatment.

Phenothiazine. In the treatment of flocks showing evidence of stomach worm infestation the most satisfactory results will be obtained from the administration of phenothiazine. This drug is available in the form of a powder which mixes with water to form a suspension suitable for drenching. Ready-mixed suspensions are also available.

The dose rate will vary according to the age of the sheep under treatment, but for general purposes the following dosage is recommended:—

- Grown sheep—
- 1 lb. phenothiazine per 20 sheep.
- Weaners (8-12 months)—
- 1 lb. phenothiazine per 25 sheep.
- Lambs (4-8 months)—
- 1 lb. phenothiazine per 40 sheep.

In preparing the drench the water should be added to the powder gradually and thoroughly stirred so as to form a creamy suspension. The remainder of the water is then added bringing the mixture up to the strength required for drenching. Before use the mixture should be passed through a fine sieve such as a double thickness of flywire. As an example if it is desired to treat weaners at the rate of 1 lb. of phenothiazine to 25 animals, take 1 lb. of powder and add water, stirring thoroughly until the volume of the mixture reaches 25 fluid ounces. One fluid ounce of this mixture will provide the correct dosage. Similarly in the treatment of grown sheep the volume of the mixture should be brought up to 20 oz. by the addition of water and here again a fluid ounce of the mixture will contain the required dose of the drug.

Phenothiazine suspension may be conveniently administered by means of a single-dose drenching gun capable of delivering a dose of one fluid ounce. Some of the more recent types of automatic drenching guns will also be found suitable. Automatic apparatus fitted with or using the principle of the McMaster Tube enables the administration of phenothiazine cleanly and safely.

Care should be exercised to prevent staining of the wool which may result from drippings from the syringe, from contact of the soiled mouths of drenched sheep with other sheep, and by phenothiazine excreted in the urine, and this may be avoided by rinsing or wiping the nozzle of the syringe after each filling and by releasing the sheep into a large yard immediately they are drenched.

Two drenchings separated by an interval of 14 days are recommended and the treatment may be repeated at intervals of three-four weeks thereafter should this be found necessary. Phenothiazine in the above dosage is also effective against the hair worm and the large-mouthed bowel worm.

In addition to treatment, the flock should be removed from infected pastures, e.g., low-lying areas which remain green and moist in summer and the level of nutrition should be improved by hand feeding or by the provision of good pas-

ture should such be available. Hand feeding should be practised on a generous scale and if possible cereal grains such as wheat, oats or barley should be included in the ration. A rapid improvement in the condition of the sheep may not, however, be expected to occur until green feed becomes abundant. The measures which should be adopted for the prevention of infection are discussed more fully under the heading of "Prevention and control."

THE HAIRWORM OR BLACK SCOUR WORM

(*Trichostrongylus* spp.)

In Western Australia the *Trichostrongylus* or hairworms rank next in economic importance to the large stomach worm. These parasites inhabit the first 15-20 feet of the small intestine. They are pink in colour and are extremely small and slender, measuring from $\frac{1}{4}$ inch to $\frac{1}{3}$ inch in length. Even when present in very large numbers the parasites, which are difficult to detect, may be overlooked unless a very careful examination is made.



Fig. 5.—HAIRWORM OR BLACK SCOUR WORM (*Trichostrongylus* species)—natural size.
(After F. H. S. Roberts.)

Symptoms.

The hairworms are essentially parasites of young sheep. Symptoms are rarely observed in animals over 18 months old. Older sheep which have been exposed to infection as lambs subsequently develop a strong resistance to the parasite. In this State, weaners are principally affected,

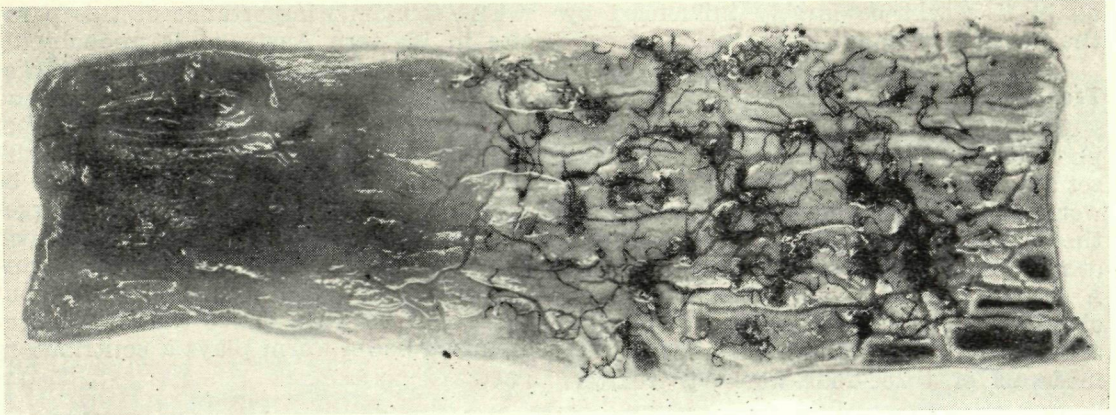


Fig. 6.—A portion of the small intestine of a sheep opened up to show hairworms. A solution of iodine is often used to stain the worms and make them readily visible.

showing symptoms of the infestation during the summer months after the feed has dried off and the nutritional conditions have become poor.

One of the earliest symptoms is loss of appetite. This is not always realised by the stockowner and is, in fact, difficult to detect in grazing sheep. However, careful observation of the behaviour of young sheep may show that they are standing about or wandering aimlessly instead of either grazing, resting and chewing the cud or walking purposefully to feed or water.

