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THE CYSTIC TAPEWORMS
(BLADDER-WORMS)
OF SHEEP

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When sheep are examined at post-mortem, bladder-like structures or cysts containing a clear watery fluid may frequently be observed in the body cavity and in various tissues and organs. These are tapeworm cysts and represent larval or immature forms of tapeworms, the adult form of which is found in the intestine of the dog and other closely allied animals.

Three kinds of tapeworm cysts are found in sheep in Western Australia. Two of these are Cysticerci in which the cyst contains a single tapeworm head. The third is the Echinococcus or hydatid cyst which contains numerous tapeworm heads and frequently grows to a large size. These cysts rarely affect the general health of the sheep and their presence is detected only when the animal is subjected to post-mortem examination. Two of them, however, are of considerable importance. Cysticercus ovis is responsible for the condition known as "sheep measles" and causes the rejection of lamb and sometimes mutton carcases intended for export. The Echinococcus or hydatid cyst not only occurs in sheep but affects other animals and man, constituting a danger to human health.

The sheep become infected by swallowing tapeworm eggs passed out by infected dogs which contaminate the pastures. The dog in turn becomes infected from the consumption of raw offal containing tapeworm cysts. For the control of the parasite it is necessary to break this cycle firstly by the treatment of dogs for the removal of the adult tapeworms and secondly by the adoption of precautions which will prevent the dog from obtaining access to raw offal.

Cysticercus ovis—"Sheep Measles"

Cysticercus ovis occurs principally in the heart muscle and diaphragm where the cysts may be present in large numbers. They may also be observed in various locations in the muscular system and in the tongue as well as in the walls of the oesophagus (gullet) and stomach. The cysts are oval in outline and measure about a third of an inch in length by a sixth of an inch in breadth, the tapeworm head being situated about midway between the ends. C. ovis occurs predominantly in lambs. The cysts undergo rapid regeneration and are much less frequently observed in adult sheep. From the appearance of the tissues in which the cysts are located, the condition is sometimes referred to as "sheep measles."

C. ovis is of considerable importance to the export lamb industry. Carcases showing evidence of infection, are rejected as unsuitable for export, and are sold on the local market, usually at a reduced figure, and with consequent loss to the producer. The incidence of C. ovis infection in lambs varies considerably from season to season but records which have been kept at meat export works over a number of years, indicate the average annual rejections from this cause to be in the vicinity of 0.25 per cent.
It may be mentioned that the parasite is not transmissible to man and that the presence of cysts in lamb carcases is of no importance in relation to human health.

**LIFE HISTORY**

The adult tapeworm is known as *Taenia ovis*. It occurs in the intestine of the dog and allied species such as the fox and dingo, and varies in length from about 18 in to 5 ft. Like other tapeworms the parasite is flat and ribbonlike and consists of a head and neck and a chain of segments. The head is small and provided with suckers and hooks which enable the parasite to attach itself to the lining membrane of the bowel. The segments are rectangular and increase in size from the head backwards. As the segments mature or ripen they become detached and are replaced by new segments which form behind the neck. The ripe segments contain tapeworm eggs which are passed out in the droppings and contaminate the pastures over which they may be distributed by the action of wind and rain. The tapeworm eggs are swallowed by sheep while grazing and upon reaching the intestine, the shell is digested and a minute embryo armed with six hooks is liberated. The embryo bores through the bowel wall and gains access to the blood vessels, being carried to the liver and then to the heart. From this point it passes into the general circulation and is carried to locations such as the heart muscle and diaphragm, in which it is detected at postmortem. Here the embryo continues to grow, developing into a mature tapeworm cyst after an interval of two to three months. The dog becomes infected by eating raw offal, e.g., the heart, containing tapeworm cysts, and upon reaching the intestine the bladder is digested setting free the tapeworm head which becomes attached to the bowel wall. After an interval of about two months, a chain of segments is developed and eggs commence to be voided in the droppings. This completes the life cycle of the parasite. The life histories of *Cysticercus tenuicollis* and *Echinococcus granulosus* are similar.

**Control.**

Since sheep become infected by the ingestion of tapeworm eggs voided by dogs, control measures should be directed towards the prevention of infection of dogs together with treatment for the removal of the adult tapeworm.

