HOW TO DETECT THE PARASITES OF FUR-BEARING ANIMALS

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WILLIAM A. RILEY and REED O. CHRISTENSON
Division of Entomology and Economic Zoology

The fact that animal parasites are the cause of enormous losses to growers of fur-bearing animals is now universally admitted, regardless of earlier statements to the contrary. Today, ranchers find that in spite of the expense and trouble involved and even occasional deaths it is profitable to make a practice of "worming" their animals.

Little more than a decade ago, when one of the writers began special studies of parasites of foxes, he found that even on the best ranches practically 100 per cent of the animals had hookworm and ascaris and many had numerous other forms. Under such conditions, it is advisable to treat all the animals as a routine, but progressive growers are constantly improving the sanitation of their ranches and are recognizing that the prevention of parasitic infections is vastly preferable to attempting to cure them after they have become established. As sanitary methods are perfected and put into practice, it is no more necessary to give promiscuous mass treatments than it is to treat the entire human population of a community because typhoid cases exist.

The rational first procedure, as in the case of human diseases, consists in making an accurate diagnosis of existing conditions, not only for determining what animals should be isolated and treated, but also for checking up on the sanitary condition of the ranch and on the value of the control measures being practiced. Such an examination of newly purchased animals, held in quarantine for a time, is also essential if introduction and spread of parasites in a clean ranch are to be avoided.

The only way by which the presence of liver, lung, or intestinal parasites in the living animal can be determined is through the microscopic examination of the manure, or "feces." Certain worms, or parts of them, are occasionally discharged and are to be seen with the naked eye, but this is exceptional and is not to be depended upon.

The idea that this microscopic work can be done only by a highly-trained specialist is wholly unfounded, altho it may be necessary to consult him in unusual cases. Any person intelligent enough to grow

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animals successfully can learn the method of making the necessary examination; and the essential equipment costs little as compared with the losses and waste which always follow hit-or-miss methods.

It is the purpose of this circular to describe briefly the equipment needed and the methods of using it. The eggs and cysts of the important animal parasites, with particular reference to those of foxes, are illustrated as they actually appear under the microscope.

Selection of a Microscope

To the novice, the compound microscope usually seems a complicated and formidable instrument. This is true of the elaborate research microscopes, but for the purposes of this work, a simple compound microscope with two lenses, magnifying approximately 100 and 400 diameters, is sufficient. Such an instrument is illustrated in Figure 1.

The standard American makes of this type of microscope can be purchased for approximately $70. Various much smaller and cheaply constructed microscopes are on the market which are being urged upon fur ranchers as entirely adequate for their purposes. Such microscopes usually retail in this country for about $25. It is true that they give ample magnification for determining the eggs of parasitic worms, but their satisfactory use requires more skill than do the standard instruments and they are so inconvenient that even the expert would not wish to use them where numerous examinations were to be made. It would be poor economy for the rancher with more than a few animals to select one of these small stands. If a new standard microscope can not be purchased, "rebuilt" instruments are available which can be obtained for about $50 and will be found entirely satisfactory.

Parts of the Compound Microscope

Before attempting to use his microscope the purchaser should become acquainted with its principal parts. The accompanying diagram with its labels will make this simple. Dealers in standard microscopes supply clearly written booklets on the care and use of the instrument, and these should be read carefully.

The essential optical parts—the most expensive parts of the microscope—are the "eye-piece," or "ocular," which, as its name indicates, is the one next to the eye of the observer; and the lower lenses, or "objectives." The ocular should be, preferably, one magnifying ten times, or, as designated by dealers, a 10 x ocular, while the objectives needed are two in number, a two-thirds inch (16 millimeters), or "low power," and a one-sixth inch (4 millimeters) or high power. The eye-piece fits into the small "draw tube," while the objectives are attached to the barrel, or "body tube" of the microscope by a revolving "nose piece." The object of this nose piece is to permit changing powers without unscrew-

ing and attaching each time—a procedure that is not only tedious but risky for the lenses.

From the very outset it should be remembered that the surface of the lenses should not be touched with fingers, and that only soft clean cloths or the "lens paper" to be purchased from dealers should be used in cleaning them.

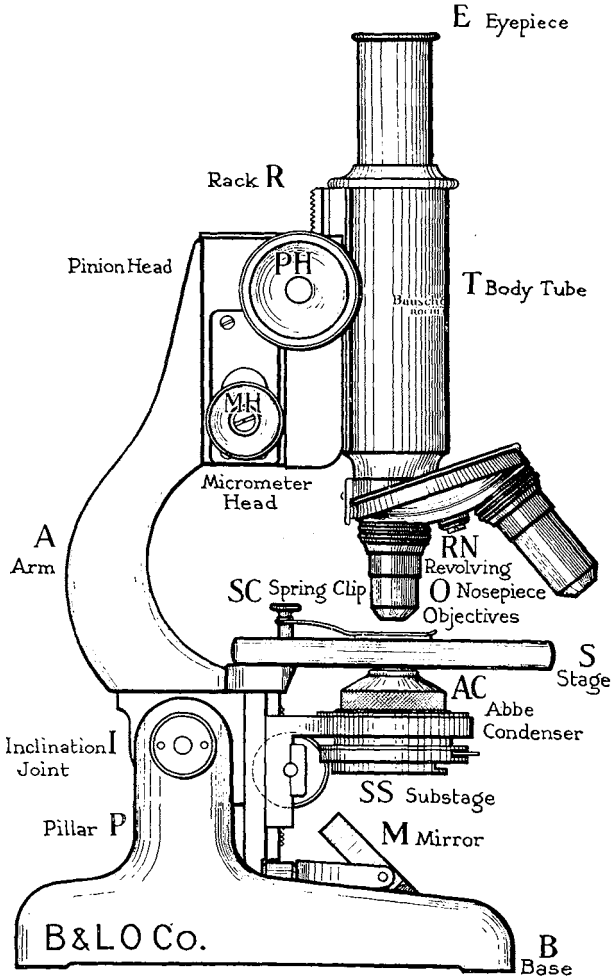


Fig. 1. Diagram of a modern microscope with the principal parts labelled.

The "base," a heavy horseshoe-shaped piece, supports the "pillar," and above this is the large rectangular "stage" with a central opening through which the light is thrown by a mirror. In the opening of the stage there is fitted an "iris diaphragm" or it may be a "substage" combining a condensing lens and an iris diaphragm for regulating the light which passes through the object to be studied. Modern micro-

scopes almost always have a joint just below the stage with which the microscope can be tilted to a convenient angle if the objects to be examined are not in fluid. The "arm," curved in the model illustrated, affords a convenient handle for carrying. At its upper part are the devices for focusing the microscope—the coarse and the fine adjustment. The external parts of these are known, respectively, as the "pinion head" (PH), and the micrometer head (MH).

