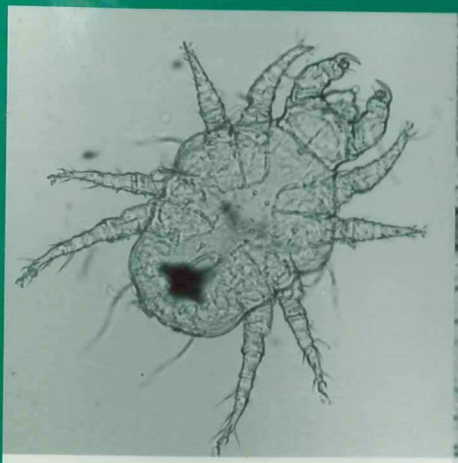
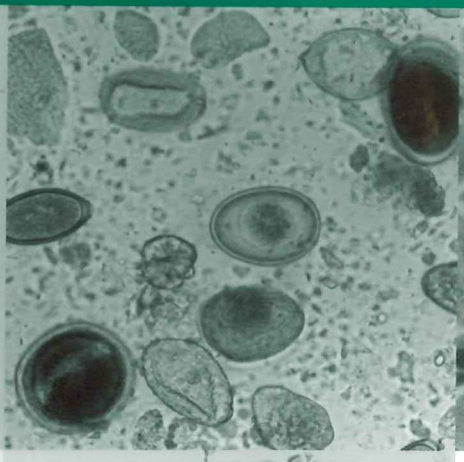
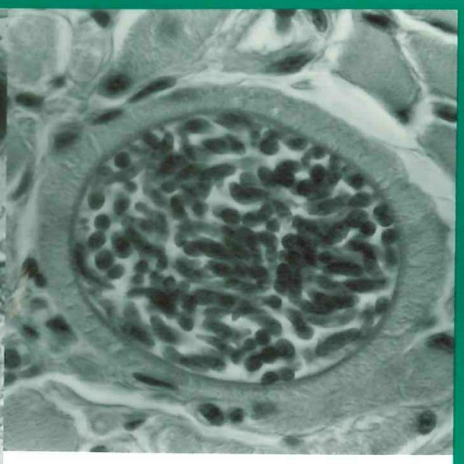
Veterinary Parasitology

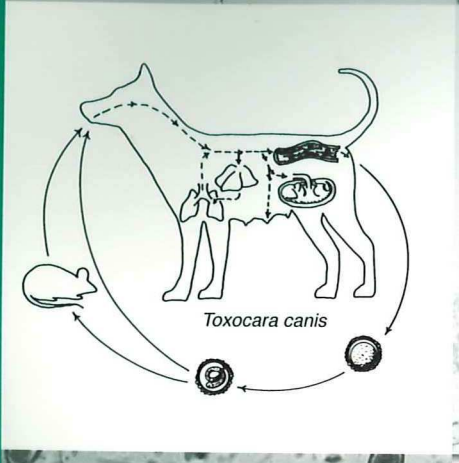
Reference Manual

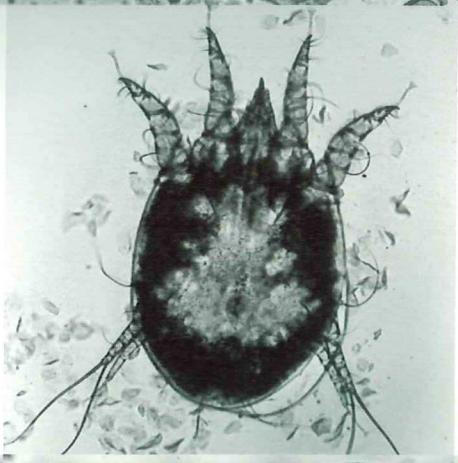
Fifth Edition

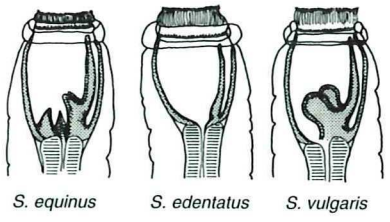


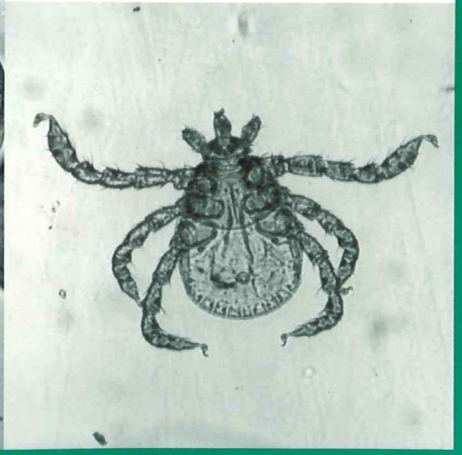












William J. Foreyt

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William J. Foreyt, Ph.D., is a professor in the College of Veterinary Medicine at Washington State University and teaches veterinary parasitology, diseases of wildlife, and diagnostic parasitology. His major research interests are parasitic and infectious diseases of wild and domestic animals with an emphasis on disease interaction between wild and domestic animals.

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The nature of drug information is constantly evolving because of ongoing research and clinical experience. While care has been taken to ensure the accuracy of the information presented, errors may have been missed. Readers are advised that decisions regarding drug use must be based on the independent judgment of the clinician, new information about the drug, and changing medical practices. Package inserts and labels for each drug product should be read carefully for dosage, route of administration, and withdrawal period. The author and publisher cannot be held responsible for any damage resulting from reliance on any information contained herein, whether with respect to drug identification, uses, procedures, dosages, or equivalencies, or by reason of any misstatement or error, negligent or otherwise, contained in this work.

CONTENTS

PREFACE

In this revised fifth edition, many references and figures have been updated and improved, newer drugs have been included, the section on parasites of marine mammals has been improved, and sections on laboratory animal parasites and human parasites have been added.

This book evolved as a response to the needs of veterinarians, veterinary students, and technicians and provides access to pragmatic reference information in veterinary parasitology. I arranged the book by host species, dogs, cats, ruminants, horses, pigs, avian, reptiles, wildlife, marine mammals, laboratory animals, and humans to allow easy access to information on parasite life cycles, importance, location in host, zoonotic potential, pertinent literature, diagnosis, and treatment. I have simplified the taxonomy of parasites for veterinary use by modifying the most easily understood taxonomic systems. Photographs of the important diagnostic stages are included to assist in the diagnosis of parasitic disease. While this book is not a complete parasitology reference encyclopedia, it meets the challenge of providing a composite reference in everyday, routine veterinary parasitology.

Many people have assisted with this publication and my thanks are extended to them. I especially thank the late Dr. Richard Wescott, Dr. Charles Leathers, Richard Dixon, Kris Foreyt, Dr. Lora Rickard, Dr. Ann Lichtenwalner, Dr. Bill Pedersen, Dr. Allan Pessier, Dan Rice, John Lagerquist, Dr. Mark Winning, Ann Foreyt, the Biomedical Communications Unit at Washington State University, Amy Wood, Dr. Murray Dailey, and Susan Barnard, who contributed to several important aspects of the book.

The Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, and the Idaho Department of Game have cooperated with me in my research projects and supplied me with thousands of wildlife samples over the years. I thank them for their enthusiastic support. Richard Dixon and Kristine Foreyt drew a majority of the illustrations, which significantly enhance the usefulness of this publication. Their artwork is greatly appreciated. Dr. Lora Rickard contributed significantly to the section on parasites of llamas. Dr. Murray Dailey contributed significantly to the section on marine mammals. Susan Barnard of the Atlanta Zoo contributed significantly to the section on reptiles. Financial support for the first edition of this publication in 1984 from The Merck Company Foundation is gratefully acknowledged.

This book is dedicated to my five exciting kids, Ann, Russell, Jane, Emily, and Kara, who are allowing me to live my second childhood through their interest in small wiggling creatures. It is equally dedicated to veterinary students to develop their biological interests and skills in the fascinating arenas of veterinary parasitology and field biology. I hope this book is useful to you.

Bill Foreyt

INTRODUCTION

Parasites are a fascinating group of invertebrates that are found in and on all groups of animals of interest in veterinary medicine. They have evolved and developed with many of their hosts and may or may not produce clinical disease, depending on a variety of environmental, ecological, immunological, physiological, and managerial factors that influence the host parasite relationship. This relationship is constantly changing, and as producers change management systems through animal breeding, animal manipulation, exotic introductions, environmental control, and use of drugs, different manifestations of disease are observed. As an example, *Fascioloides magna* is a liver fluke of white-tailed deer and elk and usually does not harm these hosts. However, when domestic sheep or goats are grazed in areas where *F. magna* is present, death of sheep and goats occurs within a relatively short time. Some hosts cannot tolerate the effects of specific parasites and die, whereas other hosts are well adapted to the parasite and no clinical signs of disease are present.