Affected animals lose condition, becoming stunted in growth and unthrifty in appearance. As the disease progresses such animals become weak and sluggish and may collapse when driven. A proportion of the animals become affected by diarrhoea, the greenish-black excretions soiling the breech and the hind quarters, this condition being commonly referred to as "black scours." Unless treatment is undertaken heavy mortality may occur. The skin and mucous membranes of the mouth and eyes do not become pale or white in colour as in the case of infestation with the large stomach worm, nor is there any evidence of "bottle jaw." The fact that hairworm infestations are almost exclusively confined to weaners together with symptoms of scouring which rarely occur in sheep infected with stomach worms will further serve to differentiate the two conditions.

Post Mortem Appearances.

The carcass is thin and wasted, otherwise there are no very obvious changes. Upon examining the small intestine large numbers of hairworms will be detected. A very careful examination must be made, otherwise the parasites may be overlooked. The first 20 feet of the small intestine should be laid open with scissors and the lining membrane should be closely examined in a good light; preferably in bright sunlight. The intestine should be stretched between the fingers and held up to the light as the examination is made. If difficulty is experienced in detecting the parasites by this method the lining membrane of the intestines should be scraped with a knife and the material thus removed transferred to a shallow glass vessel and shaken with water following upon which the small threadlike worms will be observed floating in its contents.

The worms may be seen readily if stained with a strong solution of iodine, either on the bowel wall or after scraping them off into a glass dish or white enamel tray. Add some strong iodine solution (10 per cent. liquor or tincture from the chemist) and stain for 5-10 minutes. Then add drop by drop a 10 per cent. solution of hypo (sodium thiosulphate) (4 oz. in 1 quart of water) until the iodine colour just disappears. The worms are stained deep brown.

It has been estimated that the presence of at least 10,000 hairworms is necessary in order to produce serious effects. Here

again this will be largely influenced by the nutritional conditions.

Treatment.

Affected flocks should be drenched with phenothiazine suspension in the dosage set out in the section on the large stomach worm; this drug being more effective for the expulsion of hairworms than any other preparations at present available. A second drench should be administered after an interval of 14 days and the treatment may, if necessary, be repeated at intervals of three-four weeks thereafter.

In the control of hairworm infestation, adequate nutrition is a matter of great importance. Lambs should be drenched immediately prior to weaning and thence transferred to paddocks carrying the best available feed, these having been reserved for this purpose. Hand feeding should commence early in the summer and continue until the advent of the opening winter rains. This aspect will be discussed more fully under the heading "Prevention and Control."

THE LARGE-MOUTHED BOWEL WORM (*Chabertia ovina*)

These parasites are found in the coiled portion of the colon ("crown") and on account of their comparatively large size they are unlikely to be over-looked at post mortem. They are stout creamy-white worms measuring about three-quarters of an inch in length and are often found adhering to the bowel wall.



FIG. 7.—LARGE-MOUTHED BOWEL WORM (*Chabertia ovina*)—natural size.
(After Clunies Ross & Gordon.)

The economic importance of this parasite in Western Australia is undoubtedly great. Infestations with the large-mouthed bowel worm commonly occur and they are usually associated with other parasites. Weaners suffering from hairworm infestation may at the same time be found harbouring large numbers of large-mouthed bowel worms. The effects upon the sheep are often considered to be principally due to the former parasite but there can be little doubt that the large-mouthed bowel worm plays a contributory part.

It has, moreover, been shown that the large-mouthed bowel worm is capable of inflicting considerable damage upon the bowel wall which in consequence becomes congested and much thickened. This is accompanied by symptoms of diarrhoea in which the droppings contain much mucus and are streaked with blood, together with retarded growth, weakness and loss of condition.

In field trials carried out in collaboration with the C.S.I.R.O., control of severe infestations with this parasite resulted in increased wool growth and improved wool quality.

Treatment.

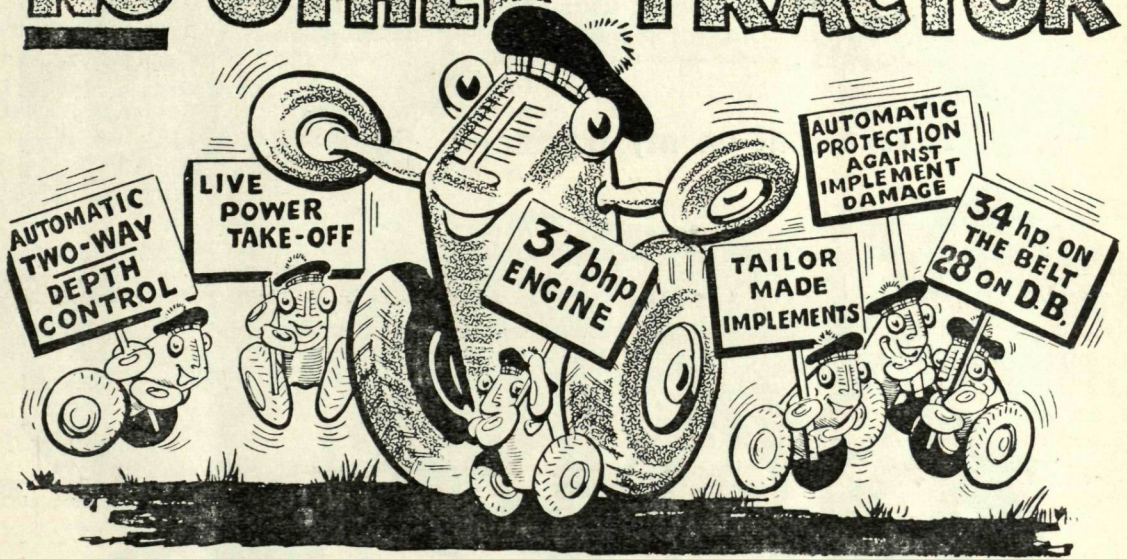
For the treatment of infested sheep, phenothiazine administered in the dosage and in the manner described for the large stomach worm is the drug of choice.

The compound 1:8 dihydroxyanthraquinone ("Diaquone," "Altan," "Istin") in doses of 2 to 3 grammes is very effective and in cases where large-mouthed bowel worm is the chief cause of symptoms it may be used alone, or it can be combined with phenothiazine to ensure removal of practically all of these worms.