In order to prevent infection, dogs should never be fed on, or allowed access to raw offal, but this material may safely be used after boiling for 10 minutes which will destroy the tapeworm cysts. In addition all dogs on sheep-raising properties should be regularly treated with drugs for the removal of tapeworms. Arecoline hydrobromide is highly effective for this purpose, and it may be procured in the form of $\frac{1}{2}$ grain tablets. This is the dose for a sheep dog of average size and it may be given either in tablet form or in solution after the tablet has been dissolved in a fluid ounce of water. In smaller dogs such as terriers, the dose should be reduced to $\frac{1}{4}$ grain while in the case of kangaroo dogs and animals of similar size, a dose of one grain may be administered. Treatment should be repeated at intervals of six months.

Since the fox, dingo and feral dog (domesticated dog gone wild), may also harbour the tapeworm, the control measures outlined above must be advocated with a good deal of reservation. A survey carried out in Victoria some years ago showed that foxes may harbour the adult tape-worms in considerable numbers. Although this survey was confined to a limited number of animals, it indicated the fox to be a natural host of the tapeworm and that foxes may be infected to a much greater extent than are dogs. Support is lent to this...
Fig. 2—Taenia ovis. This tapeworm occurs in the intestines of the dog, fox and allied species. The larval form is known as Cysticercus ovis and is found in the heart muscle and diaphragm of the sheep. (U.S.D.A.)

view by the fact that the fox frequently kills young lambs, devouring the tongue and muscular tissues, and in the light of this evidence it has been suggested that the fox may be a much more important factor in the dissemination of C. ovis infection in sheep than is the dog. It is possible in some localities that the dingo and wild dog may play a similar role and if this is the case, the control of the parasite can no longer be regarded as a practical procedure and it will be effective only to the extent to which the destruction of foxes and similar vermin is possible.

CYSTICERCUS TENUICOLLIS — THE THIN-NECKED BLADDER WORM

Cysticercus tenuicollis occurs principally in the abdominal cavity and is commonly observed at abattoirs, and in sheep killed for ration purposes. The cyst consists of a thin-walled bladder one to two inches in diameter containing clear watery fluid and may be observed hanging from the omentum and mesenteries (abdominal membranes), when the body cavity is opened. The tapeworm head appears as a white opaque spot in the wall of the cyst. Usually not more than three or four cysts are present in an affected sheep but occasionally, as the result of a gross infestation, hundreds of cysts are found scattered throughout the abdominal cavity and at times partially embedded in the liver tissue. In addition to the sheep, C. tenuicollis may be found in cattle, pigs and goats. The parasite is of no importance to human health but is sometimes confused with the Echinococcus or true hydatid cysts, particularly when embedded in the liver.

The adult tapeworm is known as Taenia hydatigena and is found in the small intestine of the dog where it may attain a length of 16ft. The life history of the parasite is similar to that described for T. ovis. Upon reaching the liver the embryo leaves the blood vessels and penetrates the liver tissues in which it wanders until it reaches the surface of that organ which it penetrates to enter the abdominal cavity and attach itself to the abdominal membranes. Here further development takes place which finally results in the development of the typical bladder-like cyst.

Despite the damage to the liver tissues caused by the migrating embryos, affected sheep suffer no ill effects, the presence of the infection only becoming apparent during examination at the time of slaughter. Since the parasite is of little economic importance and of no importance in relation to human health, the application of measures for its control are rarely warranted but should they be contemplated they would follow the lines described for the control of C. ovis.
ECHINOCOCCUS GRANULOSUS—THE HYDATID CYST

Echinococcus or hydatid cysts are found in the lungs and liver and occasionally in other tissues and organs, and they vary in size from a quarter of an inch to six inches or more in diameter. The cyst is enclosed in a firm fibrous capsule laid down by the body tissues and is lined by a delicate membrane from which tapeworm heads grow. It is filled with clear watery fluid and contains minute objects resembling grains of sand attached to the cyst wall or floating in the fluid. These are brood capsules each of which contains a number of tapeworm heads. In addition to the sheep, hydatid cysts occur in cattle, pigs, other animals and man. In the sheep, which is the natural host of the parasite, the majority of the cysts are fertile whereas in cattle the cysts are usually sterile and contain no living tapeworm heads, and this is also the case in about 20 per cent of the cysts occurring in pigs.

The parasite has a wide distribution and is especially prevalent in sheep-raising countries where hydatid cysts are common both in animals and man. In certain areas of Victoria and New South Wales from 20 to 30 per cent. of sheep and cattle examined have been found to be infected, while in New Zealand an even higher incidence than this has been recorded. The incidence of infection is much lower in Western Australia. At the Midland Junction abattoirs where all animals are subjected to postmortem inspection at the time of slaughter, the records for the year 1943 and 1944 show that less than two per cent. of the sheep examined were infected with hydatid cysts. The figures for cattle and pigs were correspondingly low, being less than 0.5 per cent., in the former and less than 0.25 per cent. in the latter.