Examples of some of the ways parasites affect hosts are:

1. The worry and scare factor. Adult bot flies do not harm directly, but terrify animals.
2. Irritation. Lice cause intense irritation and self-mutilation.
3. Transmission of diseases. Biting flies and ticks transmit a variety of diseases.
4. Ingestion of blood and lymph. An abomasal nematode, *Haemonchus contortus*, causes severe anemia.
5. Secretion of toxins. Bot fly larvae secrete toxins and may cause death.
6. Mechanical blockage. Massive ascarid infections may occlude the intestine.
7. Tissue damage. Kidney worms in dogs destroy entire kidneys.
8. Production of traumatic lesions. Larvae of *Habronema* sp. produce "summer sores" in horses.
9. Psychosomatic disease. Animals are restless when external parasites are prevalent.
10. Disruption of metabolic function. Type II *Ostertagia ostertagia* increases abomasal pH.
11. Competition for nutrients. Many parasites cause reduced weight gains and feed utilization.
12. Zoonotic infections. Certain parasites transfer from animals to humans.

Since many parasites can be pathogenic, the goal of the clinician and producer is prevention of clinical parasitism through management, nutrition, epizootiology, and effective drugs. Knowledge of life cycles and epizootiology must be used in the formulation of effective parasite control programs. Indiscriminate use of drugs is a poor substitute for suboptimal management.

A final word is that new parasites and ecological relationships are being discovered, so do not be surprised when you make a discovery contrary to published reports.

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Section 1

DIAGNOSTIC PARASITOLOGY

Collection and Submission of Samples

Diagnosis of parasitic infections depends on several factors, such as collection of the sample, transport of the sample to the laboratory, and method of laboratory evaluation. Diagnostic stages of most parasites can be detected in feces, blood, sputum, or skin scrapings. However, infections of immature parasites and latent and occult infections present a diagnostic challenge. Important factors to be considered in the diagnosis of parasitism and the interpretation of results are:

1. Age of the host,
2. Previous exposure to parasites (resistance),
3. Time of the year (spring rise),
4. Physiological relationship (pariparturient rise),
5. Geographical location,
6. Previous use of anthelmintics,
7. History of clinical disease, and
8. Other considerations.

Proper collection and submission of samples to the laboratory increase the accurate diagnosis of parasitic infection.

Fecal Samples

Feces must be fresh for accurate results. As feces age, a diagnosis is complicated because many parasite eggs develop and hatch into larvae. Contaminants such as free-living soil nematodes, fly larvae, mites, and other arthropods often invade feces and complicate a diagnosis.

At least 10 g of fresh feces should be collected. If samples are more than two hours old, samples should be stored at 4°C until examined. Many parasite stages can be stored at 4°C for at least two months with minimal development. For routine shipment to the laboratory, samples can be cooled to 4°C and then packed with ice or other coolant (blue ice) for shipment via any of the 24- to 48-hour transport services. Fecal samples are best stored and sent in whirl-pak bags, small plastic sandwich bags, plastic containers, disposable laboratory gloves turned inside out, or rectal palpation gloves turned inside out. All samples should be clearly labeled with a black indelible marker with the number of the animal, date, and the person responsible for the sample.

If coolants are not available, samples can be stored indefinitely in 10% formalin (one part feces, nine parts 10% formalin), but limitations must be noted (Fig. 1). Approximately 50% of the ruminant strongyle eggs were detected in feces stored in 10% formalin for 200 days. Storage by freezing is very inefficient, and storage in 70% ethyl alcohol or 100% methyl alcohol is unacceptable (Fig. 2).

When *Giardia* sp. is suspected, feces can be placed in polyvinyl alcohol fixative at a ratio of one part feces to two parts polyvinyl alcohol or in 5% formalin for fixation and transport. Also, fecal smears on slides can be stained with Gormori's trichrome, iron-hematoxylin, clorzol black, or Giemsa stains and submitted to the laboratory in standard slide mailers.

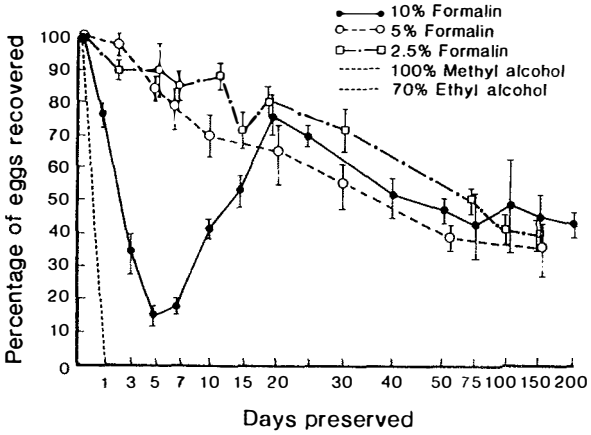


Fig. 1. Effect of formalin and alcohol preservation on mean recovery of strongyle eggs over time. Vertical lines indicate 1 SD. From Foreyt W.J.: Recovery of nematode eggs and larvae in deer: Evaluation of fecal preservation methods. *J Am Vet Med Assn* 189:1065-1067, 1986. Reprinted with permission.

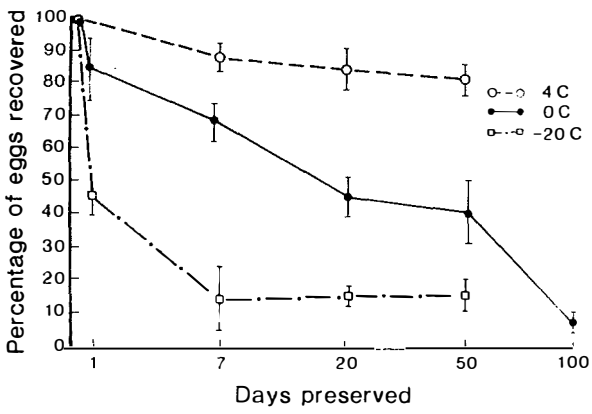


Fig. 2. Effect of temperature on the mean recovery of strongyle eggs from deer feces over time. From Foreyt W.J.: Recovery of nematode eggs and larvae in deer: Evaluation of fecal preservation methods. *J Am Vet Med Assn* 189:1065-1067, 1986. Reprinted with permission.

Fecal Flotation

For normal stools, the usual diagnostic test is the fecal flotation test. This test concentrates eggs and oocysts present in the feces into a drop of solution for easy identification and enumeration of parasitic stages. Important comparative factors in the fecal flotation technique are the specific gravity of the flotation solution, the viscosity or type of solution used, and the rate of plasmolysis caused by the solution. A specific gravity that is too low will not float many stages, whereas a solution with a specific gravity that is too high will cause plasmolysis, osmosis, or rupture of the stages, making diagnosis difficult (Fig. 3). Also, as the specific gravity is increased, excessive debris also floats, which decreases the efficiency of the test. Most parasitic stages float efficiently at a specific gravity of 1.2 to 1.3. My laboratory uses sugar solution (specific gravity = 1.27). Sugar has a distinct advantage over salt solution in that less plasmolysis and distortion occur in the eggs and oocysts. Fecal-flotation slide preparations from sugar solution can be kept at 4°C for at least 24 hours, and often for several weeks to months, with a minimum of distortion of eggs. These slides can be used as next-day reference and teaching slides. Disadvantages of sugar solutions are that sugar can be messy and sticky, and sugar attracts flies and other arthropods. When salt solutions are used, egg distortion usually occurs in a few hours, and the slides have a tendency to crystallize and dry out very quickly. To increase the shelf life of a fecal-flotation slide, one can put fingernail polish or quick-drying glue around the coverslip. Freezing the prepared slide is often effective for preserving the material for many months or years. One additional advantage of sugar solution is that some parasite eggs, such as the salmon poisoning fluke, *Nanophyetus salmincola*, float better in sugar than salt solutions. In salt solutions, the eggs often do not float and are often missed during examination.

Blood

Blood is used for the diagnosis of specific parasitic stages found in the circulatory system. These parasites generally include blood protozoa such as *Babesia* spp., *Leucocytozoon* spp., and immature stages of filarial parasites, such as microfilariae of *Dirofilaria immitis*. Whole blood can be collected in tubes containing anticoagulant, such as ethylenediaminetetraacetate (EDTA), and sent to the laboratory at 4°C or in a chilled container.

For most blood parasites, blood smears on standard microscope slides can be made from fresh blood or blood with anticoagulant. After air drying, smears are routinely stained with Giemsa stain or Wright's stain. Stained or unstained slides can be sent to the laboratory.