THE LARGE LUNGWORM (*Dictyocaulus filaria*)

These are long slender creamy-white worms measuring up to four inches in length. They are found in the air passages of the lungs where they will be detected without difficulty at post mortem. Infestations with the large lung worm occur principally in the higher rainfall areas. The effects produced may be serious if the

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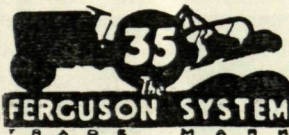
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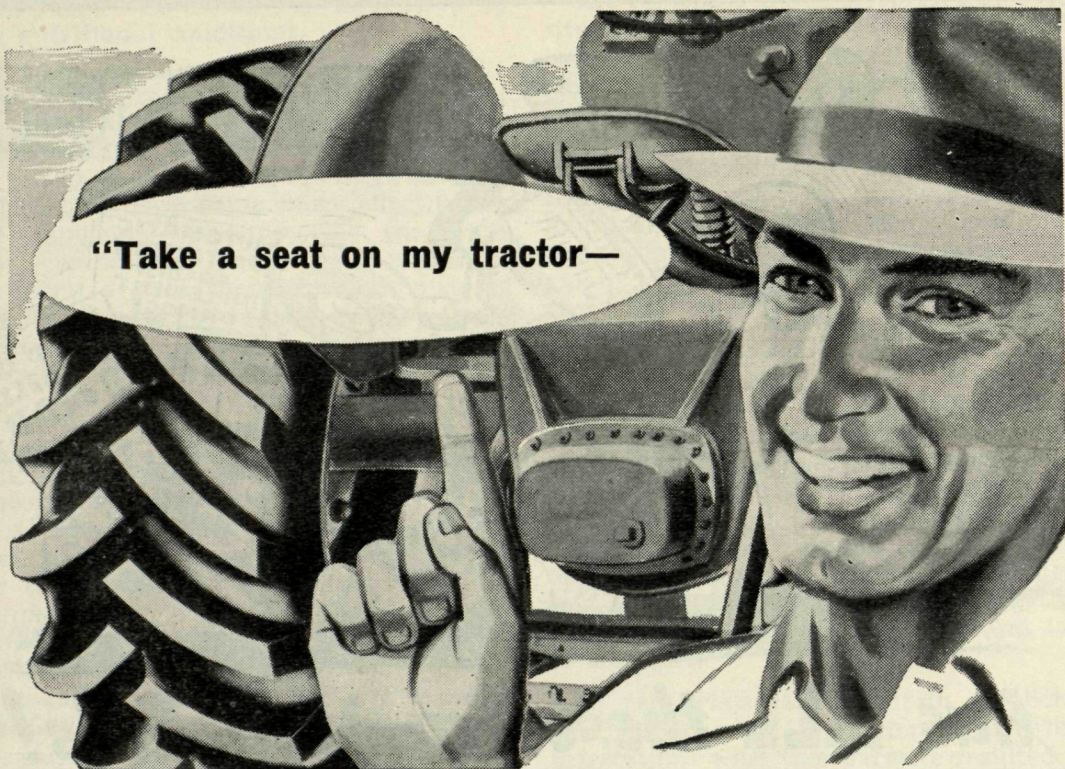


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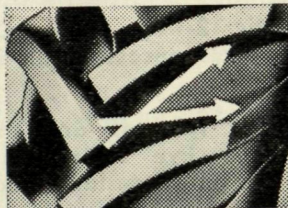
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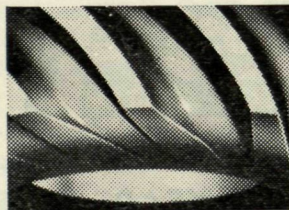
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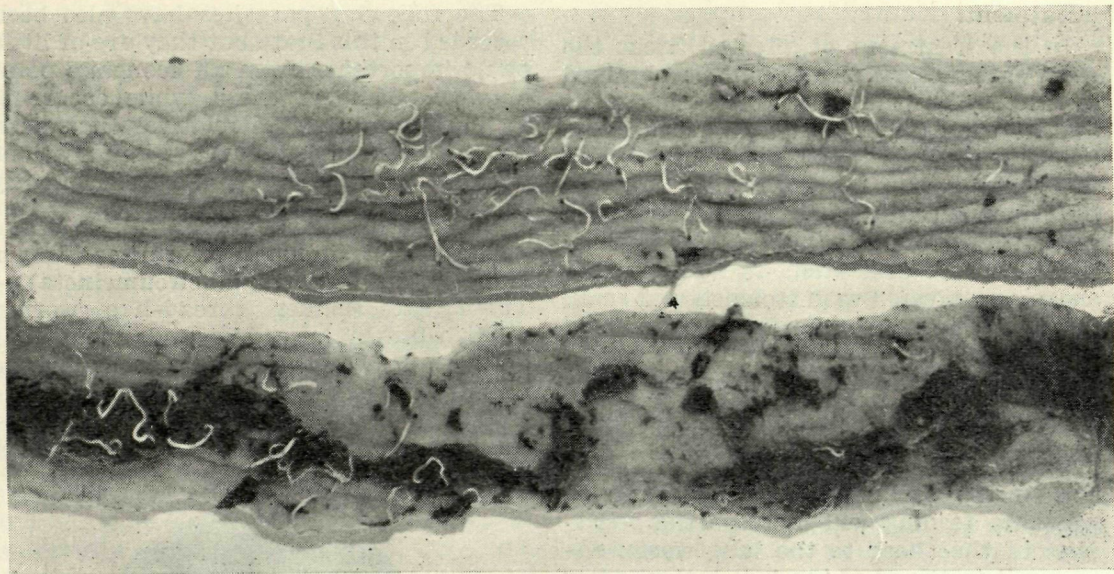


Fig. 8.—Sections of the colon (crown) opened up to show infestation with the large-mouthed bowel worm. This parasite is commonly present in sheep in the South-West of Western Australia. It increases in numbers some weeks after the hairworm or black scour worm.

nutritional conditions are poor and the sheep are at the same time infested with stomach and small intestinal worms.

