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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 carcase values and in the quantity and quality of wool produced. Furthermore, heavy infestations with worms are frequently responsible for serious mortalities.

In Western Australian 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. 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 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.

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

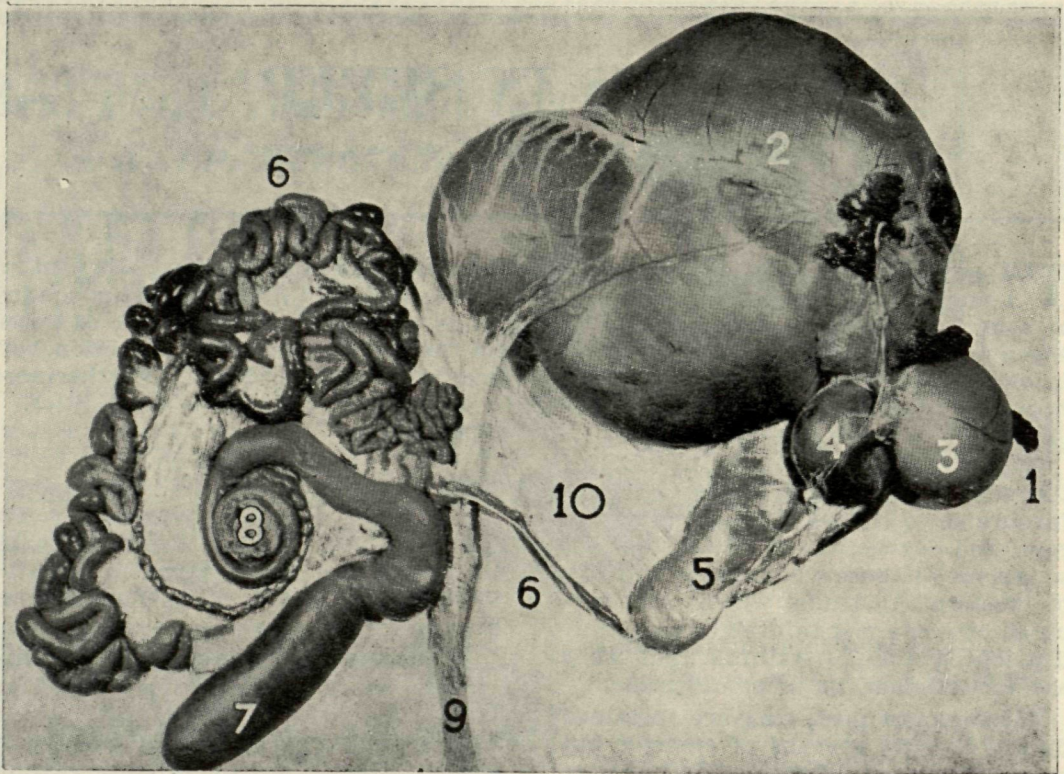


Fig. 1.—DIGESTIVE TRACT OF SHEEP. 1. Oesophagus (gullet). 2. Rumen (first stomach or paunch). 3. Reticulum (second stomach or honeycomb). 4. Omasum (third stomach or bible). 5. Abomasum (fourth stomach or rennet). 6. Small intestine (runners). 7. Caecum (blind gut). 8. Colon (crown). 9. Rectum (hind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

(After Clunies Ross and Gordon.)

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 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. Unthriftness 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; others are completely harmless. 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 hairworms 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.

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 probably the most serious of the internal parasites found in sheep in Western Australia. 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 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.