Use of the Microscope

With few exceptions, objects to be studied under the microscope are viewed by "transmitted light," that is, they must be so transparent that the light from the mirror below can be thrown through them. The examination of feces of animals for the detection of eggs or cysts of parasites is made possible by diluting them with water or other fluid in the manner described below.

For preliminary practice use the test slide, which a dealer will furnish if requested, or prepare a slide of fecal material, following carefully the directions below. The 3×1-inch glass slide bearing the material is placed on the stage in such a position that the part to be studied is in the center of the opening.

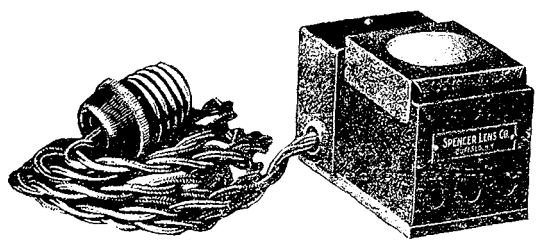


Fig. 2. A convenient type of microscope lamp for use where electric current is available

The microscope is placed on a table before a window but out of the sun. The mirror is so adjusted that its concave surface will throw the light upward through the object. The best light is that from a sky covered with white clouds, but that can not always be available. Indeed, it is often necessary to depend on artificial light. In that case a glazed electric bulb or a blue one is much preferable to the ordinary one. A miniature lamp of the type illustrated in Figure 2, provided with the so-called "daylight glass," is most convenient. If electric current is not available, a kerosene lamp can be used as a last resort.

When the preliminary lighting of the object has been accomplished, attention should be directed to the focusing of the microscope. In undertaking this, the objective must not be allowed to touch the object slide or both it and the lens may be injured. The designation of the objective as a two-thirds-inch (16 millimeter) or a one-sixth-inch (4

millimeter) lens means that they must be approximately those distances, respectively, above the object in order to be in focus. The preliminary examination should always be with the aid of the low-power, or two-thirds-inch objective. It should be noted that the high-power objective is the one which magnfies most and *not* one which is highest when in focus, for it is the one-sixth-inch lens.

The first step in focusing is to swing the low-power lens into position until it clicks on the revolving nose-piece, being sure that the tube of the microscope is raised up high enough that the lens does not touch the slide as it is brought into position. Then, watching from the side, turn the pinion head of the coarse adjustment (see Fig. 1, PH) to lower the lens until it is about one-half inch above the low-power lens. Now look in the eye-piece and focus *up* until the objects come clearly into view. At this time the lighting should be more accurately adjusted by slightly opening or closing the iris diaphragm by means of its projecting pin under the stage. With the coarse focusing completed,

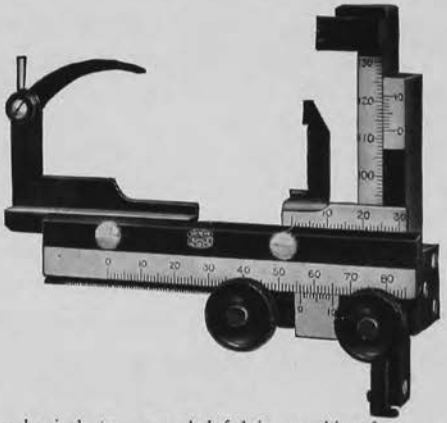


Fig. 3. A mechanical stage very helpful in searching for eggs of parasites

more accurate focusing is accomplished by means of the fine adjustment, or micrometer head (MH). This must be in constant use while studying an object, as even with the low-power lens the magnification is so great that objects at one level may be completely invisible while others above or below, as the case may be, are clearly in view.

In searching for evidences of parasitism, the slide should be moved by steady motion and in a systematic manner over the stage of the microscope so as to bring all parts of the mount within the field of the lens. At first this will seem difficult, for every movement is magnified as much as are the objects, and one's finger muscles must be trained. Mechanical stages (Fig. 3), which are available from dealers, are very convenient as an aid to thoro search, but they are not essential for general work.

After examination with the low-power lens, the one-sixth-inch one should be swung into position. If you have a modern microscope, properly adjusted by the dealer, the lens will be so nearly in focus when it replaces the low-power that focusing can be completed with a partial turn of the fine adjustment. Here, especially, precaution against focusing down into the object must be observed, as the lens is very nearly in contact with the cover glass when it is in approximate position. The habit should be acquired of constantly moving the slide very slightly back and forth while making the final adjustment. Then if there is any contact of the objective and cover glass, it is quickly detected.

If an object already located under low-power is to be studied under high-power, it should be placed as nearly as possible in the center of the field before the objectives are changed. With the lenses described, the field to be seen under high-power is only one twenty-fifth as large as that included by the low-power. The result from this is that objects in the outer part of the field of the two-thirds-inch objective will not be in position to be seen with the high-power.

The microscope should be protected from direct sunlight and from dust. Dust not only interferes with clear vision but specks on the lenses may lead to confusion in diagnosis. If, on looking through the microscope, the object studied appears dim or dirty, rotate the eye-piece; if that is the source of the trouble the spots will move with it. If they move when the slide is moved, the slide is the source. If neither the slide nor the ocular is at fault, examine the objectives. The lenses should always be cleaned with the special lens paper furnished by dealers, or with a clean old linen or silk cloth. Water or other fluid should not be allowed to dry on them but should be promptly wiped off.

Other Equipment

In the study of parasites it is often important to make accurate measurements of eggs, cysts, or parts. The unit of measurement in microscopic work is the *micron*, which is one twenty-five thousandths of an inch. For obtaining measurements, a very accurately ruled disk known as an *ocular micrometer* is fitted into the eye-piece or is obtainable, already in place, in a special eye-piece. The dealer from whom the microscope is purchased can furnish this already standardized so that the value of the rulings under both low- and high-power will be known.