Symptoms.

Young sheep are most frequently affected. Coughing is a prominent symptom and is most evident on the sheep camp at night or after the sheep have been yarded. This is at first the only symptom. In lightly infested sheep the cough is strong and harsh and is not accompanied by any loss of condition. In heavily-infested sheep the cough becomes soft and weak and may be altogether absent. The respiration is rapid and shallow. The animal becomes weak and sluggish and loses condition rapidly until death occurs. Suffocation resulting from the complete blockage of the air passages with the parasites is the principal cause of death. Less often pneumonia may be responsible.

Post Mortem Appearances.

At post mortem the parasites will be found in large numbers in the air passages of the lungs. In making the examination the trachea (wind pipe) should be split open with scissors and the finer air passages (bronchi and bronchioles) leading into it should in turn be opened. The

presence of a large number of worms may result in complete blockage of the smaller air passage, resulting in the collapse of portions of the lung tissues which thus become functionless. These collapsed areas are red in colour and solid and fleshy in consistency. In addition the lungs may contain more or less extensive solid pneumonic areas which contrast sharply with the pale pink, spongy, healthy lung tissues which surround them.

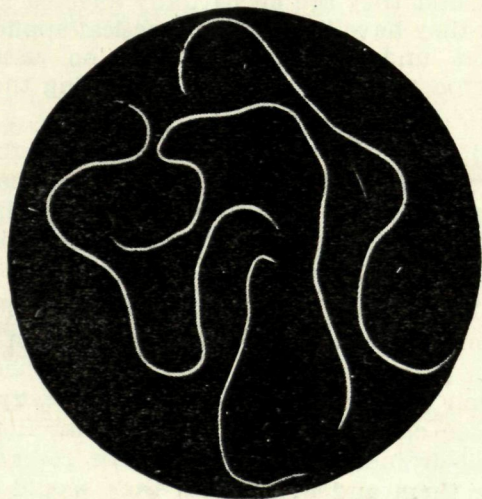


Fig. 9.—LARGE LUNGWORM (*Dictyocaulus filaria*)—natural size.
(After Clunies Ross & Gordon.)

Treatment.

In the treatment of affected flocks the most satisfactory results will be obtained by improving the nutritional conditions and at the same time treating the sheep for the removal of stomach and small intestinal worms. In this regard it should be remembered that serious lung worm infestations for the most part occur when feed is scarce and when, in addition, the sheep are infested with stomach and small intestinal worms. Affected flocks should be treated by the administration of phenothiazine drenches. They should be transferred to the best available pastures and the grazing should be supplemented by hand feeding. The removal of stomach and small intestinal worms together with adequate feeding will increase the resistance of the sheep to the lung worm, enabling it to throw off the infestation. After treatment it is important that the flock should be removed from low lying swampy areas in order to prevent reinfection.

In the past, medicinal treatment for the purpose of removing the parasites from the lungs has not proved highly efficient. Various methods of treatment have been employed, including the injection of drugs into the wind pipe or trachea (intra-tracheal injections) and the inhalation of chloroform or the fumes of burning sulphur while the sheep are confined in a closed chamber. Such methods of treatment are attended by considerable risk. At best they are on partially affected and as they have little or no practical application under field conditions no useful purpose will be served by describing them here.

Recently a new compound, cyanacetyldrazide ("Dictycide," "Helmox") has been discovered in England. It is effective when given either by mouth or by injection under the skin.

In the prevention of lung worm infestation, special attention should be given to the protection of lambs and young sheep. Such animals should not be allowed to graze on low lying swampy areas. High, well-drained country should be reserved for them and in addition they should be adequately fed, which will greatly increase their resistance to infection.

The following parasites have also been recorded in this State but they are of little or no importance from an economic point of view. Some of these, while occurring in large numbers, are relatively harmless. In the case of others the infestations which occur are light and consequently produce no serious effects.

The Small Stomach Worm or Brown Hair Worm (*Ostertagia circumcincta*).—These are slender thread-like worms, reddish-brown in colour and about half an inch in length. They occur in the fourth stomach where they will be detected when the lining membrane is carefully examined. The small stomach worm

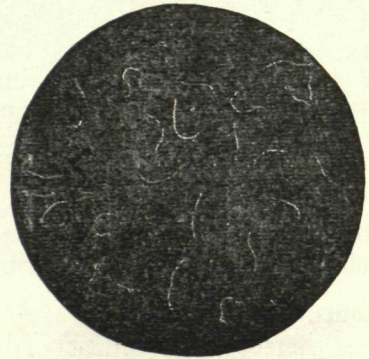


Fig. 10.—SMALL STOMACH WORM OR BROWN HAIR WORM (*Ostertagia Circumcincta*)—natural size.
(After Clunies Ross & Gordon.)

is a common parasite of sheep in Western Australia. The infestations are usually light or moderate and cause no apparent ill effects. Heavy infestations are stated to cause intermittent scouring, loss of condition and stunted growth in young sheep.

The Hookworm (*Bunostomum trigonocephalum*).—These are large stout reddish-brown worms measuring about one inch in length. They are found in the small intestine and will be distinguished from other worms which inhabit that portion of the digestive tract on account of their relatively large size. Hookworms are rarely met with in sheep in Western Australia and then only in very small numbers. Heavy infestations are capable of producing serious effects, the symptoms being similar to those caused by the large stomach worm.