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

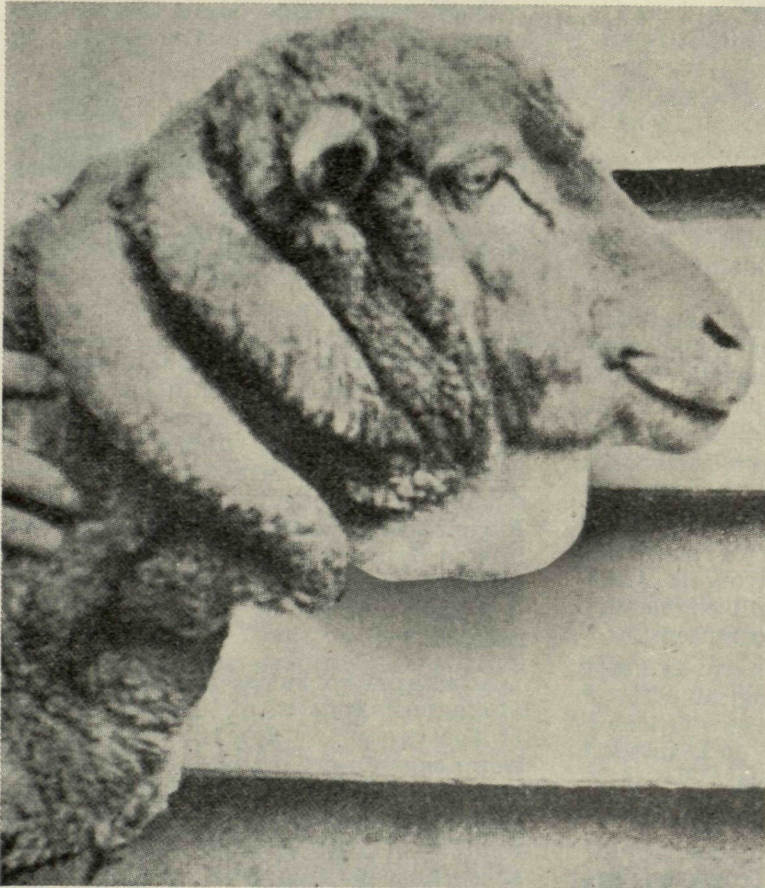


Fig. 2.—A sheep showing "bottle jaw," a symptom characteristic of stomach worm infestation.

(After G. R. Moyle.)

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.

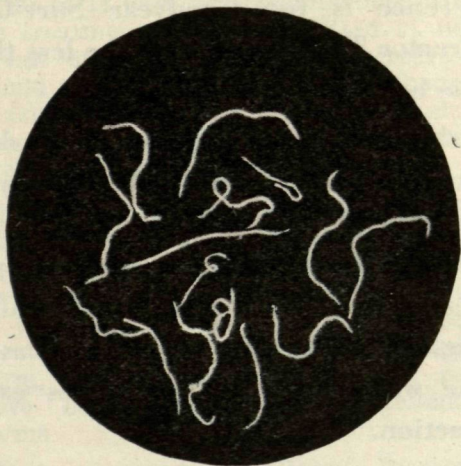


Fig. 3.—Large stomach worm or Barber's pole worm (*Haemonchus contortus*) natural size.
(After F. H. S. Roberts.)

Post Mortem Appearances.

The blood is reduced in amount and watery in appearance. The carcass is light and emaciated, the fat being replaced by gelatinous material. 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.

Any of the following drenches may be employed:—

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. It is marketed under various trade names such as "Phenovis," "Phenovine" and "Phenzeen" and is supplied in 1 lb. and 7 lb. containers. 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.

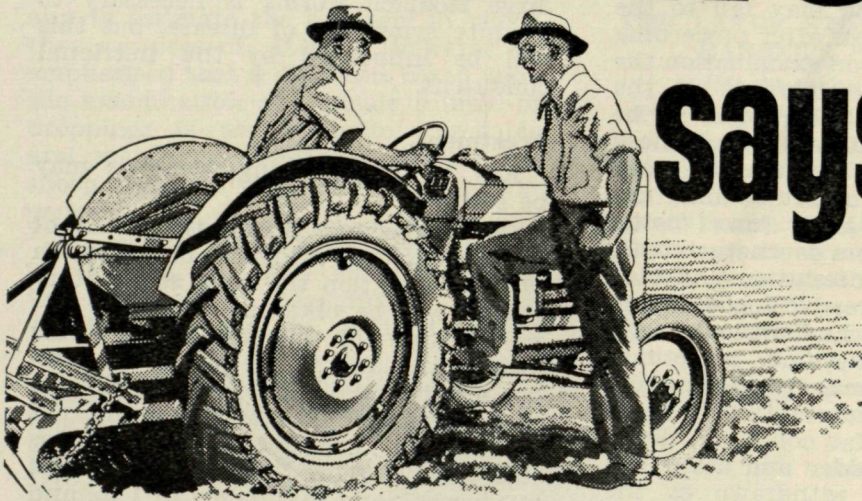
Lambs (4-8 months)—

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

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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.

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.

Bluestone—Arsenite of Soda. This preparation has the advantage of cheapness costing about threepence per 100 sheep as compared with phenophiazine at 4d.-7d. per head. It is, however effective only against the large stomach worm, whereas phenothiazine will remove both stomach and intestinal worms.