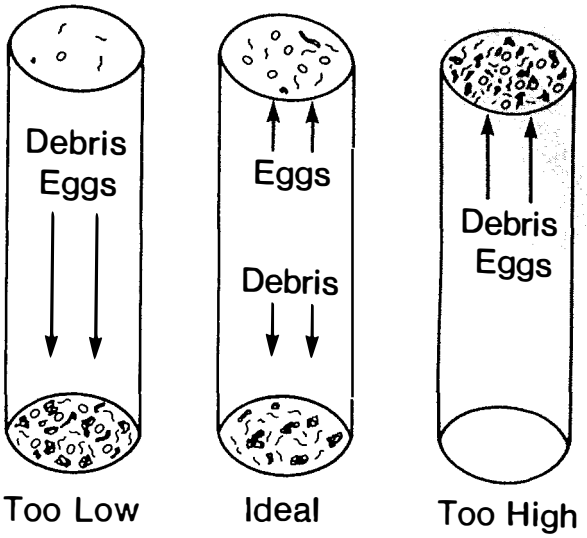


Fig. 3. Effect of specific gravity on egg flotation.

Skin Scrapings

When mites are suspected, skin scrapings can be collected and forwarded to the laboratory by placing them in glycerin in a tightly sealed vial for shipment. Vials should be packed carefully to prevent breakage or leakage.

Internal Parasites

Most internal parasites can be preserved in 10% formalin or glycerin for shipment. Specimens should be placed in leak-proof vials and packed carefully in sturdy containers to prevent breakage.

External Parasites

Arthropod parasites can be most effectively stored in 70% ethyl alcohol or glycerin for shipment or long-term preservation. Formalin (10%) will also preserve arthropods. Leak-proof vials and a sturdy shipping container are needed for safe transport.

Labeling

All specimens must be clearly labeled with animal species, location in host, date of collection, place collected, and collector's name, address, and telephone number.

Diagnostic Techniques

Table 1. Modified double centrifugation technique

1. Mix 1 g of feces in 10–12 ml water in a beaker and stir until feces are in suspension.
2. Pour the mixture through a tea strainer into another beaker. Press the material in the strainer with a spatula and discard the material in the strainer.
3. Pour the contents into a 15-ml centrifuge tube and fill to the top with water.
4. Centrifuge the tubes at 1,500 rpm for 5–10 minutes.
5. Decant the tube and then fill one half full of flotation solution. Stir the sediment with a wooden applicator stick and then fill the tube almost to the top with flotation solution.
6. Place the tube in the centrifuge and with a dropper add flotation solution to the tube so the solution is about level with the top of the tube. Place a 22-mm^2 coverslip on top of the tube and in contact with the sugar solution.
7. Centrifuge at 1,500 rpm for 5–10 minutes. The coverslip will not fall off if the centrifuge has free-swinging trunions that swing out to the horizontal position.
8. Remove coverslip by lifting straight upward, and place on a glass slide. All parasite stages that floated should be in the drop under the coverslip.
9. Examine the slide under ×100 (×10 ocular and ×10 objective) or higher magnification and observe all parasite stages present.

Note: The centrifuge must have free-swinging buckets. If the centrifuge has a fixed bucket position, the coverslips will fall off. Fecal flotations can also be done without centrifugation by allowing samples in step 4 to set for 20 minutes and in step 7 to set for 30 minutes. This method is not as effective as centrifugation, but results are usually reliable.

Table 2. Common flotation solutions for the fecal flotation technique

Sugar:	Granulated sugar (sucrose)	454 g	or	10 pounds
	Tap water	355 ml		3550 ml
	(specific gravity = 1.27)			

Dissolve sugar in hot tap water directly, or add sugar to hot water over a low heat and stir. Approximately 2 ml of 37% formaldehyde or phenol crystals can be added to deter growth of mold.

Sodium chloride:	Saturated NaCl or NaCl	400 g
	Tap water	1,000 ml
	(specific gravity = 1.18–1.2)	
Magnesium sulfate:	$MgSO_4$	400 g
	Tap water	1,000 ml
	(specific gravity = 1.2)	
Zinc sulfate:	Zinc sulfate	371 g
	Tap water	1,000 ml
	(specific gravity = 1.18)	
Sodium nitrate:	Sodium nitrate	400 g
	Tap water	1,000 ml
	(specific gravity = 1.18)	

Table 3. Ether–formalin sedimentation technique

1. Mix 1 g of feces in 15 ml of water, strain the mixture, and pour into a 15-ml centrifuge tube.
2. Centrifuge at 1,000 rpm for 1–2 minutes.
3. Decant supernatant, add fresh water, and centrifuge again for 1–2 minutes.
4. Decant, add 10 ml of 10% formalin, and let stand for 10 minutes.
5. Add 3 ml of ether, apply a stopper, and shake the contents vigorously. Centrifuge the mixture for 2 minutes.
6. Remove the debris on top of the tube with a cotton-tipped swab. Decant the rest of the fluid.
7. Collect the sediment with a pipette, place it on a microscope slide, and examine it microscopically for parasite eggs.

Note: This technique is good for detection of trematode eggs.

Table 4. Fecal sedimentation technique for *Fasciola hepatica* and some other fluke eggs

1. Mix 5 g feces in 200 ml water in a beaker.
2. Pour the mixture through a tea strainer and discard the material in the strainer.
3. After 10 minutes, decant approximately 70% of the supernatant and refill the beaker with fresh water.
4. Repeat step 3 for three to five times until the supernatant is clear.
5. Pour off 90% of the supernatant and pour the sediment into a Petri dish.
6. Examine the sediment under a dissecting microscope (×20–×30) or scanning objective (×4) of the microscope (total magnifications = ×40) for large, yellow, operculated eggs of *Fasciola hepatica*.

Note: A commercial device consisting of two sieves is sold under the trade name Flukefinder and is available from Visual Differences, 106 North Bear Bluff Road, Preston, ID 83263 *(www.flukes@mac.com)*.

Table 5. Baermann technique for lungworm larvae isolation

1. Place warm water (approximately 25°C) into a glass funnel that has a stopcock or clamp on a rubber hose on the end of the funnel.
2. Take 5 g (or more) feces, wrap the feces in two layers of gauze and place the feces in the water in the funnel.
3. After 8 hours, withdraw the bottom 10–15 ml of fluid from the funnels into a 15-ml centrifuge tube.
4. Centrifuge the tube for 5 minutes at 1,500 rpm.
5. With a pipette, withdraw the bottom 2–3 drops from the centrifuge tube and transfer to microscope slide. Add a coverslip and look for larvae under the microscope.

Table 6. Modified McMaster technique for parasite eggs

This is a dilution method of estimating eggs present in fecal samples.

1. Mix 3 g feces in 15 ml of water and pour through a tea strainer.
2. Pour strained material into a 15-ml centrifuge tube and centrifuge at 1,500 rpm for 2 minutes.
3. Mix the sediment in 10 ml of flotation solution and pour into a beaker; add additional 32 ml of flotation solution.
4. With a pipette, transfer suspension to a McMaster counting chamber and fill both chambers.
5. Transfer the slide to a microscope and count all eggs inside the ruled squares.
6. Multiply the number of eggs in both chambers by 50 for the total number of eggs per gram of feces.

Note: This technique is not very accurate for samples with small numbers of eggs. McMaster Slides are available from Advanced Equine Products, 5004 228th Ave. SE, Issaquah, WA 98029, 425-391-1169, *(www.advancedequine.com/veterinary)*.

Table 7. Direct smear

This technique is used primarily for diagnosis of *Giardia.* It is a very inefficient technique for diagnosis of other parasite infections.

1. Mix a fecal sample the size of the head of a match (1–2 mm^3) with a drop of water or saline on a microscope slide.
2. Mix the drop with a circular motion until the specimen is approximately 1 × 1 cm.
3. Add a coverslip and examine under the microscope.
4. If large particles are present under the coverslip, remove the particles or start with a new sample.

Table 8. Skin scraping for external parasites

This technique is used primarily for the diagnosis of mites.

1. Add several drops of mineral oil or glycerin to the area to be scraped. The area should be at the periphery of the cutaneous lesion, not in the center of the lesion.
2. With a scalpel blade, scrape the area to a depth that blood begins to ooze from the wound.
3. Transfer the bloody material that was scraped to a microscope slide.
4. Add additional mineral oil and cover with a coverslip.
5. Examine under low power (×40) of the microscope first, and if nothing is seen, increase the magnification.

Note: Large amounts of hair or skin can be digested in 10% KOH for 12–24 hours, and the sediment can be examined for mites either directly after centrifuging, or the sediment can be mixed with the sugar flotation solution.

Table 9. Evaluation of blood for microfilariae

Knott's test:

1. Mix 1 ml of blood with 9 ml of 2% formalin in a 15-ml tube. Mix by inverting the tube several times after covering the top of the tube with your thumb.
2. Wait 2–3 minutes and centrifuge the tube for 5 minutes at 1,500 rpm.
3. Use a pipette to draw off 1 or 2 drops of sediment from the base of the tube and transfer to a microscope slide.
4. Add a coverslip and examine at ×400.

   A drop of 0.1% methylene blue added to the drop on the microscope slide can be helpful in making the diagnosis.