During the course of meat inspection at abattoirs, organs such as lungs and livers containing hydatid cysts are condemned and subsequently destroyed and since the cysts do not usually occur elsewhere in the body, condemnation of the carcase is rarely necessary. Infected sheep appear to suffer no ill effects from the presence of the cyst; even massive infections causing extensive damage to the liver tissues are usually only detected during inspection of the abattoirs.

Life History.

The adult tapeworm occurs in the intestine of the dog and allied species such as the dingo fox. Unlike the other tapeworms described, it is extremely small, rarely exceeding a quarter of an inch in length and containing only two or three segments. On account of its small size and the fact that dogs rarely show any symptoms of the infection, the presence of the parasites is generally overlooked.

The life history of Echinococcus granulosus is similar to that described for T. ovis. Tapeworm eggs voided by infected dogs are swallowed by sheep while grazing and upon reaching the intestine the shell is digested and an embryo is liberated. The embryo penetrates the bowel wall gaining access to the blood vessels by which means it is carried to the liver or lungs where it becomes arrested. Here the embryo continues to grow developing after a period of several months into an Echinococcus or hydatid cyst. Dogs become infected by the consumption of raw offal containing the cysts.

Infection of Man.

The importance of the parasite lies chiefly in its relation to human health; tapeworm cysts located in the liver, less frequently in the lungs and sometimes in the bones causing hydatid disease, a serious and sometimes fatal condition in man. In Western Australia hydatids is not a notifiable disease under the Health Act and consequently the incidence of infection in human beings is unknown. Statistics, however, show that a small number of deaths have occurred annually from the condition.

As in the case of the sheep and other animals, infection in man results from ingestion of tapeworm eggs passed out by infected dogs. The risk of infection is greatest from contact with dogs kept at slaughter houses or on farms and stations where they are able to gain access to raw offal. In cities and large town where a system of meat inspection exists resulting in the condemnation and destruction of diseased organs, the risks of infection are remote.

The principal risk lies in the handling and fondling of infected dogs. Dogs kept on the chain or confined in yards, pass
their droppings in the vicinity of the kennels, and these eventually disintegrate and become mixed with the dust which may contaminate with tapeworm eggs. The risk of infection from the handling of dogs kept under such conditions is apparent, particularly when the precaution of washing the hands is overlooked. The danger is greatest in children who have no knowledge of hygiene. The majority of infections are believed to occur during childhood but these often do not become apparent until adult life.

Other methods of infection include the consumption of raw vegetables such as lettuce contaminated by tapeworm eggs derived from the excretions of dogs, or of water similarly contaminated, but these are considered to be of minor importance.

Prevention of Infection.

Since hydatid disease in man results from the ingestion of tapeworm eggs voided by infected dogs, particular attention should be directed towards the prevention of infection in those animals. Raw offal such as livers, lungs and hearts should never be fed to dogs and provision should be made for the sterilisation of such material by boiling, so as to destroy the parasites. In addition dogs should be regularly treated with arcoine hydrobromide for the removal of tapeworms. Dogs while under treatment, should be chained until purgation has ceased, when the droppings which may contain large numbers of ripe segments and eggs, should be collected and burned. Similarly dog yards and kennels should be maintained in a clean condition, droppings and bedding being regularly collected and destroyed by burning.

The precaution of washing the hands after handling dogs should never be neglected and this is particularly necessary before partaking of meals. Children require particular supervision in this connection. Young children should not be allowed to play with dogs or in the vicinity of their kennels. Dogs should be excluded from rooms in which food is being prepared or stored. Raw vegetables such as lettuce should be thoroughly washed in running water before use and dogs should be excluded from vegetable gardens. If the drinking water is drawn from a doubtful source it should be boiled before use.

These precautions should be practised in country districts, but they should not be necessary in cities and large towns where an efficient system of meat inspection exists.
KNOW YOUR TIMBERS

Habit.
Karri is one of the giant trees of Australia reaching a height of 270 feet with a clean bole of 100-140 feet. The diameter at the butt may exceed 9 feet. The tallest karri measured has a height of 281 feet and is known as the Standout. It is a smooth clean gum-type bark carried the full length of its straight, shapely trunk; the very thick bark is of a yellowish-white colour, blotched with pale to dark bluish patches. Karri regenerates readily after milling and the rate of growth is fast. At present 25,000 acres of cut-over forest have been given treatment for regeneration and placed under complete fire protection.