For making mounts, standard slides, costing about $1.25 a gross, and cover slips, at $1.50 an ounce, will be needed. The former are clear glass slips 3 x 1 inches in size while the cover glasses are of very thin glass, preferably in squares ⅞ inch in size. They should be cleaned in soap solution and wiped with a clean lint-free cloth. The cover glasses are so readily broken that special care must be exercised

in cleaning them. Grasp them between the thumb and forefinger of one hand and with the other wipe both sides of the glass simultaneously in such a way that the pressure is equalized. When the slides and covers have been used in making fecal examinations, drop them into dishes of 5 per cent cresol, or similar disinfecting and cleansing fluid. To avoid breaking the covers slip them off into a separate dish of the fluid.

A supply of glass tubing ¼-inch in diameter and from 6 to 8 inches long should be available. For much of the work, the paraffined paper straws are equally good, but must be discarded after once using. A box of flattened toothpicks is indispensable; flat tongue-depressors obtainable from medical supply houses are very convenient. Lacking these, a supply of clean sticks about six inches in length should be available.

For collecting samples for examination, it is customary to use one-ounce tin salve or ointment boxes, but as these must either be discarded or thoroly cleaned after each using, it is much better to use inexpensive paraffined paper drinking cups and envelopes as used on Pullman cars. If examinations are to be made promptly, a covered receptacle is not needed.

For shipping or preserving fecal samples, a supply of wide-mouthed, one-ounce bottles, good corks, labels, mailing tubes, and commercial formalin is needed. One part of the formalin in nine parts of water is a suitable strength for the preservative. In this is placed a sample of fecal material the size of a hazel nut and the container must be labelled to show source, number of pen or animal, and date.

Collection of Samples

For a general survey of the ranch, it is usually sufficient to collect fecal samples from the pen, numbering the container to correspond. If it is desirable to examine individual animals, tattoo marks or other distinguishing characteristics should be noted.

Samples must be fresh, as old, dried specimens are not reliable. They should be picked up between two sticks with as little as possible of adhering dirt or sand. This point must be strictly observed, for such material adds greatly to the difficulty of making microscopic examinations. New sticks must be used for each sample or there may be contamination.

In the course of collection, careful note should be made of the possible presence of entire worms or segments that have been accidentally expelled. So, too, the condition of the feces, whether firm, mushy, fluid, or with blood or mucus, should be noted.

Specimens should be examined promptly. Hookworm eggs, particularly, hatch in a very short time after expulsion. If the examination must be postponed, place the samples on ice until they can be examined.

Preparing Mounts for Study

When about twenty-five samples are to be examined, the simplest and quickest method of preparing mounts of fecal material is by the *direct smear* method. By its use, moderate to heavy infections can be detected, but light infections may be overlooked. Moreover, often a good deal of coarse vegetable debris complicates the examination.

Direct Smear Method.—A drop of clean water is placed in the center of the slide and from several parts of the sample, small bits of the fecal material are taken up by a previously unused toothpick or splinter of wood. This is transferred to the drop of water and mixed with it by a rotary motion. A clean cover glass is then carefully dropped on the preparation.

The usual tendency of beginners is to use too much material and make an emulsion so dense that it can not be studied accurately under the microscope. A good rule is to make it so that newspaper print can be read through the preparation.

Straining and sedimenting.—The detection of parasitic eggs is much facilitated if the coarse material of the fecal sample has been removed and if the eggs have been concentrated. This is accomplished by various methods, of which we have found sieving, or straining, and sedimentation the most reliable. For convenient operation as many test tubes are needed, approximately six inches long and one inch in diameter, as there are samples; also wooden test-tube racks for holding these upright, a supply of soda-water straws, and a loose-meshed cloth reasonably free from lint, for straining. We have found organdie or two-ply French voile very satisfactory. This is cut into four-inch squares. A piece of fecal material the size of a hazel nut is placed in one of these squares, which is then suspended in a test tube filled to within an inch of the top with clean water. After the material has thoroly softened in the water, straining may be facilitated by pressure with a toothpick at the side of the bag.

After a half-hour, at least, a little of the sediment is taken from the bottom of the tube by means of a clean straw or glass tube. A finger is held over the top of the straw while it is lowered to the bottom of the tube, when the finger is partially and carefully removed until some of the fluid and sediment is drawn up about a quarter of an inch. The finger is then closed down again on the top and the few drops of material is transferred to a slide and covered. As with other methods, care must be taken to avoid a dense preparation.

A considerable number of tubes may be prepared at one time and if desired the specimens may be allowed to strain and sediment over night. In warm weather some of the hookworms will hatch under these conditions, but many will not and the larvae which have emerged can readily be recognized.

Flotation methods.—Several recent writers have recommended exclusively the mixing of fecal samples in a highly concentrated sugar solution, or one of table salt, in which many eggs float to the top and can be "looped off" for mounting. The method yields excellent results for certain species, but is open to the very grave objection that capped eggs, such as those of the broad tapeworm and of flukes, do not rise to the top and hence their presence is not discovered.

Microscopic Examination

Make a mount of fecal material in the manner described above, guarding against excess of fluid and overdensity. Place it on the stage of the microscope, center the preparation, adjust the light from the mirror, and focus carefully with the low (two-thirds-inch) objective. Adjust the iris diaphragm until the more transparent objects in the field stand out sharply.

Beginning at the upper right hand corner of the square cover glass, move the slide slowly across the field, shift just enough to bring a new field into view, and continue until the whole preparation has been studied, if necessary. During examination, the fine adjustment (Fig. 1, MH) should be constantly in use so as to bring different depths of the preparation sharply into view.

At the outset, distinguish the microscopic fragments of plant and animal tissues that are always present in fecal material. These are likely to be irregular in outline and in size as contrasted with parasitic gegs, which are sharply defined and of nearly uniform size. If an apparent egg is found, move it as nearly as possible into the center of the field, examine it closely, and then swing the high-power lens into position. Focus slightly up and down until the objects in the field are sharply in view, and if the egg is not there move the slide very slightly back and forth until it is found. Adjust the iris diaphragm, for the lighting which is best for low-power may not be suitable for the high-power examination.

These various manipulations, which may seem very complicated to the beginner, very quickly become automatic and require but a few seconds.

In the earlier work, until some conception as to relative size of objects under the microscope is acquired, it is well to measure the objects by means of the ocular micrometer. This should have been standardized for both the low- and the high-power. Move the slide until the object to be measured lies under the scale. If, for example, it covers four spaces and the value of each of these has been found to be 15 microns, the egg is 60 microns in length. If, under high-power, the value of each space were 3 microns, the same egg would extend over 20 spaces.

Eggs and Cysts of Typical Parasites

We shall describe briefly and illustrate eggs and cysts of the chief parasites affecting fur-bearing animals. As those of the fox are best known and most important we shall devote most of the discussion to them.