Hematocrit method:

1. Fill a microhematocrit tube with blood and centrifuge for 1 minute.
2. Wait a few minutes and then examine the buffy coat with a dissecting microscope. Look for live microfilariae.
3. Break the tube at the buffy coat and dab the buffy coat on a microslide. Add coverslip and examine for microfilariae on low power on the microscope.

Direct blood smear:

1. Place 1 drop of fresh blood or heparinized blood on a microslide and cover with a coverslip.
2. Examine under low power for live microfilariae.
3. To slow the microfilariae, place a drop of 10% formalin at the edge of the coverslip.

Microscopy

Table 10. Calibration of the microscope

The accurate measurement of microscopic diagnostic stages of parasites requires the calibration of the microscope. Two scales are necessary: the ocular micrometer in the ocular of the microscope, which is a glass disc bearing an arbitrary scale of 50 or 100 divisions, and the stage micrometer, which is a commercial slide etched with an absolute scale 1 or 2 mm long, subdivided into units of 0.1 mm and 0.01 mm.

Most microscopic objects are measured in microns (µm) or (Fm). Therefore, these units of measurement are important:

1 mm = 1,000 µm
0.1 mm = 100 µm
0.01 mm = 10 µm

Most parasite diagnostic stages are between 10 µm and 100 µm long.

The number of magnifications is determined by multiplying the ocular power (usually ×10) by the objective power. Therefore, a ×10 ocular with ×4 objective is ×40.

On the lowest power of the microscope (usually a ×4 objective), superimpose the ocular micrometer over the stage micrometer. Line up the left-hand ends of the scales. Find a place on the scales where one line on each scale coincides directly over the others and count the number of ocular units with a known metric unit on the stage micrometer.

Example: 58 units of the ocular micrometer coincides with 0.36 mm on the stage micrometer.

One space of the ocular micrometer, therefore, equals 0.36 mm divided by 58 units = 0.0062 mm per ocular unit or 6.2 µm per ocular unit. When a parasite egg is measured and is 12 ocular units long, multiply the conversion factor (6.2) by 12 ocular units to obtain the length of the egg (74.4 µm).

Using the same technique, calibrate all objectives on the microscope and record the conversion factors on the microscope. Most microscopes with ×10 eyepieces will have conversion factors similar to these:

×4 objective = 25.0 µm per unit space
×10 objective = 9.0 µm per unit space
×40 objective = 2.5 µm per unit space
×100 objective = 1.0 µm per unit space

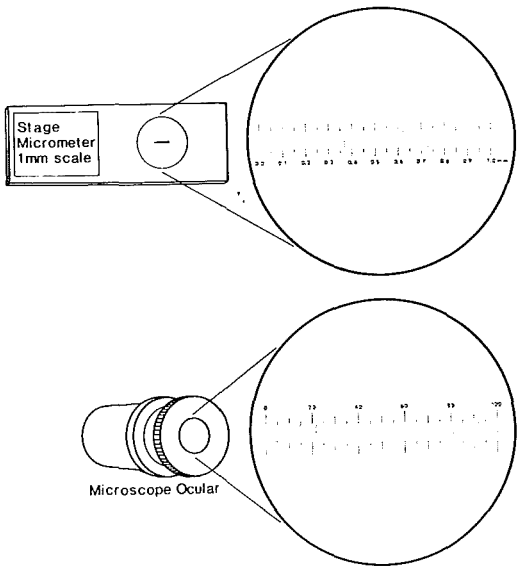


Fig. 4. Example of a stage micrometer and an ocular micrometer in the eyepiece.

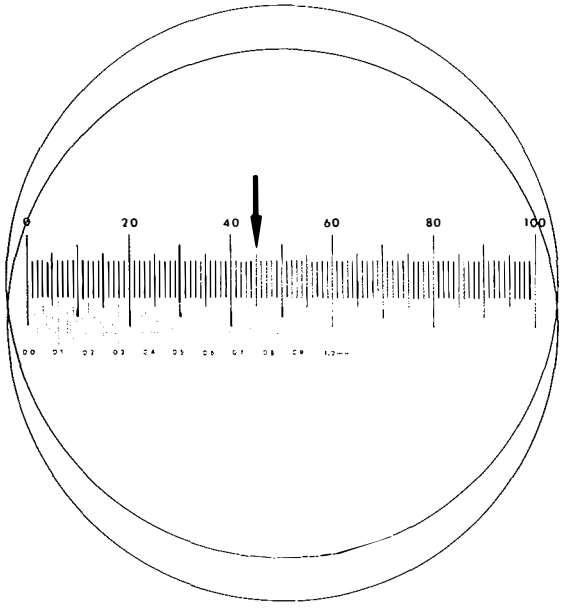


Fig. 5. Example of calibration of the ocular micrometer with the ×4 objective and 10 ocular. Note: 45 spaces = 0.76 mm = 760 µm; 1 space = 16.9 µm.

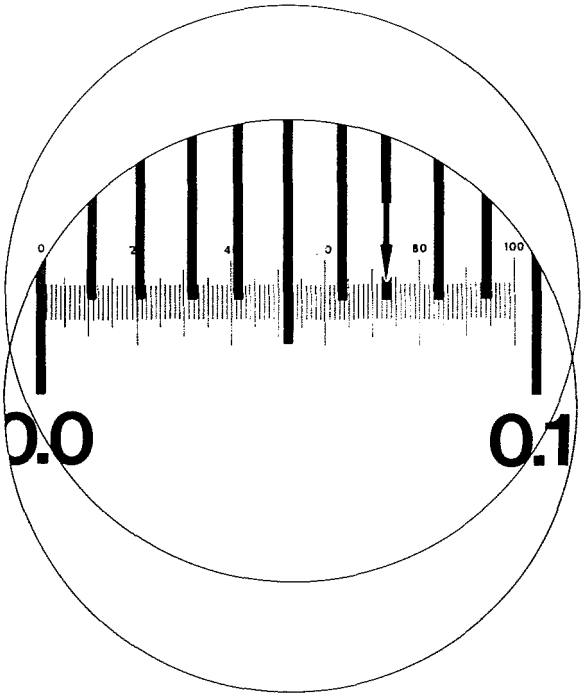


Fig. 6. Example of calibration of the ocular micrometer with the 100 (oil emersion) objective and ×10 ocular. Note: 73 spaces = 0.07 mm = 70 µm; 1 space = 1.04 µm.

Bibliography

Adam KMG, Zaman PJV: *Medical and Veterinary Protozoology*. London, Churchill Livingstone, 1971.

Arundel JH: Field procedures for counting gastrointestinal worms in sheep and cattle. *Aust Vet J* 43:592–597, 1967.

Beane RD, Hobbs NT: The Baermann technique for estimating *Protostrongylus* infection in bighorn sheep: Effect of laboratory procedures. *J Wild Dis* 19:7–9, 1983.

Bowman DD: *Georgis' Parasitology for Veterinarians*. 7th edititon. Philadelphia, W.B. Saunders Co., 1999.

Brunner CJ, Hendrix CM, Blagburn BL, et al.: Comparison of serologic tests for detection of antigen in canine heartworm infections. *J Am Vet Med Assoc* 192:1423–1427, 1988.

Calpin JP, Prestwood AK: Diagnosis of protozoan infections. In Greene CE (ed): *Clinical Microbiology and Infectious Diseases of the Dog and Cat*. Philadelphia, W.B. Saunders Co., 1984, pp. 137–143.

Christie N, Jackson F: Specific identification of strongyle eggs in small samples of sheep feces. *Res Vet Sci*, 32:113–117, 1982.

David ED, Lindquist WD: Determination of specific gravity of certain helminth eggs using sucrose gradient centrifugation. *J Parasitol* 65:916–919, 1982.

Foreyt WJ: Diagnostic Parasitology. In Parry BW (ed): *The Veterinary Clinics of North America: Clinical Pathology*, Part II. Philadelphia, W.B. Saunders Co, 1989, pp. 979–1000.

Foreyt WJ: Recovery of nematode eggs and larvae in deer: Evaluation of fecal preservation methods. *J Am Vet Med Assoc* 9:1065–1067, 1986.

Garcia LS, Ash LR: *Diagnostic Parasitology Clinical Laboratory Manual*. 2nd edition. St. Louis, CV Mosby, 1979.

Gibbs HC, Herd RP, Murrell KD (eds): *The Veterinary Clinics of North America: Food Animal Practice – Parasites: Epidemiology and Control*. Philadelphia, W.B. Saunders Co., 1986.

Gordon H, McL, Whitlock HV: A new technique for counting nematode eggs in sheep feces. *Council Sci Ind Res (Australia)*, 12:50–52, 1939.

Grieve RB (ed): *The Veterinary Clinics of North America: Small Animal Practice – Parasitic Infections*. Philadelphia, W.B. Saunders Co., 1987.

Hangay G, Dingley M: Biological Museum Methods. Vol. 2. *Plants, Invertebrates and Techniques*. Academic Press, New York, 1985.