Timber.
The timber of karri is reddish-brown, closely resembling jarrah in appearance, although generally lighter in colour. Growth rings are not well defined and a wavy or striped figure due to interlocked grain is often shown. Karri can be distinguished from jarrah by the burnt splinter test, the former giving a white ash after burning, whereas jarrah burns slowly to a black char.

Karri is moderately heavy in weight, having a green density of 73 lb. per cubic foot, and when dried to 12% moisture content has a range from 49-62 lb. per cubic foot, with a mean density of 57.4 lb. per cubic foot, before reconditioning. In drying from the green condition to 12% moisture content the average shrinkage, before reconditioning of a backsawn board, is 10% (tangential shrinkage) and average shrinkage before reconditioning of a quartersawn board is 4.9% (radial shrinkage). Reconditioning only reduces these averages to 9.5% and 4.6% respectively, showing that very little collapse takes place.

Seasoning.
Karri requires more care in seasoning than does jarrah, since it dries more slowly and has a much greater tendency to check. Occasionally fine ring checks occur as well as the usual ray checks. Thicknesses up to 2 inches can be kiln-dried from the green condition, but the considerable care required, the strict control of drying conditions, and the fairly long period required for drying would in most cases make this practice uneconomical. Good results may be obtained by partially air-drying prior to kiln-drying, particularly if protecting masks and shielding of stacks is given during periods of warm and dry weather. The seasoning schedule used for jarrah is applied to karri.

Relatively slight collapse occurs, and reconditioning is not generally practised, but it provides the advantage of making the timber milder for dressing and giving slightly larger sizes. Approximately four weeks are required to kiln-dry 1 inch green stock.

Mechanical Properties.
Karri is both stiffer and tougher than jarrah and has been included in Strength Group "B" together with spotted gum and Sydney blue gum. At 12% moisture content karri has an average modulus of rupture of 28,600 lb./sq. in. compared with 15,900 lb./sq. in. for mountain ash and 14,900 lb./sq. in. for jarrah. In compression parallel to the grain karri has an average value of 10,500 lb./sq. in. compared with 9,700 lb./sq. in. for mountain ash at 12% moisture content. Karri is tougher than jarrah, having a toughness value when dry of 245 in. lb. compared with 110 in. lb. for jarrah.

General.
Karri, together with such timbers as blackbutt, southern blue gum, messmate, stringybark and red mahogany, is classified in durability class 3 and the sapwood is immune to Lyctus attack. It is fairly difficult to work and the grain has a tendency to rise; nevertheless with care it can be finished well and highly polished. It bends well at a radius of 6 inches after a minimum steaming period of one hour per inch thickness. Backsawn and quartersawn material have been found to bend equally well if free from checks, but selection requirements are more stringent with backsawn than with quartersawn stock. The bark of karri has a tannin content which varies from 11 to 22% and gives a leather of a good light colour. There are certain difficulties associated with the extraction process and these have been studied by the Division of Forests Products. The bark, if not dried soon after felling, undergoes a change which is not fully understood, whereby some of the tannins become insoluble. It was, however, found possible to obtain yields of 90-95% of the total tannin present by the use of sodium bisulphite in extraction. There seems to be a definite possibility in this material as a basis for tannin extraction since karri bark could be made available at large mills in sufficient quantities to justify the erection of extraction plants.

Uses.
This timber is well known overseas as well as in Australia for its valuable qualities. It is popular for superstructures because of its great strength, its availability in large sizes and long lengths, and its comparative freedom from defects. It is widely used in wharf and bridge structures.

In railway workshops it is used for wagon, van and carriage construction. It is largely used in agricultural implements, especially for bent parts. It is also used in shipbuilding and as mine lift guides in South Africa, and for crossarms in Great Britain. In dwellings it is used for rafters, studs, joists, flooring, interior trim for furniture. It is used largely in Western Australia for export apple cases and when treated, for wooden pipe lines. It can be rotary cut or sliced to provide a very good plywood and plywood, and these products are available commercially. Tests at the Division of Forest Products have shown that karri glues satisfactorily with casein, urea and tego resin film glues. Sleepers treated with preserving, have been found eminently suitable when used in dry climates.

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