The illustrations are not more or less diagrammatic drawings, but are photographs of the actual objects as they appear under the high power of the microscope. We wish to acknowledge our indebtedness to V. P. Hollis, University photographer, for his efficient co-operation in obtaining these illustrations.

In the course of the examination, one may expect to find representatives of one or more of the following groups: Coccidia, tapeworms, flukes, and roundworms.

Coccidia

The Coccidia are minute, one-celled animals which live within the tissue of the intestine or liver of the animal. Here they develop by millions, destroying the tissue and causing the disease "coccidiosis." It is highly fatal among young animals—rabbits, foxes, minks, and muskrats—each of which has its own special variety of the parasite.

Coccidia are transmitted from diseased to healthy animals by means of firm-walled cysts which undergo a part of their development outside of the body of the animal. When first discharged, the content of the cyst appears as a simple compact mass, as shown in Figure 4, which is that of a recently discharged cyst from a fox. The remainder of the cyst is perfectly clear. Within a few hours the central mass has divided into two spherical masses, as shown in Figure 5, another species from the fox.

There are two groups, or genera, of coccidia, which may affect these animals. In the first, known technically as *Isospora* (Figs. 4 and 5), each of the two bodies becomes covered by a hard wall. In the second type, known as *Eimeria* (Fig. 6), they divide again, making four bodies before they develop their firm walls.

The coccidia most dangerous to carnivorous animals belong to the *Isospora* type, those of rabbits, sheep, and cattle to *Eimeria*. For practical work it is not customary to distinguish between the two types, but for critical work the cysts should be allowed to remain in water in a warm room for two or three days, until they have developed the two or the four spores characteristic of the respective genera. It should also be noted that two or more species of either genus may occur in the same kind of animal or even simultaneously in the same individual. This is illustrated by Figure 7, which shows two species of coccidia from the fox, distinguishable by the size of the cysts.

Tapeworms (*Cestoda*)

While tapeworms are not of prime importance as parasites of fur-bearers, they occur occasionally and may considerably affect the thriftiness of the animal. Their presence may sometimes be detected by seeing the segments in the droppings, as well as by finding the eggs by microscopic examination. The forms most commonly found are species of *Taenia,* one of which is acquired from infected rabbit flesh, and the broad tapeworm, *Diphyllobothrium latum* from fish.

Eggs of *Taenia* (Fig. 8) and related forms are round or ovoid, brownish in color and surrounded by a so-called "shell" which is characteristically radially striated, something like the milling on a penny. The eggs of the species most common in foxes, and occasional in minks, measure about 75 microns in diameter. When discharged they already contain an embryo whose six small hooks can readily be seen under high-power lenses.

Those of the broad tapeworm, *Diphyllobothrium latum* (Fig. 9), are considerably larger, elliptical, and provided with a small cap or lid at one end. It is necessary to adjust carefully the lighting and focusing in order to see the fine line which separates this cap from the body of the shell. In length they vary from 60 to 70 microns. The content is coarsely granular.

A species of tapeworm known as *Mesocestoides lineatus* has been reported for both foxes and minks. Its egg differs from either of those described above in being ovoid, without either striated "shell" or cap. It measures about 50 microns in length and contains a typical six-hooked embryo.

Flukes (*Trematoda*)

Flukes as parasites of fur-bearing animals have received little attention, but there is ample reason to regard them as serious enemies of minks, muskrats, and other fish-eating forms. At least eight species infect minks. They have been regarded as rare parasites of foxes.

The eggs of all the flukes that are likely to be encountered in this work are capped, similarly to those of the broad tapeworm. It should be remembered that such capped eggs are not to be detected by the so-called flotation methods commonly in use for the detection of parasite eggs in feces.

Figures 10 and 11 represent typical fluke eggs. The latter is from a lung fluke, *Paragonimus kellicotti,* which is a highly dangerous and not uncommon parasite of minks. The eggs of this species measure approximately 80 microns in length by 50 in width.

Round Worms (*Nematoda*)

On the whole, the group of roundworms, or *Nematoda,* includes the most troublesome of the worm parasites of man and animals. Here are grouped the hookworms and related forms, the ascarids (often called *the* roundworms) the lungworms, the trichina, and numerous other dangerous forms. Altho they may be found in various parts of the body, they occur chiefly in the intestine, liver, and lungs, and their eggs pass out with the feces. Most of them must undergo a considerable period of development in the soil before they are capable of infecting the animal again. Some of them, such as ascaris and the lungworm eggs, are exceedingly resistant to unfavorable weather conditions and may remain alive in the soil for months and even years.

Hookworm eggs (Figures 12 and 13) are elliptical, thin-shelled, and so transparent that they may readily be overlooked if the field is too brightly lighted. For this reason it is necessary to adjust the iris diaphragm carefully in searching for them. The content of the egg may be in the form of two, four, eight, or many spherical cells, or, in material that has stood for some hours, it may contain a coiled worm. The worms may even escape and be found free in fecal material that has stood for a day, in warm weather. Two species of hookworms, *Ancylostoma caninum* and *Uncinaria stenocephala,* have been reported for foxes, and also for dogs and cats. For practical purposes it is not necessary to distinguish between the two species, but detailed measurements have shown that the eggs of *A. caninum* are about 80 microns in length, while those of *U. stenocephala* are sufficiently smaller to make the distinction possible if several measurements are taken. They are especially dangerous to young animals.

On opening the small intestines of animals dead from the infection, hookworms may be seen as whitish threads less than an inch long, firmly attached to the lining wall.

Ascarid eggs.—The most common of the roundworms infecting young foxes, as well as kittens and puppies, are the ascarid worms. They are usually referred to as *the* roundworm, but that is incorrect as hookworms, lungworms, and various other parasites are also roundworms, or Nematoda. Of the ascarids, there are three species which occur in the fox—*Toxocara canis, Toxocara mystax,* and *Toxascaris limbata.* The eggs of both species of Toxocara (Figure 14) are almost globular, about 75 microns in diameter, and have a characteristic thin, pitted shell. If the microscope is focused on the surface of the egg, its pitting resembles that of an almond shell. As in *Toxascaris limbata* (Figures 15 and 16), the content may be undivided or divided into two or more cells, or even contain a coiled worm if the eggs are two weeks or more old.

The eggs of *Toxascaris limbata* (Figures 15 and 16), the third ascarid of foxes, as well as of dogs, are about the same size and shape as that of *Toxacara*, but the shells are thick and smooth.