Herd RP (ed): *The Veterinary Clinics of North America: Equine Practice – Parasitology*. Philadelphia, W.B. Saunders Co., 1986.

Hubert J, Kerboeuf D: A new method for culture of larvae used in diagnosis of ruminant gastrointestinal strongylosis: Comparison with fecal cultures. *Can J Comp Med*, 48:63–71, 1984.

Jorgensen RJ: Isolation of infective *Dictyocaulus* larvae from herbage. *Vet Parasitol*, 1:61–67, 1984.

Lappin MR, Calpin JP, Prestwood AK: Laboratory diagnosis of protozoal infections. In Green C.E. (ed): *Infections Diseases of the Dog and Cat*. Philadelphia, W.B. Saunders Co., 1990, pp. 751–762.

McKenna PB: The diagnostic value and interpretation of fecal egg counts in sheep. *N Z Vet J* 29:129–132, 1981.

Melvin DM, Brooke MM: *Laboratory Procedures for the Diagnosis of Intestinal Parasites*. U.S. Dept. of Health and Human Services, Public Health Service, Atlanta, Georgia, 1980.

Ministry of Agriculture, Fisheries and Food. *Manual of Veterinary Parasitological Laboratory Techniques*. Technical Bulletin No. 18, London, Ebenezer Baylis and Son, The Trinity Press, 1976.

Parry BV (ed): *The Veterinary Clinics of North America: Small Animal Practice—Clinical Pathology. Part 2*. Philadelphia, W.B. Saunders Co., 1989.

Pritchard MH, Kruse GOW: *The Collection and Preservation of Animal Parasites*. Lincoln, Nebraska, University of Nebraska Press, 1982.

Reinecke RK: Identification of helminthes in ruminants at necropsy. *J S Afr Vet Assoc* 55:135–143, 1984.

Roberts JL, Swan RA: Quantitative studies of ovine haemonchosis I. Relationship between fecal egg counts and total worm counts. *Vet Parasitol* 8:165–171, 1981.

Schillhorn van Veen TW: Methods for Diagnosis of Parasitism in Small Ruminants. In Gibbs HC, Herd RP, Murrell KD (eds): *The Veterinary Clinics of North America: Food Animal Practice – Parasites: Epidemiology and Control.* Philadelphia, W.B. Saunders Co., 1986, pp. 335–344.

Sloss MW, Kemp RL, Zajak AM: *Veterinary Clinical Parasitology.* 6th edititon. Ames, Iowa, Iowa State University Press, 1994.

Traunt AL, Elliott SH, Kelly MT, et al.: Comparison of formalin-ethyl ether sedimentation, formalin-ethyl acetate sedimentation, and zinc sulfate flotation techniques for detection of intestinal parasites. *J Clin Microbiol* 13:882–884, 1981.

Whiteley HE: Your diagnostic protocol for *Dirofilaria immitis* infection in dogs. *Vet Med*, 8:328–345, 1988.

Williams JF, Zajac A: *Diagnosis of gastrointestinal parasitism in dogs and cats.* Ralston Purina, St. Louis, Missouri, 1980.

Section 2

GENERAL PARASITOLOGY

Classification Simplified

Table 11. Parasite classification simplified

Example: *Ascaris suum*, the swine roundworm

Kingdom – Animalia
Phylum – Nemathelmintes
Class – Nematoda
Subclass – Secernentea (Phasmida)
Order – Ascaridata
Superfamily – Ascaridoidea
Family – Ascarididae
Subfamily – Ascaridinae
Genus – *Ascaris*
Species – *suum*

Classification of Parasites of Veterinary Interest

Phylum: Sarcomastigophora (Protozoa), the single-celled animals			
Subphylum:	Sarcodina (Amoebas)	Example:	*Entomoeba* sp. in swine
Subphylum:	Mastigophora (Flagellata)	Example:	*Giardia canis* in dogs, *Trichomonas* sp. in birds
Subphylum:	Apicomplexa (Sporozoa)	Example:	*Toxoplasma gondii* in cats, *Eimeria* spp. in ruminants
Subphylum:	Ciliophora (Ciliata)	Example:	*Balantidium coli* in swine

Phylum: Nemathelminthes, the roundworms			
Class: Nematoda			
Superfamily: Ascaridoidea, the ascarids, very large worms in the intestine, direct life cycles			
Family:	Ascaridae	Example:	*Ascaris suum* in swine
	Heterakidae	Example:	*Heterakis gallinarum* in poultry
Superfamily: Oxyuroidea, the pinworms, females have long pointed tails, direct life cycles			
Family:	Oxyuridae	Example:	*Oxyuris equi* in horses
Superfamily: Spiruroidea, the spiruroids, spiral tails in males, use intermediate hosts			
Family:	Spiruridae	Example:	*Habronema microstoma* in horses
	Thelaziidae	Example:	*Thelazia lacrimalis* in horses
	Acuariidae	Example:	*Physaloptera rara* in dogs
Superfamily: Metastrongyloidea, the lungworms, small buccal capsule, usually have intermediate hosts			
Family:	Metastrongylidae	Example:	*Metastrongylus apri* in swine
	Protostrongylidae	Example:	*Muellerius capillaris* in goats
	Crenosomatidae	Example:	*Crenosoma vulpis* in dogs
	Filaroididae	Example:	*Aelurostrongylus abstrusus* in cats

Table 11. Parasite classification simplified (*continued*)

Superfamily: Trichostrongyloidea, small hairlike worms, "strongyles", large bursa in males

Family:	Trichostrongylidae	Example:	*Haemonchus contortus* in sheep
	Heligmonsomatidae	Example:	*Nematospiroides dubius* in mice
	Amidostomatidae	Example:	*Amidostomum anseris* in ducks
	Ollulanidae	Example:	*Ollulanus tricuspis* in cats
	Dictyocaulidae	Example:	*Dictyocaulus viviparus* in cattle

Superfamily: Rhabditoidea, free living cycles, very small worms, small buccal capsule

Family:	Strongyloididae	Example:	*Strongyloides westeri* in horses

Superfamily: Strongyloidea, large buccal capsule, cuticular appendages,

Family:	Strongylidae	Example:	*Strongylus vulgaris* in horses
	Trichonematidae	Example:	*Oesophagostomum radiatum* in cattle
	Ancylostomatidae	Example:	*Ancylostoma caninum* in dogs
	Stephanuridae	Example:	*Stephanurus dentatus* in swine
	Syngamidae	Example:	*Syngamus trachea* in birds

Superfamily: Filarioidea, the filarioids, long slender worms, have microfilariae in the blood

Family:	Filariidae	Example:	*Parafilaria bovicola* in cattle
	Setariidae	Example:	*Setaria equina* in horses
	Onchocercidae	Example:	*Dirofilaria immitis* in dogs

Phylum: Nemathelminthes, the roundworms
Class: Nematoda (continued)

Superfamily: Dracunculoidea, rare in domestic animals

Family:	Dracunculidae	Example:	*Dracunculus medinensis* in dogs

Superfamily: Trichuroidea, long narrow esophagus with stichisome cells

Family:	Trichuridae	Example:	*Trichuris suis* in swine
	Trichinellidae	Example:	*Trichinella spiralis* in swine

Superfamily: Dioctophymoidea, the large kidney worm. These are rare in domestic animals.

Family:	Dioctophymatidae	Example:	*Dioctophyme renale* in dogs

Phylum: Acanthocephala – thorny-headed worm (*Macracanthorhynchus* sp. in swine)

Phylum: Platyhelminthes – flatworms
Class: Trematoda, flukes
Subclass: Monogenea, mostly on fish or amphibians and reptiles.
Subclass: Digenea, alternation of sexual and asexual generations, one or more intermediate hosts

Family:	Fasciolidae	Example:	*Fasciola hepatica* in cattle
	Paramphistomatidae	Example:	*Paramphistomum cervi* in cattle
	Dicrocoeliidae	Example:	*Platynosoma fastosum* in cats
	Opisthorchiidae	Example:	*Metorchis conjuctus* in dogs
	Heterophyidae	Example:	*Cryptocotyle lingua* in dogs
	Troglotrematidae	Example:	*Paragonimus kellicotti* in cats
	Echinostomatidae	Example:	*Echinostoma revolutum* in birds
	Strigeidae	Example:	*Alaria canis* in dogs
	Plagiorchidae	Example:	*Prosthogonimus macrorchis* in birds
	Schistosomatidae	Example:	*Schistosoma nasali* in horses

Table 11. Parasite classification simplified (*continued*)