It is prepared as follows:—Dissolve $\frac{1}{2}$ lb. bluestone in 1 gal. of water. Dissolve 2oz. of arsenite of soda containing 60-65 per cent. As_2O_3 in 1 gal. of water. Mix the two and a green sediment forms. This is cleared by the addition of $1\frac{1}{2}$ fluid ounces of Spirits of Salts (commercial hydrochloric acid). Finally make up to 3 gal. with water and strain the mixture through a piece of cloth to remove any undissolved arsenic that may be present.

The dosage is as follows:—

| | |
|--------------------|---------------------------------|
| Grown Sheep | 1 fluid oz. (30cc.) |
| Sheep 12-18 months | $\frac{3}{4}$ fluid oz. (25cc.) |
| Sheep 8-12 months | $\frac{1}{2}$ fluid oz. (15cc.) |
| Sheep 4-8 months | $\frac{3}{8}$ fluid oz. (12cc.) |

Treatment should be repeated after an interval of 14 days and if necessary at intervals of three to four weeks thereafter.

Bluestone—Nicotine. These drugs may be used in either two per cent. or four per cent. solutions. The two per cent. solution on account of the larger volume of the dose is recommended for lambs and weaners; the stronger solution is preferred for older animals. A two per cent. solution may be prepared by dissolving 1 lb. of bluestone in 5 gal. of water and adding 16 fluid ounces of nicotine sulphate (commercial black-leaf 40). A four per cent. solution is made by dissolving 1 lb. of bluestone in $2\frac{1}{2}$ gal. of water and adding 16 fluid ounces of nicotine sulphate. There are many ready-mixed bluestone-nicotine preparations available on the market which will generally be found more convenient than home-made drenches.

The dosage is as follows:—

| Age | 2% Solution |
|--------------------|-----------------------------------|
| Grown Sheep | 2 fluid ozs. (60cc.) |
| Sheep 12-18 months | $1\frac{1}{2}$ fluid ozs. (45cc.) |
| Sheep 8-12 months | 1 fluid oz. (30cc.) |
| Sheep 4-8 months | $\frac{3}{4}$ fluid oz. (25cc.) |
| Age | 4% Solution |
| Grown Sheep | 1 fluid oz. (30cc.) |
| Sheep 12-18 months | $\frac{3}{4}$ fluid oz. (25cc.) |
| Sheep 8-12 months | $\frac{1}{2}$ fluid oz. (15cc.) |
| Sheep 4-8 months | $\frac{3}{8}$ fluid oz. (12cc.) |

Treatment should be repeated after 14 days and thereafter if necessary every three to four weeks. In addition to the removal of stomach worms bluestone-nicotine drenches may also be used for the control of *Trichostrongylus* (Hair worms) but they are by no means as effective as phenothiazine for this purpose.

Where bluestone-arsenic or bluestone-nicotine drenches are used for the control of the large stomach worm it will frequently be found that about ten per cent. of the affected sheep do not re-

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spond satisfactorily to treatment and these animals will require to be re-treated with phenothiazine in the dosage set out above.

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 pasture 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.

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, showing symptoms of the infestation during the summer months after the feed has dried off and the nutritional conditions have be-

come poor. 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.

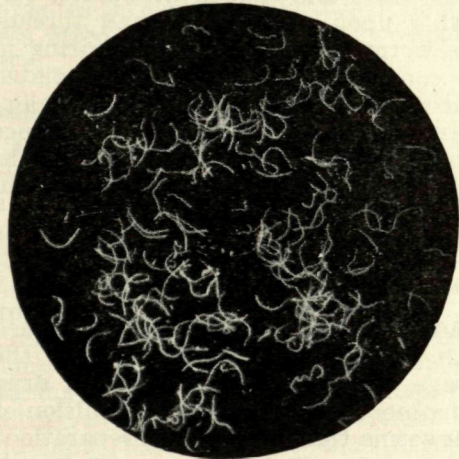


Fig. 4.—Hairworms (*Trichostrongylus* spp.) natural size.

(After F. H. S. Roberts.)

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 infested 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 thread-like worms will be observed floating in its contents. 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 on page 173; 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.

Alternatively the two per cent. blue-stone-nicotine drench described on page 175 may be used but this is considerably less effective than phenothiazine and repeated treatment will generally be found necessary in order to establish a satisfactory measure of control.

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 overlooked 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.