Lungworms, known technically as *Eucoleus aerophilus*, are among the most dangerous parasites of foxes and various other carnivorous animals. On fox ranches they are often the cause of heavy losses, and as the eggs remain alive for a long time in the soil, the infestation is hard to stamp out. The eggs (Figure 17) are lemon-shaped, brown or brownish, with thick, netted shells with a colorless plug at each end, and average about 80 microns in length. Their contents are in a single mass when discharged, and they develop gradually in the soil. Altho the worms occur in the lungs and trachea, the eggs when coughed up are swallowed and discharged in the feces. Here they may be mistaken for the very similar but rarer eggs of the whipworm, *Trichuris vulpis* (Figure 18) but are smaller and more pointed. They live in the intestines of the dog and fox. Hall (1922) states that the eggs of *T. vulpis* measure from 77 to 86 microns, while those of the lungworm are "about 64-74 microns long according to measurements of American material in the Bureau of Animal Industry collection."

The giant kidney worm.—The largest known parasitic roundworm, *Dioctophyme renale*, lives in the kidney and, occasionally, in the body cavity of various carnivores. It has been reported for the dog, wolf, otter, various weasels, and seems to be most frequent in minks. The eggs (Figure 19) are ellipsoid, brownish, and have a coarsely pitted shell. They are discharged with the urine, but may be found by microscopic examination of urine-contaminated feces.

A serious but, fortunately, rare parasite of the digestive tract of foxes, wolves, dogs, and probably other carnivores is known technically as *Spirocerca sanguinolenta*. These worms, which are blood-red when fresh, live, several together, in tumors about the size of a walnut in the walls of the stomach and esophagus and sometimes in other organs. Our available specimens are immature and hence we can not show the eggs. They are ellipsoid and measure, according to Railliet, 20 to 30 microns in length by 11 to 14 microns wide and contain a worm when deposited.

Application of the Microscope Technic

In the preceding pages we have outlined the methods of making feces examinations, and have discussed the more important types of animal parasites which can be determined by this method. The practical application of the findings is not limited to diagnosis of disease under conditions of severe outbreaks. Much more important is the prevention of acute conditions through the adoption of sanitary meas-

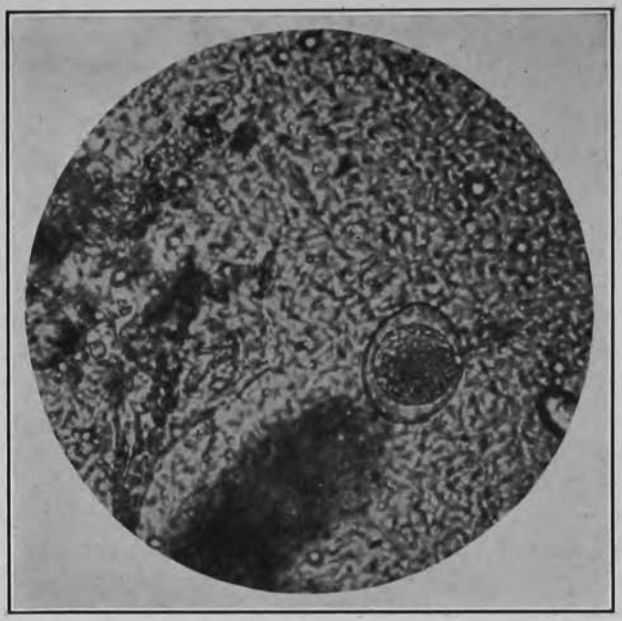
ures and the checking of the value of control measures that are being attempted.

Through such examinations, animals found to be infected can be isolated for treatment. A treated animal should not be returned to its pen, there to scatter all of the infective material that is eliminated by the drug, but should be kept isolated for a couple of days and all of its manure be burned.

Newly purchased animals should be kept in quarantine until thoroly examined, and, if infected, properly treated. Indeed, it would be better policy to insist on a thoro examination at time of purchase and necessary treatment at the risk of the seller.

Determination of Parasites

Specimens of animal parasites of domesticated and fur-bearing animals or of man, will be determined and information regarding their life history and control furnished if they are preserved in formalin solution (one part of commercial formalin and nine parts of water) and mailed, securely packed, to the Division of Entmology and Economic Zoology, University Farm, St. Paul. Specimens should be labeled to indicate source, date, and sender, and accompanied by a letter with additional information.



Fi. 4. Undivided cyst of a coccidian, *Isospora* from the fox. Magnified 460 x.

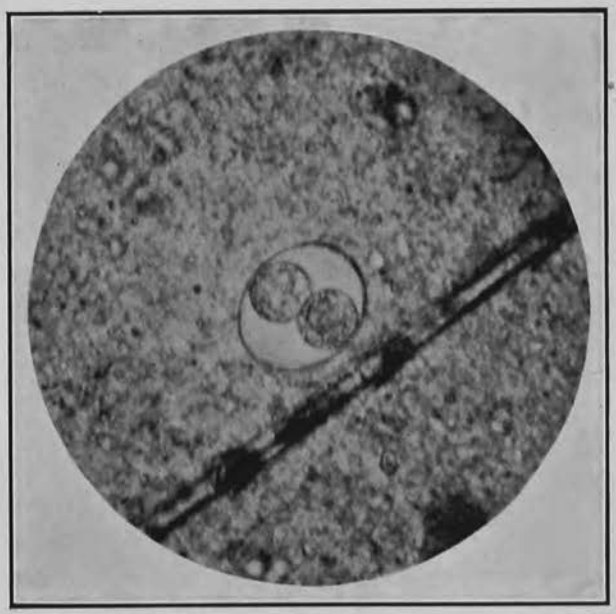


Fig. 5. Developing cyst of a coccidian, *Isospora*, some hours after discharge from the fox. Magnified 460 x.