Class: Cestoidea, tapeworms			
Order: Pseudophyllidae, scolex unarmed, bothria present			
		Example:	*Diphyllobothrium latum* in dogs
		Example:	*Spirometra* sp. in cats
Order: Cyclophyllidea, scolex with four suckers			
Family:	Davaineidae, scolex-armed, small intestine of birds	Example:	*Davainea* sp. and *Raillietina* sp. in birds
	Anoplocephalidae, scolex unarmed without rostellum	Example:	*Moniezia benedeni* in cattle
	Mesocestoididae, scolex without rostellum, median genital pores	Example:	*Mesocestoides* sp. in cats
	Dilepididae, rostellum armed, two lateral genital pores	Example:	*Dipylidium caninum* in dogs
	Hymenolepididae, small intestine of birds, mammals, and humans	Example:	*Hymenolepis* sp. in rats
	Taeniidae, scolex armed, genital pore lateral	Example:	*Echinococcus granulosus* in dogs
Phylum: Arthropoda			
Class: Insecta, the insects			
Order: Diptera – flies		Example:	*Musca* spp., *Siphona* sp., on cattle
Siphonaptera – fleas		Example:	*Ctenocephalides* sp. on dogs
Mallophaga – biting lice		Example:	*Bovicola* spp. on cattle, *Trichodectes* sp. on dogs
Anoplura – sucking lice		Example:	*Haematopinus* sp., *Linognathus* sp. on horses
Class: Arachnida			
Order: Araneida – spiders			
Order: Acarina – mites and ticks			
Family	Ixodidae – hard ticks	Example:	*Dermacentor* sp., etc.
	Argasidae – soft ticks	Example:	*Otobius* sp., etc.
	Dermanyssidae – mites	Example:	*Dermanyssus* sp., etc.
	Sarcoptidae – mites	Example:	*Sarcoptes* sp., etc.
	Demodicidae – mites	Example:	*Demodex* sp., etc.
	Cheyletidae – mites	Example:	*Cheyletiella* sp., etc.
	Psoroptidae – mites	Example:	*Psoroptes* sp., etc.

Bibliography

Anderson RC: *Nematode Parasites of Vertebrates.* Cambridge, United Kingdom, University Press, 1992.

Anderson RC, Chabaud AG, Willmot S (eds): *CIH Keys to the Nematode Parasites of Vertebrates.* Farnham Royal Bucks, England. Commonwealth Agricultural Bureau.

No 1. Anderson RC, Chabaud AG, Willmot S: General Introduction, Glossary of Terms, Keys to Subclasses, Orders and Superfamilies, 1974.

No 2. Hartwich G: Keys to Genera of the Ascaridoidea, 1974.

No 3. Chabaud AG, Anderson RC, Bain O: Keys to the Order Spirurida (3 parts), 1975-1976.

No 4. Petter AJ, Quentin JC: Keys to Genera of the Oxyuroidea, 1976.

No 5. Anderson RC: Keys to Genera of the Superfamily Metastrongyloidea, 1976.

No 6. Chabaud AG: Keys to Genera of the Superfamilies Seuratoidea, Cosmocercidea, Heterakoidea and Subuluroidea, 1976.

No 7. Lichtenfels JR: Keys to Genera of the Superfamily Strongyloidea, 1980.

No 8. Lichtenfels JR: Keys to Genera of the Superfamilies Ancylostomatoidea and Diaphanocephaloidea, 1980.

No 9. Anderson RC, Bain O: Keys to the Dioctophymatoidea, Rhabditoidea, Trichuroidea and Muspiceoidea, 1982.

No 10. Durette-Desset MC: Keys to Genera of the Superfamily Trichostrongyloidea, 1983.

Bowman DD: *Georgis' Parasitology for Veterinarians.* 7th edition. Philadelphia, W.B. Saunders Co., 1999.

Brown HW, Neva FA: *Basic Clinical Parasitology.* 5th edition. Norwalk, Connecticut, Appleton-Century-Crofts, 1983.

Cheng TC: *The Biology of Animal Parasites.* Philadelphia, W.B. Saunders Co., 1964.

Davis JW, Anderson RC (eds): *Parasitic Diseases of Wild Animals.* Ames, Iowa, Iowa State University Press, 1971.

Davis JW, Anderson RC, Karstad L, Trainer DO (eds): *Infectious and Parasite Diseases of Wild Birds.* Ames, Iowa, Iowa State University Press, 1971.

Dunn AM: *Veterinary Helminthology.* London, William Heinemann Medical Books Ltd., 1978.

Flynn RS: *Parasites of Laboratory Animals.* Ames, Iowa, Iowa State University Press, 1973.

Forrester, DJ: *Parasites and Diseases of Wild Mammals in Florida.* Gainesville, Florida, University Press of Florida, 1992.

Fowler ME (ed): *Zoo & Wild Animal Medicine.* 2nd edition. Philadelphia, W.B. Saunders Co., 1986.

Fowler ME (ed): *Zoo and Wild Animal Medicine. Current Therapy 3.* Philadelphia, W.B. Saunders Co., 1993.

Gaafer SM, Howard WE, Marsh RE (eds): *Parasites, Pests, and Predators.* New York, Elsevier, 1985.

Gibbs HC, Herd RP, Murrell KD (eds): *The Veterinary Clinics of North America: Food Animal Practice—Parasites: Epidemiology and Control.* Philadelphia, Philadelphia, W.B. Saunders Co., 1986.

Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, W.B. Saunders Co., 1990.

Grieve, RB (ed): *The Veterinary Clinics of North America: Small Animal Practice – Parasitic Infections.* Philadelphia, W.B. Saunders Co., 1987.

Gutierrez Y: *Diagnostic Pathology of Parasitic Infection with Clinical Correlation.* Philadelphia, Lea and Febiger, 1990.

Hendrix CM: *Diagnostic Veterinary Parasitology,* Mosby, 1998.

Herd RP (ed): *The Veterinary Clinics of North America: Equine Practice—Parasitology.* Philadelphia, W.B. Saunders Co., 1986.

Kranz GW: *A Manual of Acarology.* 2nd edition. Corvallis, Oregon, Oregon State University Book Stores, 1978.

Lapage E (ed): *Monnig's Veterinary Helminthology and Entomology.* 5th edition. Baltimore, Maryland, William & Wilkins, 1962.

Lapage, G: *Veterinary Parasitology.* 2nd edition. Springfield, Illinois, Charles C. Thomas, 1968.

Lee JJ, Hutner SH, Bovee EC (eds): *An Illustrated Guide to the Protozoa.* Lawrence, Kansas, Allen Press, 1985.

Levine ND: *Nematode Parasites of Domestic Animals and of Man.* 2nd edition. Minneapolis, Minnesota, Burgess Publishing Co., 1980.

Levine ND: *Protozoan Parasites of Domestic Animals and Man.* Minneapolis, Minnesota, Burgess Publishing Co., 1980.

Levine ND: *Textbook of Veterinary Parasitology.* Minneapolis, Minnesota, Burgess Publishing Company, 1978.

Monnig HO: *Veterinary Helminthology and Entomology.* 5th edition. London, Bailliere, Tindall and Cox, 1986.

Olsen OW: *Animal Parasites: Their Biology and Life Cycles.* 2nd edition. Minneapolis, Minnesota, Burgess Publishing Co., 1967.

Plumb DC: *Veterinary Drug Handbook.* 3rd edition. Ames, Iowa, Iowa State University Press, 1998.

Samuel WM, Pybus MJ, Kocan AA: *Parasitic Diseases of Wild Mammals.* 2nd edition. Ames, Iowa, Iowa State University Press, 2001.

Schell SC: *Handbook of Trematodes of North America North of Mexico*. Moscow, Idaho, University Press of Idaho, 1985.

Schmidt GA: *Handbook of Tapeworm Identification*. Boca Raton, Florida, CRC Press, 1986.

Sloss MW, Kemp RL, Zajak AM: *Veterinary Clinical Parasitology*. 6th edition. Ames, Iowa, Iowa State University Press, 1994.

Soulsby EJL: *Helminths, Arthropods and Protozoa of Domesticated Animals (Monnig)*. Philadelphia, Lea & Febiger, 1968.

Soulsby EJL: *Textbook of Veterinary Clinical Parasitology*. Philadelphia, F.A. Davis Company, 1965.

Thienpont D, Rochette F, Vanparijs OFJ: *Diagnosing Helminthiasis Through Coprological Examination*. Beerse, Belgium, Janseen Research Foundation, 1979.

Urquhart GM, Armour J, Duncan JL, Dunn AM, Jennings FW: *Veterinary Parasitology*. 2nd edition. Oxford, England, Blackwell Science, 1996.

Wallach JD, Boever WJ: *Diseases of Exotic Animals*. Philadelphia, W.B. Saunders Co., 1983.

Williams JF, Zajac A: *Diagnosis of Gastrointestinal Parasitism in Dogs and Cats*. Ralston Purina Company, Saint Louis, Missouri, 1980.

Section 3.