The economic importance of this parasite in Western Australia is still a matter in which some doubt exists. Infestations with the large-mouthed bowel worm commonly occur but they

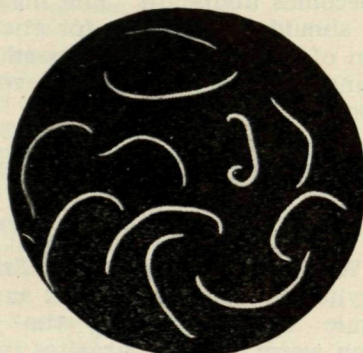


Fig. 5.—Large-mouthed bowel worm (*Chabertia ovina*) natural size.
(After Clunies Ross and Gordon.)

are usually associated with other parasites. Weaners suffering from hair worm infestation may at the same time be found harbouring large numbers of large-mouthed bowel worms. The effects upon the sheep are 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.

Treatment.

For the treatment of infested sheep phenothiazine administered in the dosage and in the manner described on page 173 is the drug of choice. There are no other drenches which when given by the mouth are effective for the removal of these parasites from the large bowel.

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

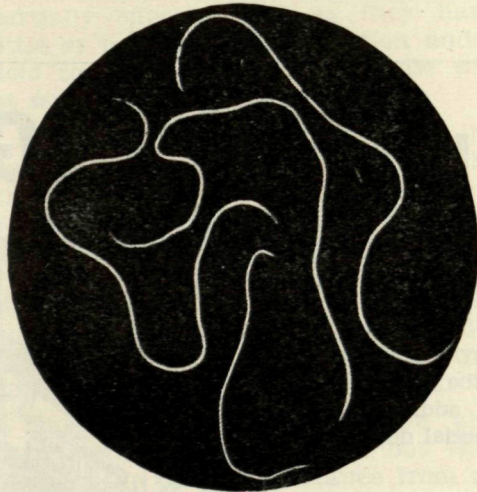


Fig. 6.—Large lung worm (*Dictyocaulus filaria*) natural size.
(After Clunies Ross and Gordon)

may be serious if the 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

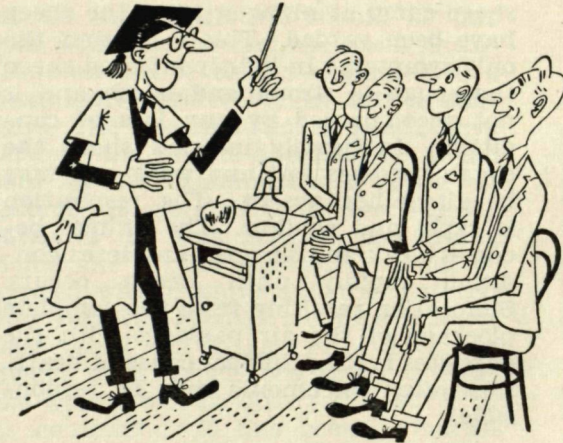
sheep camp at night or after the sheep have been yarded. This is at first the only symptom. In lightly infested sheep the cough is strong and harsh and is not accompanied by any loss of condition. In heavily infested sheep the cough becomes soft and weak and may be altogether absent. The respiration 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.

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



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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.

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 only partially effective and as they have little or no practical application under field conditions no useful purpose will be served by describing them here.

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 is a common parasite of sheep in Western Australia. The in-



Fig. 7.—Small stomach worm or brown hair worm (*Ostertagia circumcincta*) natural size. (After Clunies Ross and Gordon.)

festations 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 trigonoccephalum*).—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 $\frac{1}{2}$ in. to $\frac{3}{4}$ in. 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 re-

ported in parts of Eastern Australia, where they produce symptoms of scouring and loss of condition.

Cooperia spp.—These are small slender parasites measuring from $\frac{1}{4}$ in. to $\frac{1}{3}$ in. 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 of no economic importance.

The Whip Worm (*Trichurus spp.*)—These parasites are found in the caecum or blind gut, attaching themselves firmly to the lining membrane. They are white in colour and about 3 in. in length. The head end of the parasite

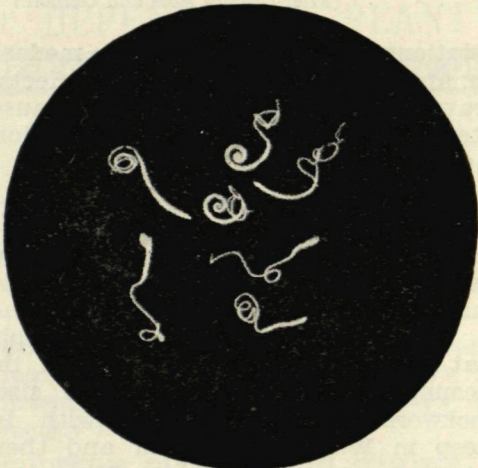


Fig. 8.—Whip worms (*Trichurus spp.*) natural size.
(After F. H. S. Roberts.)