The Thin-necked Intestinal Worm (*Nematodirus* spp.).—These parasites are found in the small intestine from 10-20 feet behind its junction with the fourth stomach. They are pink or white in colour and from $\frac{1}{2}$ inch to $\frac{3}{4}$ inch in length. The neck is long, slender, and coiled. Although it commonly occurs in Western Australia this parasite appears to be of little importance on account of the light infestations which occur. Serious infestations are reported in parts of Eastern Australia, where they produce symptoms of scouring and loss of condition.

***Cooperia* spp.**—These are small slender parasites measuring from $\frac{1}{4}$ inch to $\frac{1}{2}$ inch in length. They occur in the small intestine and will be distinguished from the hairworms because they are somewhat stouter and brighter in colour and are usually coiled. This species is rarely encountered in Western Australia and is no economic importance.

The Whip Worm (*Trichuris* spp.).—These parasites are found in the caecum or blind gut, attaching themselves firmly to the lining membrane. They are white

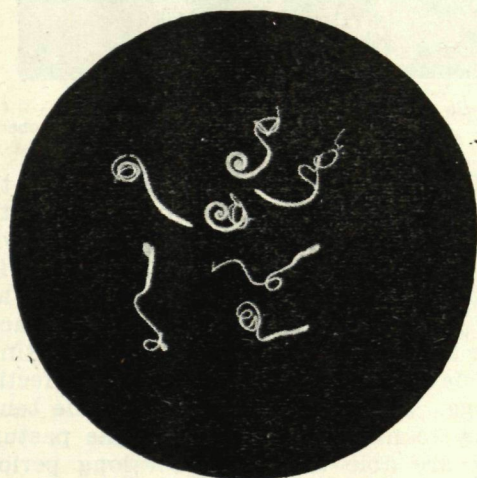


Fig. 11.—WHIP WORM (*Trichuris* species)—natural size. (After F. H. S. Roberts.)

in colour and about 3 inches in length. The head end of the parasite is long and slender and the body by comparison short and stout—hence the popular name “whip worm.” Even when present in large numbers these parasites appear to cause no ill effects.

***Oesophagostomum venulosum*.**—This parasite has been recorded only in the higher rainfall districts of the South-West. It is a stout, whitish worm about $\frac{1}{2}$ inch in length and is found in the caecum or blind gut. It is a relatively harmless parasite producing no ill effects upon the animal.

The Small Lung Worm (*Muellerius capillaris*).—The presence of this parasite is indicated by the occurrence of shot-like nodules in the lung tissues. The worm itself, which inhabits the finest air passages and is small in size, is rarely detected. The small lung worm is apparently harmless. Heavily infested sheep show no evidence of ill-health.

The Sheep Tapeworm (*Moniezia* spp.).—The tapeworms are found in the small intestine. They are flat ribbon-like worms measuring up to 18 feet in length and half an inch in breadth, creamy-white in colour and segmented. The head of the parasite is extremely small; the body increases in width from the head backwards. In heavy infestations the white segments which are passed out by the sheep may be observed in the droppings. Despite their large size, the tapeworms do not usually produce any serious effects. Lambs under six months old, upon becoming heavily infested, may show evidence of stunted growth and unthriftiness accompanied by diarrhoea or constipation. In the case of older sheep the parasite is harmless. Bluestone-nicotine drenches are very effective for the removal of this parasite.

LIFE HISTORY

A knowledge of the life history of the parasites is an essential to the application of control measures. The life cycles of the stomach and intestinal worms are in general similar. The female worms which are present in the digestive tract of the sheep produce large numbers of eggs which are passed out with the droppings and infect the pastures. Some species are prolific egg layers. A female *Haemonchus contortus* (large stomach worm) may produce 5,000-10,000 eggs daily. Within a few days the eggs hatch into larvae which, under favourable conditions of temperature and moisture, continue to grow and develop reaching the infective stage after a further interval of four-six days. In-