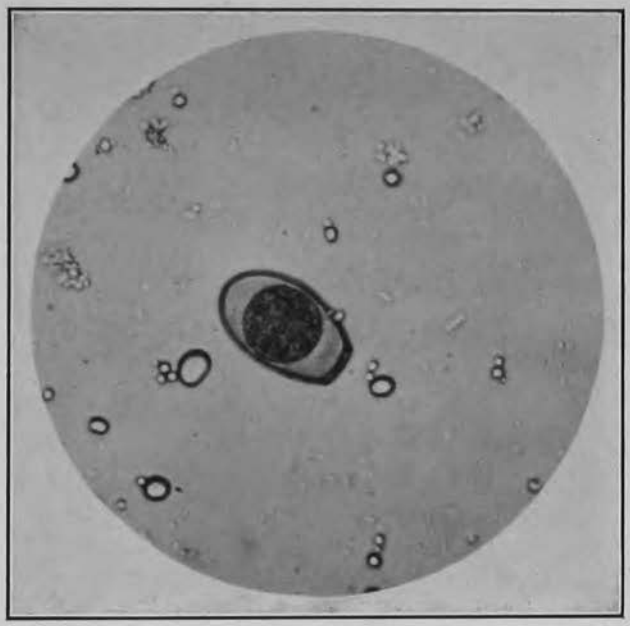


Fig. 6. Cyst of a coccidian, *Eimeria*, from the rabbit, before development. Magnified 460 x.

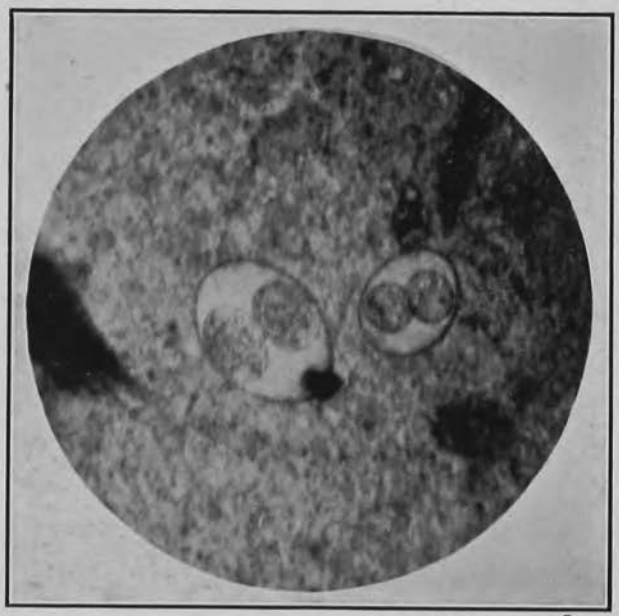


Fig. 7. Cysts of two species of *Isospora* from the fox. Magnified 460 x.

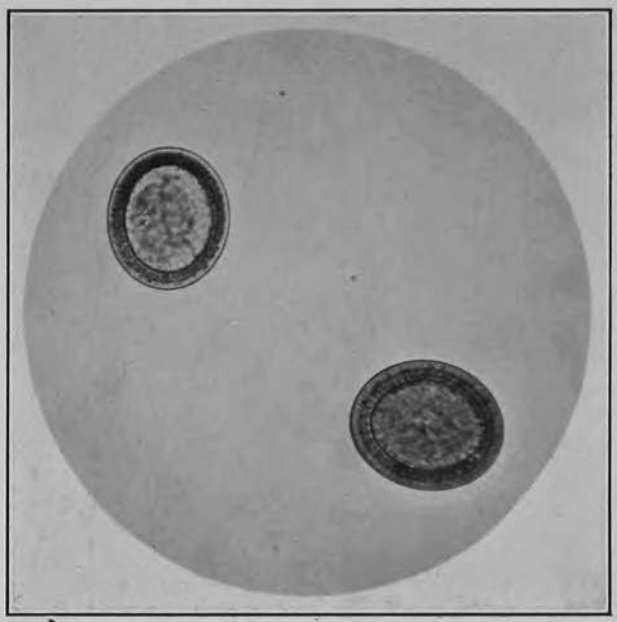


Fig. 8. Eggs of a tapeworm, *Taenia pisiformis* which may develop in foxes fed on rabbits. Magnified 460 x.

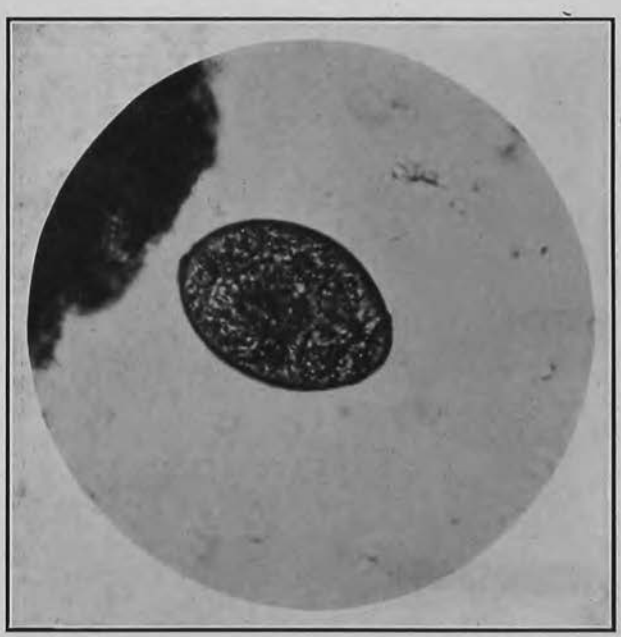


Fig. 9. Eggs of the broad tapeworm, *Diphyllobothrium latum* contracted from a fish diet. Magnified 460 x.

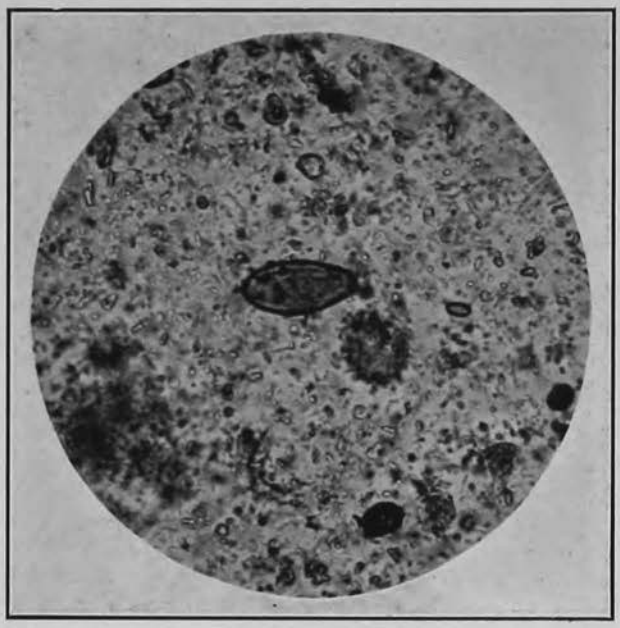


Fig. 10. Egg of an intestinal fluke from the fox. Magnified 460 x.