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 $\frac{1}{2}$ in. 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. Infective larvae crawl up the blades of grass or herbage and are swallowed by the sheep

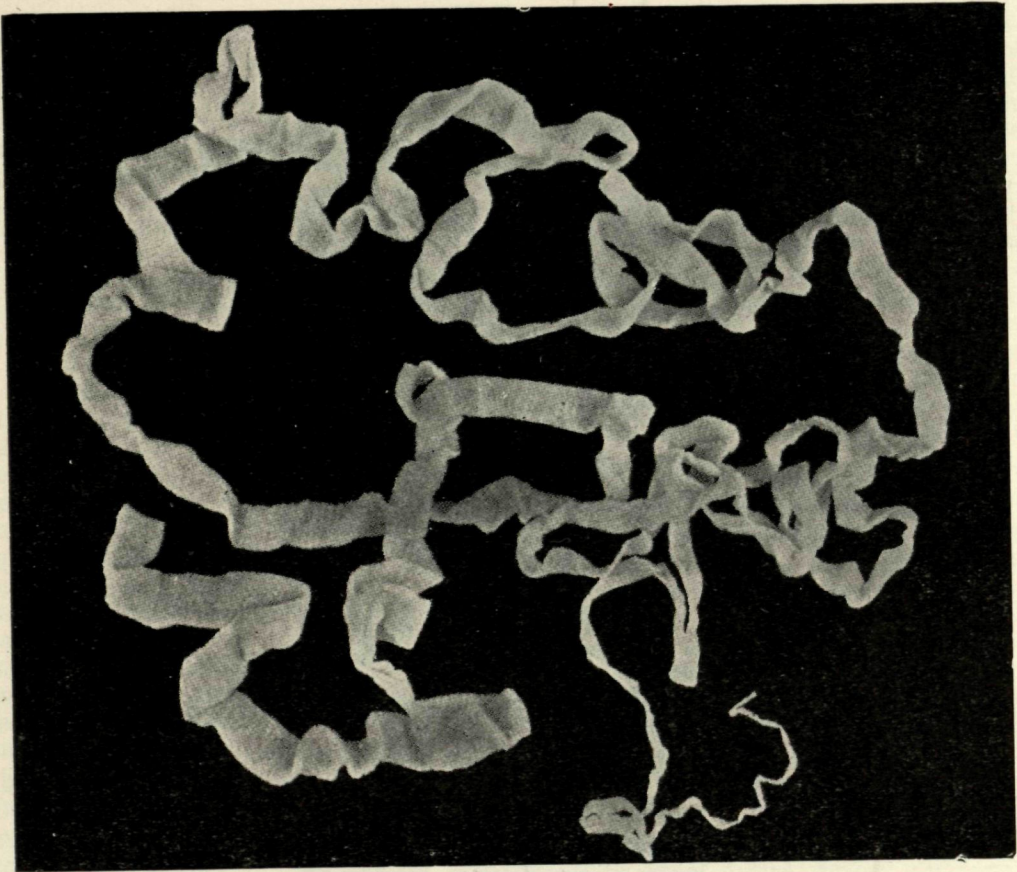


Fig. 9.—The Sheep Tapeworm—natural size.

(After F. H. S. Roberts.)

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 a sheath 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* (hairworms) are

highly resistant and may survive for considerably more than 12 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



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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. 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.

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.—Systematic drenching will play an essential part in any method of control. As a routine measure the flock should be drenched in the spring before the feed has dried off. In this connection it should be remembered that heavy infestations are generally acquired during the warm moist conditions of spring and that the effects become apparent in summer as the nutritive conditions become poor. Similarly in cold and wet districts in which the feed remains scarce throughout the winter months, flocks should be drenched as a routine practice during late autumn or early winter.

A Phenothiazine drench should be employed for this purpose and the treatment may with advantage be repeated after an interval of 14 days. Phenothiazine is highly effective both against stomach and intestinal worms and in addition by the removal of these parasites the resistance of the sheep to lung worm infestation is greatly increased.

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 become 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 precautions 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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