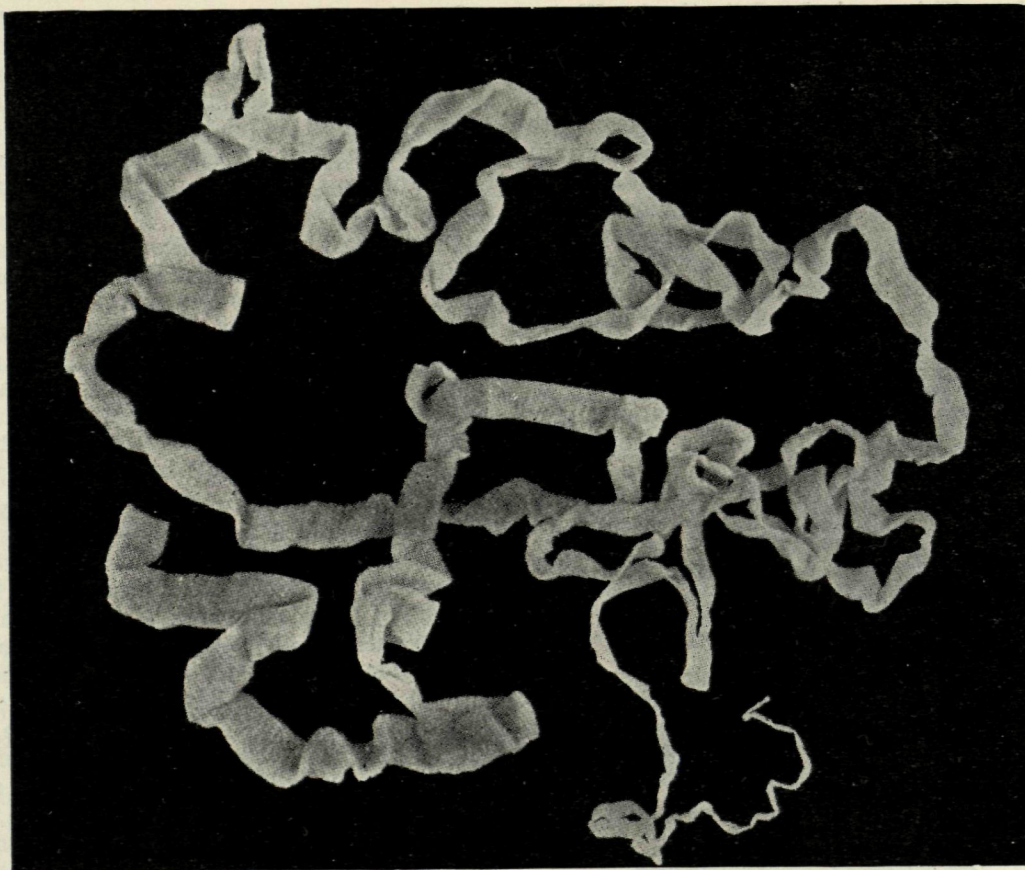


Fig. 12.—SHEEP TAPEWORM (*Moniezia* species)—natural size.

(After F. H. S. Roberts.)

fective larvae crawl up the blades of grass or herbage and are swallowed by the sheep while grazing. Upon reaching the digestive tract they develop to maturity. The infective larvae are active when the pasture is wet with rain or dew, ascending in the evening and descending in the morning. In dull rainy weather they may remain on the pasture during the whole of the day, considerably increasing the risk of infection.

The infective larvae are enclosed in sheaths and are consequently very resistant to heat and dryness, which enables them to survive on the pasture for several weeks under summer conditions. Before reaching the infective stage, larvae show little resistance to such conditions and do not survive very long. The eggs of some species such as the *Trichostrongyles* (hair-worms) are highly resistant and may survive for some months.

In the case of the large lung worm, the eggs are laid in the air passages of the lungs, are coughed up into the pharynx (throat) and are swallowed. In the intestine they hatch into larvae which are passed out in the droppings. On reaching the outside world the larvae continue to develop and pass on to the infective stage. Infective larvae show little tendency to migrate upwards on the pasture, but are able to survive for long periods (up to nine months) in shallow water where they are swallowed by sheep when drinking or grazing over marshy areas. Upon reaching the intestine, the larvae burrow into its wall and enter the lymph vessels by which means they are carried to the lungs, where they grow to maturity.

In the case of the tapeworms, segments containing the eggs are passed out with droppings and are consumed by an earth mite in which they hatch into larvae.



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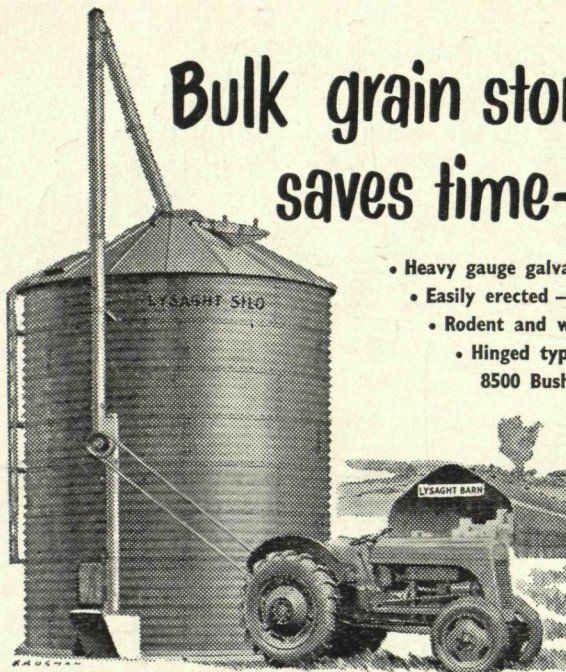
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Fig. 13.—These two sheep illustrate the advantages of well-applied worm control measures. The sheep in the rear is one of a group drenched four times with phenothiazine during a period of 15 months. The sheep in front is typical of a similar group that were not drenched. Note the difference in condition. The drenched group averaged 89.5 lb. liveweight and cut an average of 11 lb. 5 oz. of wool per sheep. The undrenched group weighed only 77 lb. and cut 9 lb. 1 oz. of wool.



These mites are swallowed by sheep while grazing and the larvae which they contain

are by this means transported to the small intestine where they develop into adult tapeworms.

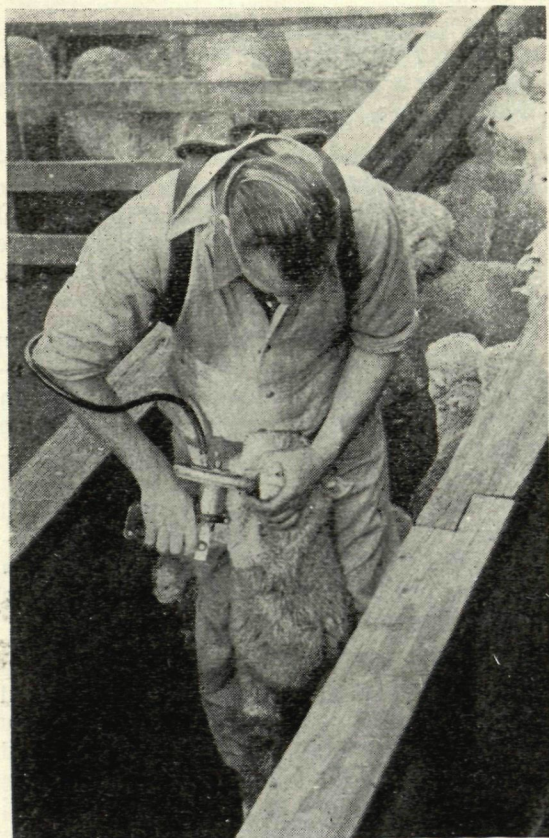


Fig. 14.—Drenching with an automatic drenching gun which incorporates an oesophageal tube. A narrow race is desirable and small sheep or lambs which can be restrained easily may be approached from behind. Large sheep are best approached from the front.