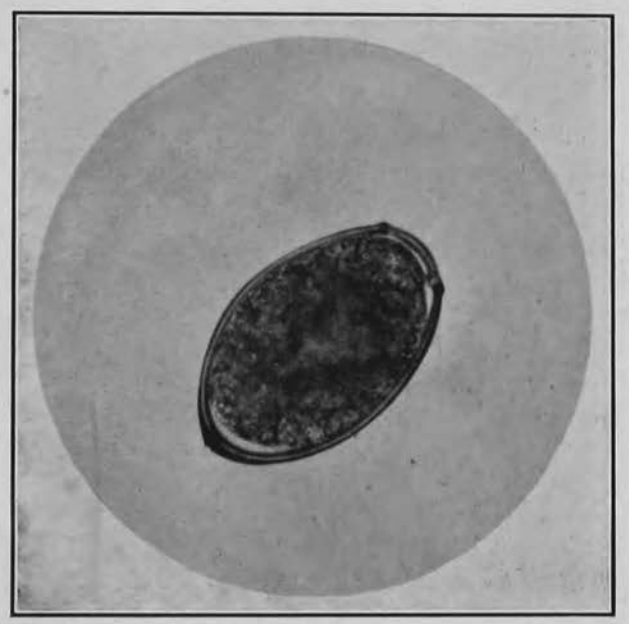


Fig. 11. Egg of a lung fluke, *Paragonimus kellicotti*, from a mink. Magnified 460 x.

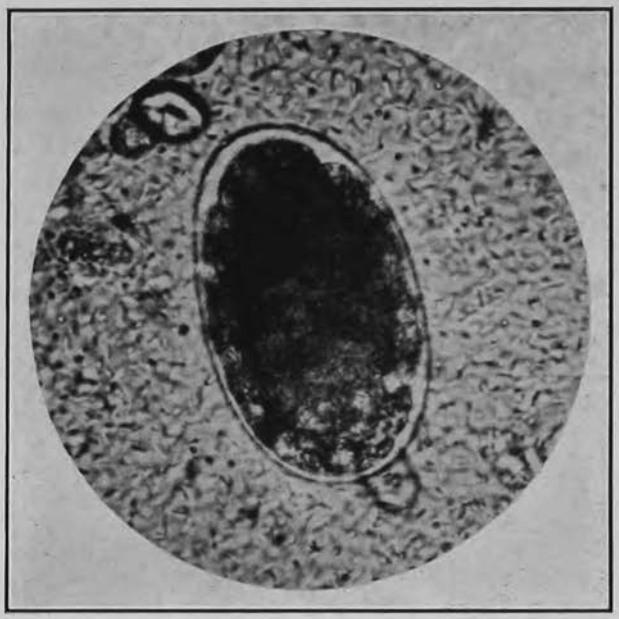


Fig. 12. Hookworm egg soon after discharge from the intestine of the fox. Magnified 620 x.

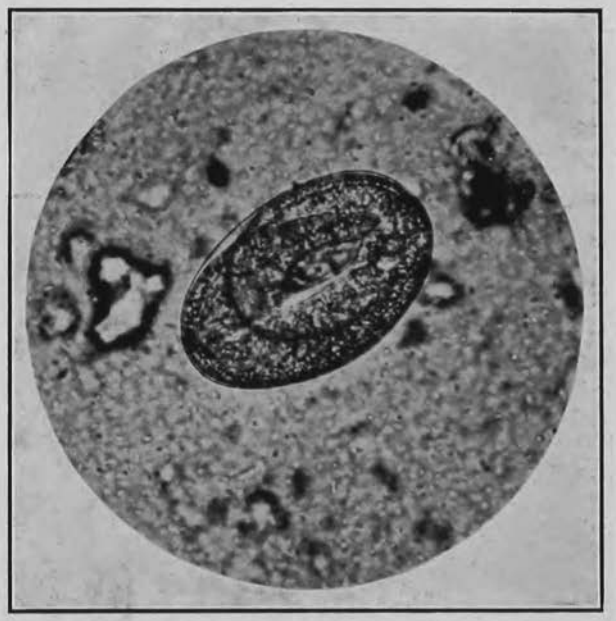


Fig. 13. Egg of a hookworm several hours after discharge from a fox. The coiled worm can already be seen. Magnified 460 x.

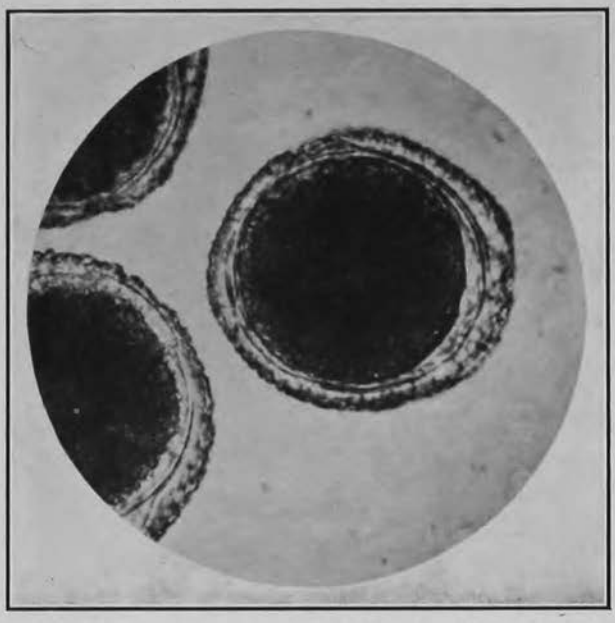


Fig. 14. Eggs of an ascarid worm, *Toxocara*, as found in fresh feces of the fox. Magnified 460 x.

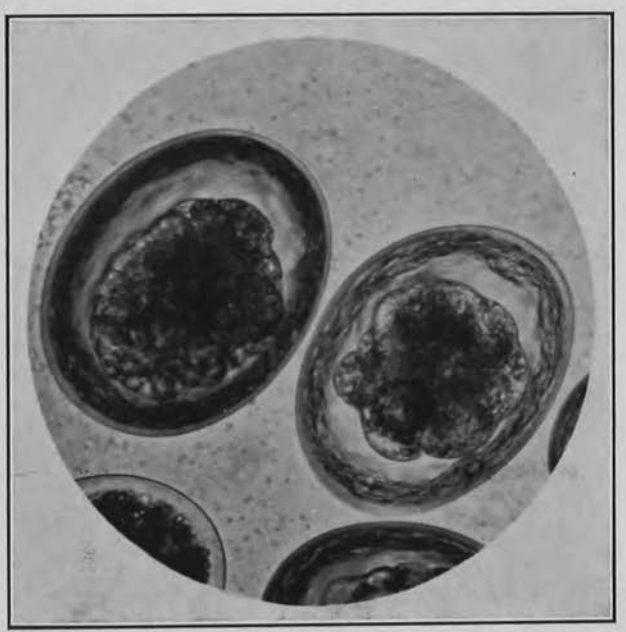


Fig. 15. Developing eggs of an ascarid, *Toxascaris*, a few days after discharge from the fox. Magnified 560 x.