PARASITES OF DOGS

Fecal Eggs and Oocysts

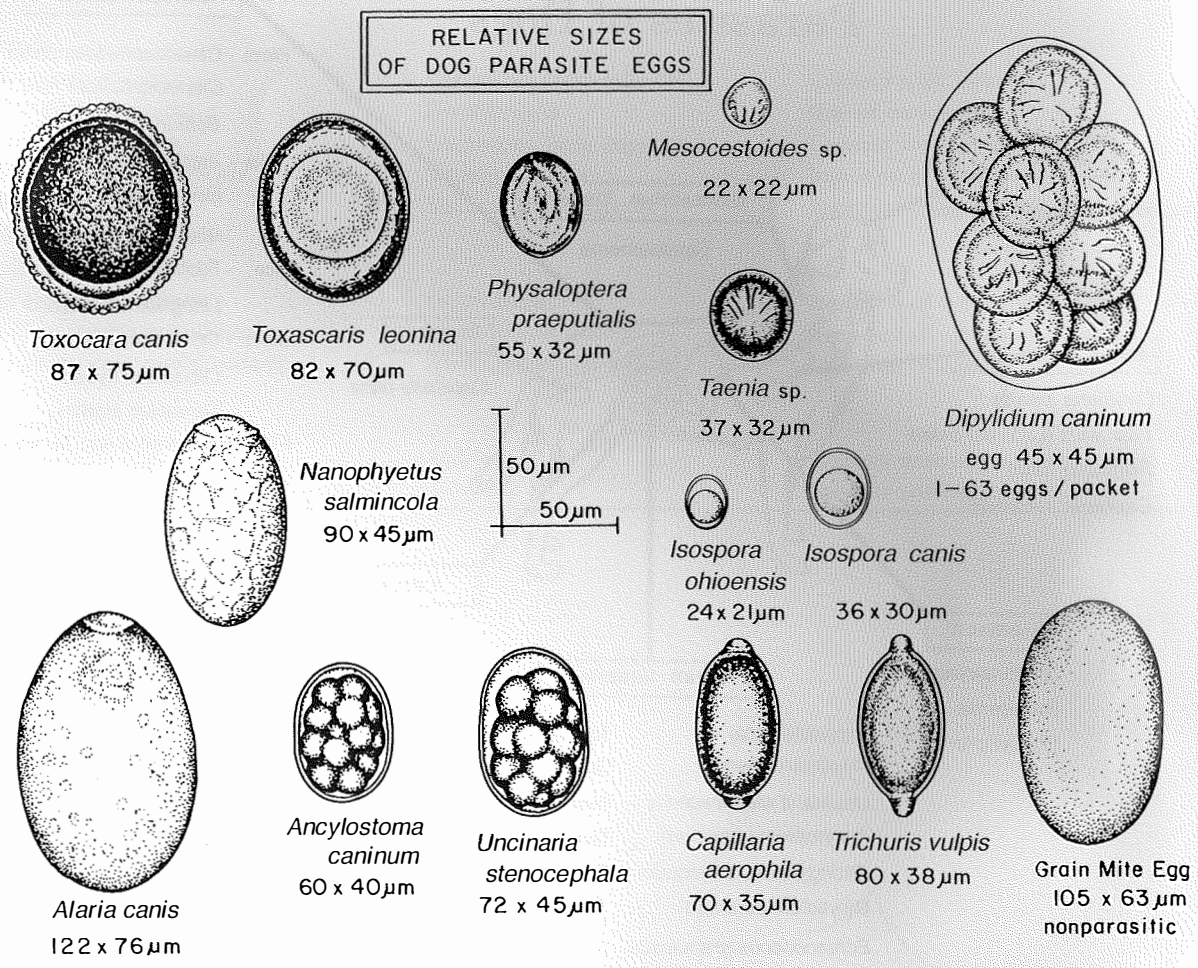


Fig. 7. Common parasite eggs and oocysts found in dog feces.

Location of Major Parasites

Zoonotic Diseases

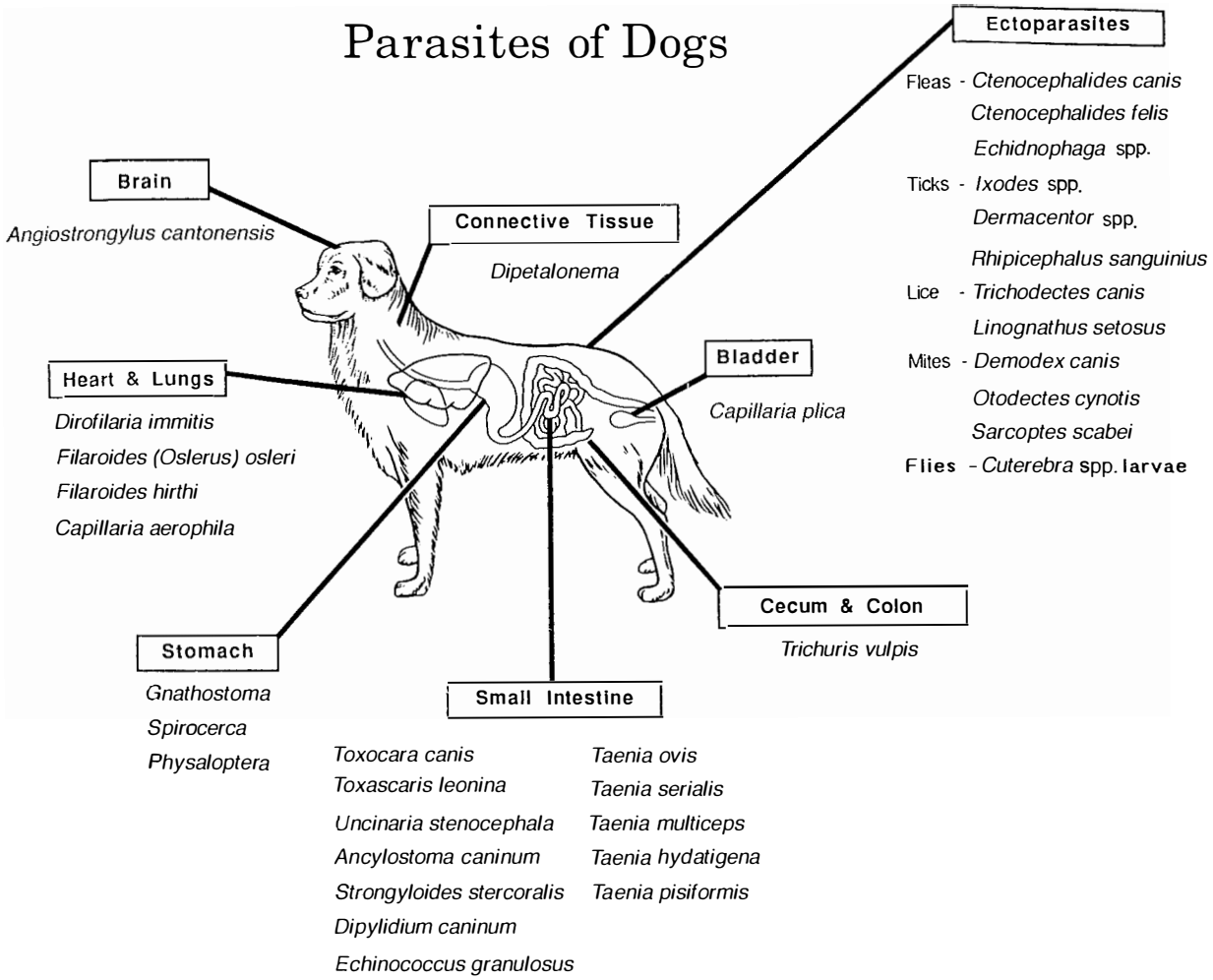


Fig. 8. Locations of the major parasites found in dogs.

Table 12. Major zoonotic diseases associated with dogs

Organism	Disease	Method of Infection
Protozoa		
Entomoeba histolytica	Amoebiasis	Ingestion
Leishmania donovani	Visceral leishmaniasis	Contact with arthropod vector
Leishmania donovani	Cutaneous leishmaniasis	Contact with arthropod vector
Pneumocystis carinii	Pneumocystis infection	Ingestion or inhalation
Trypanosoma cruzi	Trypanosomiasis	Contact with arthropod vector
Nematodes		
Ancylostoma spp.	Cutaneous larva migrans	Contact with larvae
Dirofilaria immitis	Dirofilariasis	Bite of mosquito
Strongyloides spp.	Cutaneous larva migrans	Contact with larvae
Strongyloides stercoralis	Strongyloidiasis	Ingestion of larvae
Toxocara canis	Visceral larva migrans	Ingestion of larvated eggs
Cestodes		
Dipylidium caninum	Dipylidiasis	Ingestion of cysticercoid in flea
Echinococcus granulosus	Hydatid cyst disease	Ingestion of eggs
Echinococcus multilocularis	Alveolar hydatid disease	Ingestion of eggs
Arthropods		
Cheyletiella spp.	Acariasis	Contact with infected dog
Sarcoptes scabiei	Acariasis	Contact with infected dog

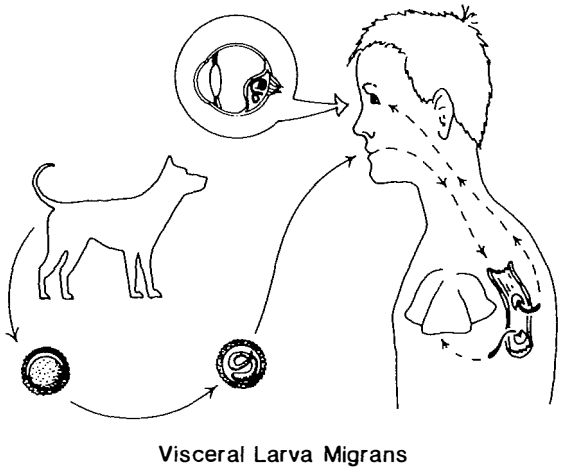


Fig. 9. Visceral larva migrans caused by *Toxocara canis*. (See also page 21.)