PREVENTION AND CONTROL

In the control of worm infestation reliance should not be placed upon drenching alone. Other control measures are available which, when combined with drenching and thoroughly applied, are capable of greatly reducing the degree of infestation. The measures which may be adopted are described hereunder. While they may not be fully applicable in all cases they should as far as possible be adapted to meet the particular conditions which obtain.

Drenching.—The drenching of flocks is an important feature of any programme of worm control, but as this involves the flock owner to outlay for materials and labour it is essential that the work should be carefully planned to give the best possible results.

As a result of experimental work carried out in this State by the C.S.I.R.O. and the Department of Agriculture, we now have a reasonably accurate picture of the seasonal trends in worm infestation—when the worm burdens are likely to rise or decline, when they are highest and when they are at their lowest levels.

This gives a good indication of the times when drenching is likely to be most effective. (See Fig. 15.)

GENERAL SEASONAL TREND OF WORM INFESTATION IN SHEEP IN WESTERN AUSTRALIA WITH INDICATIONS OF
TIMES FOR PREVENTIVE DRENCHING

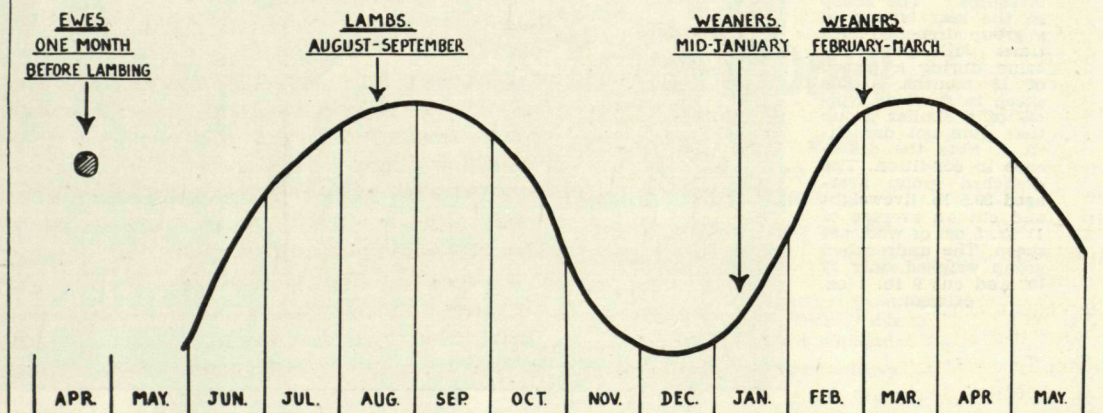


Fig. 15.—Diagram showing when worm infestation is likely to be severe in this State, and when drenches are likely to be most effective.

Lambs on contaminated pastures pick up worm larvae as soon as they commence to graze and, in order that they should receive a reasonably worm-free start in life, it is recommended that the ewes should be drenched about a month prior to lambing.

With the approach of warm, moist weather, the worm infestation increases and lambs should be drenched in August-September to rid them of heavy worm burdens. At this time, the ill-effects of the heavy infestation may not be obvious, but they would become apparent as the feed dries off and becomes less nutritious during the summer months.

By drenching the weaners in mid-January, the worm burdens are again reduced and the pastures are not heavily contaminated when the seasonal "break" occurs in the autumn.

A further drenching in February-March tides the weaners over the build-up of worm burdens which usually occurs at this period.

These drenching times apply, in the main, to districts with annual rainfalls of 15 inches or more. In the drier districts, the routine treatments may be reduced to the August-September and mid-January drenchings but where wet years

are encountered it would pay to follow the programme described for the wetter districts.

Phenothiazine drenches should be employed as this drug is highly effective against both stomach and intestinal worms. The removal of these parasites increases the resistance of the sheep to lung worm infestation.

A planned drenching programme, in combination with the other measures described here, will help to prevent worm infestation. There is an understandable reluctance on the part of many flock-owners to drench sheep and lambs which are apparently thriving but **it should always be remembered that when the animals are showing obvious signs of worm infestation, it is already too late to obtain the full benefit from treatment.**

Nutrition.—Good feeding will enable the sheep to resist worm infestation and is no less important than systematic drenching as a control measure. Improved pastures should be provided, clover being especially valuable in this respect. Hand feeding should be practised during the summer months. Whenever possible, grain such as oats, wheat or barley should be incorporated in the ration at the rate of $\frac{1}{4}$ - $\frac{1}{2}$ lb. per head daily. Adequate feeding

is of special importance in the case of young sheep, and particularly so for the control of hairworm infestation in weaners against which parasite drenching is only partially effective.

Rotation and Spelling of Pastures.—If a paddock is left unstocked with sheep for a month or longer, large numbers of the worm larvae infesting the pastures will die out. Although the more resistant forms are able to survive for long periods, the spelling of pastures in this manner will enormously reduce the degree of infestation. The hot dry conditions of summer are particularly effective in bringing this result about. Consequently if a system of rotation is practised whereby sheep are regularly moved to paddocks which have been spelled for not less than a month, the risk of worm infestation will be greatly reduced.

Burning off at the end of summer will also assist in freeing the pastures of worm eggs and larvae. Pastures which have been spelled or burned off should be reserved for the reception of lambing ewes and weaners.