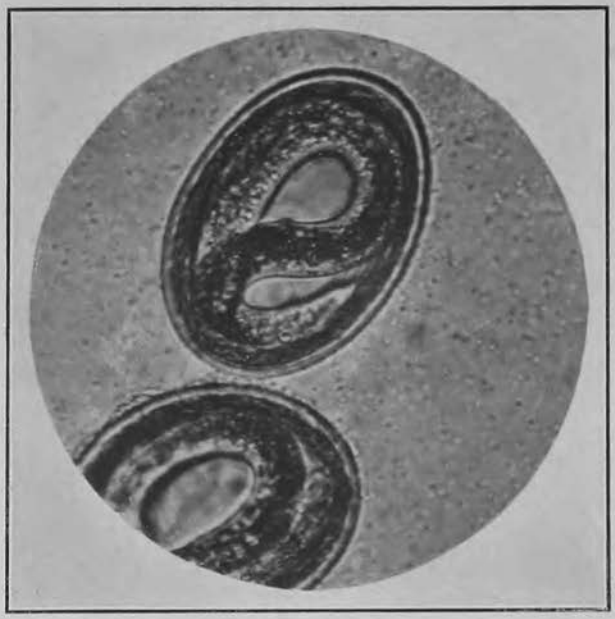


Fig. 16. Eggs of an ascarid, *Toxascaris*, two weeks after discharge from the fox. In this "coiled larva" stage they are infective. Magnified 560 x.

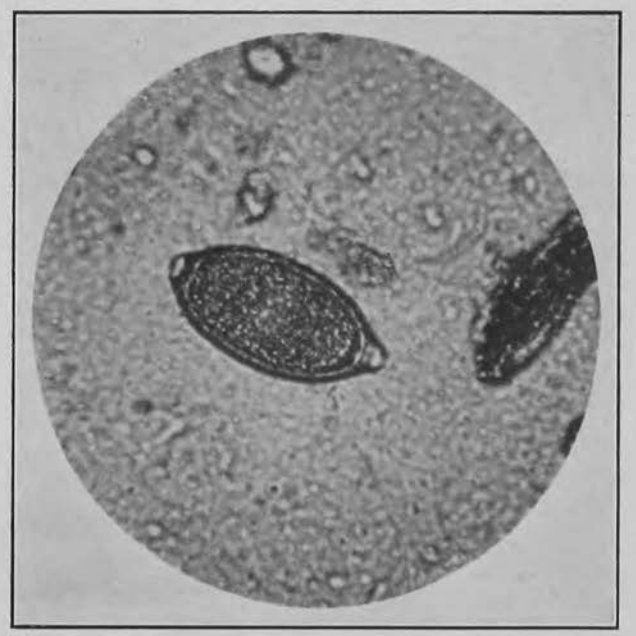


Fig. 17. Egg of the lungworm of foxes. Magnified 460 x.

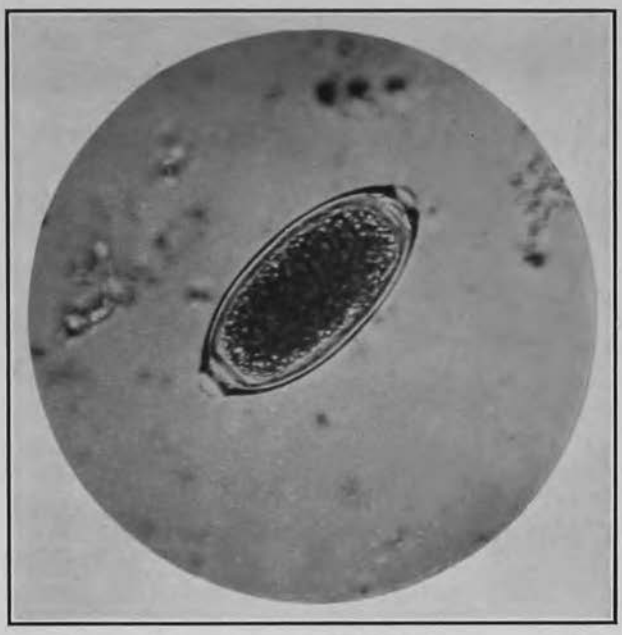


Fig. 18. Egg of the whipworm, *Trichuris vulpis*, an intestinal worm of the dog and fox. Magnified 460 x.

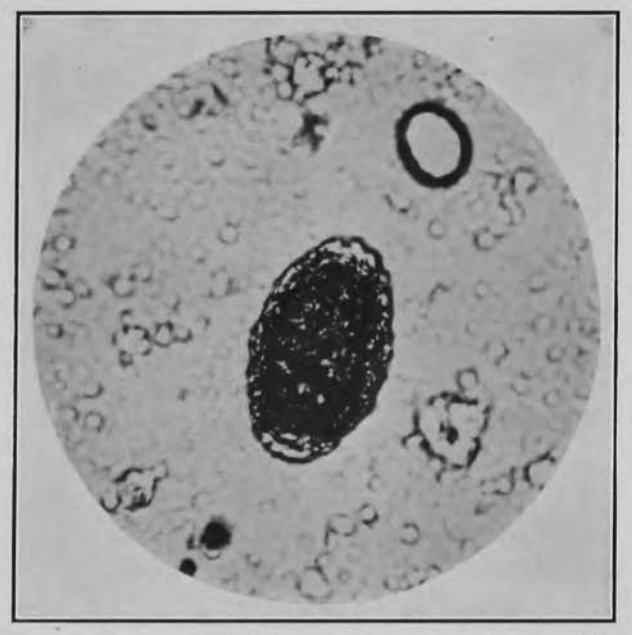


Fig. 19. Egg of the Giant Kidney Worm, *Dioctophyme renale*. Magnified 460 x.