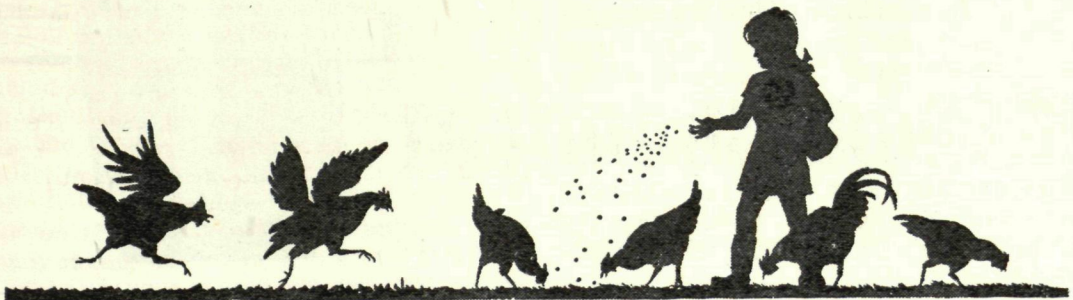
Avoid Low Lying Marshy Areas.—Moist and marshy areas which remain green during summer are especially dangerous. Sheep congregate on such areas in large numbers and as a consequence the pasture becomes heavily contaminated with worm eggs and larvae. Further contamination may result from drainage from surrounding hills. The moisture which is present favours the development of eggs and larvae and the close grazing resulting from the heavy stocking further increases the risk of infestation. Similarly swamps containing shallow water which favours the development and survival of lung

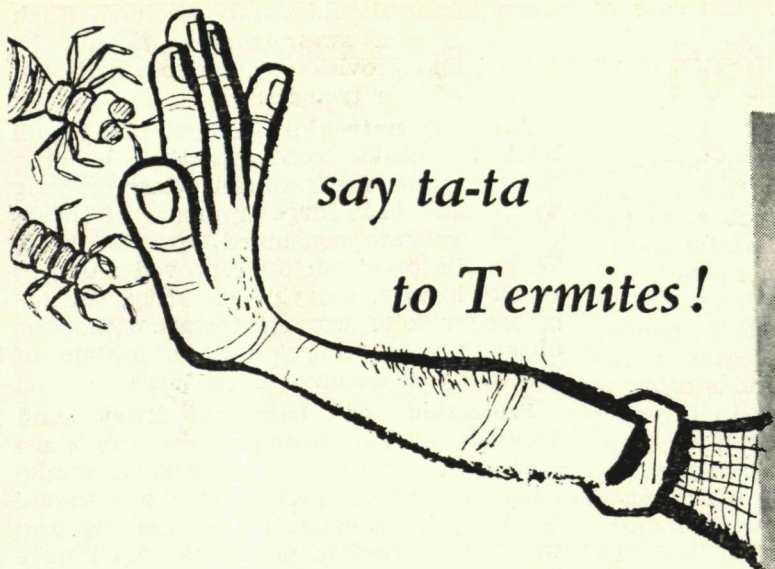
worm larvae should also be avoided. Such low lying and swampy areas should be fenced and provision should be made for watering from troughs.

Avoid Overstocking.—Overstocking will lead to heavy contamination of the pastures and the resultant close grazing will ensure that large numbers of infective larvae are consumed by the sheep. When the provision of improved pastures results in high carrying capacity, the increased risk of worm infestation may be offset by the adoption of a system of rotation and spelling of pastures.

Protection of Lambing Ewes and Weaners.—These animals are the most susceptible and special precaution should be taken for their protection. Ewes should be drenched shortly before lambing and then transferred to paddocks which have been spelled for a month or longer, or which have been burned off. Lambs should be drenched at the time of weaning and then transferred to paddocks which have been spelled for a similar period, and which are carrying good feed.

Paddocks intended for the reception of weaners should be closed up towards the end of winter, which will enable the above requirements to be fulfilled. In addition, lambs and young sheep should not be allowed access to marshy or swampy areas. Hand feeding should be practised during the summer. In the case of weaners it should commence early (December or January), which will enable the animals to accustom themselves to the feeders and will ensure that they do not suffer a set-back later on. The importance of adequate nutrition in the case of weaners cannot be over-emphasised. In the control and prevention of hairworm infestation it is the first line of defence.



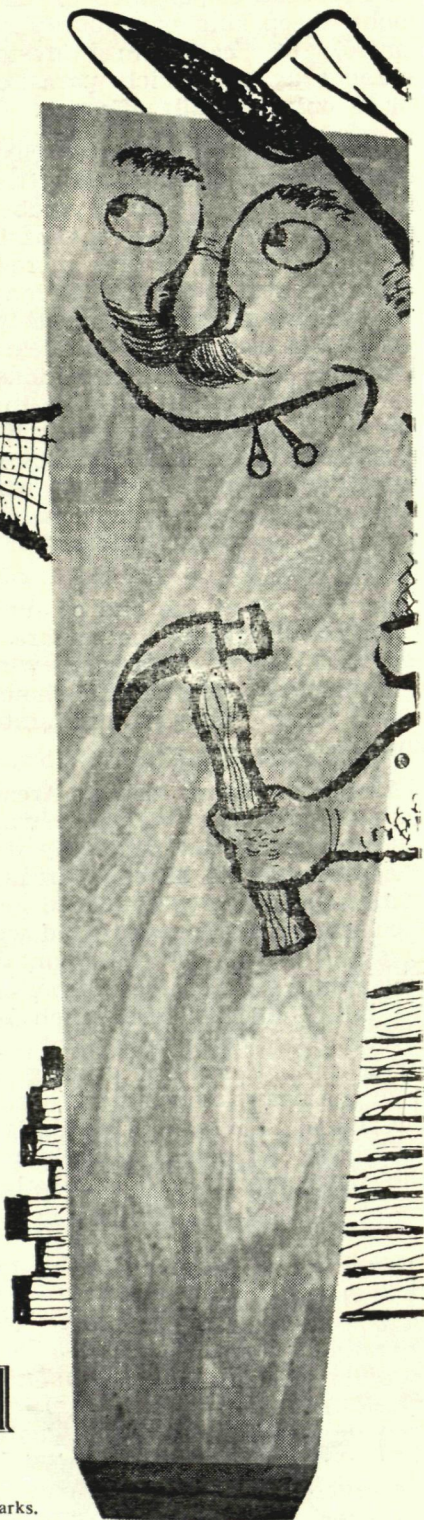


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