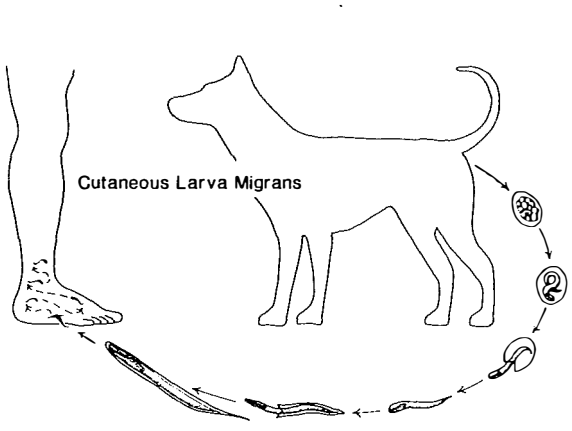


Fig. 10. Cutaneous larva migrans "creeping eruptions" caused by *Ancylostoma* spp. (See also page 22.)

Drugs

Table 13. Efficacy of anthelmintics against major internal parasites of cats and dogs

Drug	Common Trade Name	Dose (mg/kg PO)	Parasites Susceptible
Bunamidine HCL	Scolaban	25–50	Cestodes
Dichlorophene	Various	220	Cestodes
Dichlorvos	Task	5–33	Ascarids, hookworms, whipworms
Diethylcarbamazine	Caricide/Filaribits	3.0–6.6 daily 25–100	Heartworm prevention (L4) Ascarids
Disophenol	Various/DNP	7.5–10 (2nd dose in two weeks)	Hookworms
Dithiazanine	Dizan	20 q 24 h × 3–13 d	Miscellaneous nematodes, heartworm microfilariae
Epsiprantel	Cestex	5.5 (dogs) 2.8 (cats) q 24 h × 3 d (dogs & cats)	Tapeworms Tapeworms
Febantel + praziquantel + pyrantel pamoate	Drontal Plus	Combination product	Ascarids, hookworms, whipworms, tapeworms
Fenbendazole	Panacur	50 q 24 h × 3 d	Ascarids, hookworms, *Giardia*, whipworms, *Taenia* spp. tapeworms
Ivermectin	Ivomec	0.2 SC	Whipworm, many other nematodes
	Ivomec	0.05	Heartworm microfilariae
	Heartgard	0.006 (30-day intervals)	Heartworm prevention
Mebendazole	Telmintic	20 q 24 h × 3–20 d	Ascarids, hookworms, whipworms
Melarsomine	Immidicide	2.5 mg/kg IM, twice, 24 hours apart	Adult heartworms
Methylbenzene + dichlorophene	Various	200–275 mg/kg of each drug PO	Ascarids, hookworms, cestodes
Metronidazole	Flagyl	25 q 12 h x 5 d (dog) 10–25 q 12 h × 5 d (cat)	*Giardia*
Milbemycin oxime	Interceptor	0.5 (30-day intervals)	Heartworm preventative, hookworms, ascarids
Niclosamide	Yomesan	100 (dog), 200 (cat)	Cestodes
n-butyl chloride is often mixed with toluene	Various	Read the label	Ascarids/hookworms
Piperazine	Various	100–250 (2nd dose after 10 days), or 100–150 q 24 h × 2 d	Ascarids
Praziquantel	Droncit	5–50	Cestodes
Praziquantel + pyrantel	Drontal	Combination product	Cestodes, ascarids, hookworms
Pyrantel pamoate	Nemex	15 (dog), 20–30 (cat)	Ascarids, hookworms
Selamectin	Revolution	6–12 (topical)	Heartworm prevention, hookworms, ascarids (cats), many arthropods
Thenium closylate + piperazine	Various	500 q 24 h × 1 d 250 q 24 h × 2 d	Hookworms, ascarids

Note: Read label directions carefully. The label is the most authoritative source of information (See Courtney and Sundlof, 1991).

Internal Parasites

Toxocara canis

Common name: Ascarid or roundworm (Ascaridoidea).
Size of adult: 7–18 cm in small intestine.
Size of egg: 80 µm × 75 µm.
Importance: Larval migration causes liver and lung damage and death in young dogs. Chronic ill thrift, diarrhea, and pot belly appearance. Visceral larva migrans in humans.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat all puppies before 7 weeks of age, treat all dogs when eggs are detected.
Dichlorvos, 100 mg/kg PO
Fenbendazole, 50 mg/kg PO q 24 h × 3 d, or treat bitches 50 mg/kg PO q 24 h from 40th day of gestation until 3 days after whelping.
Mebendazole, 22 mg/kg PO q 24 h × 5 d
Piperazine, 110–200 mg/kg PO; repeat in 10 days.
Pyrantel, 5–10 mg/kg PO, treat bitches prior to whelping.

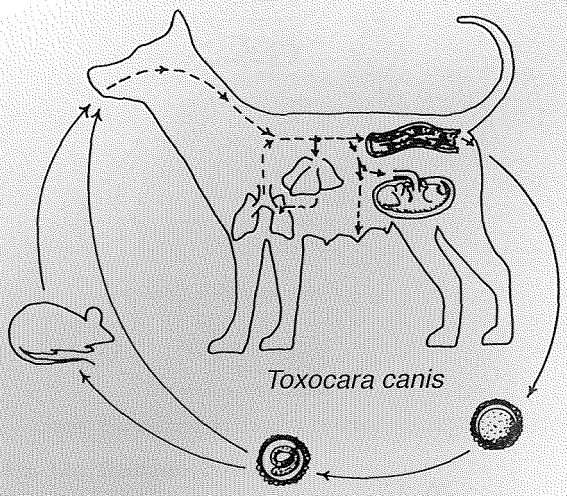


Fig. 11a. *Toxocara canis* prepatent period is 6 weeks.

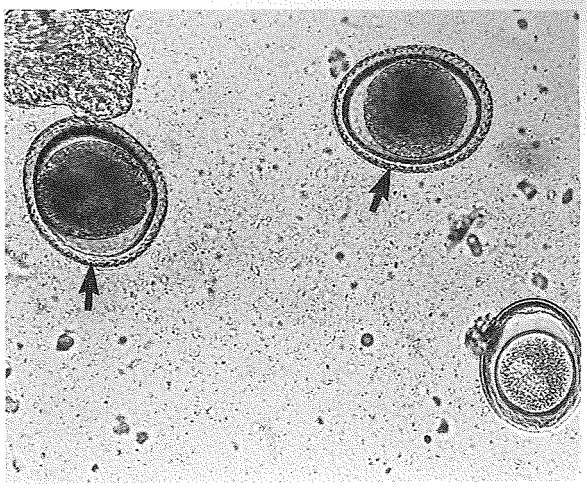


Fig. 11b. *Toxocara canis* (arrows). *Toxascaris leonina* is also shown (lower right).

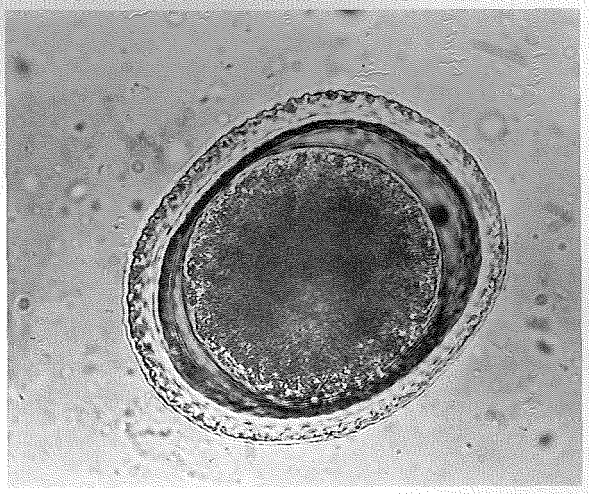


Fig. 11c. *Toxocara canis*.

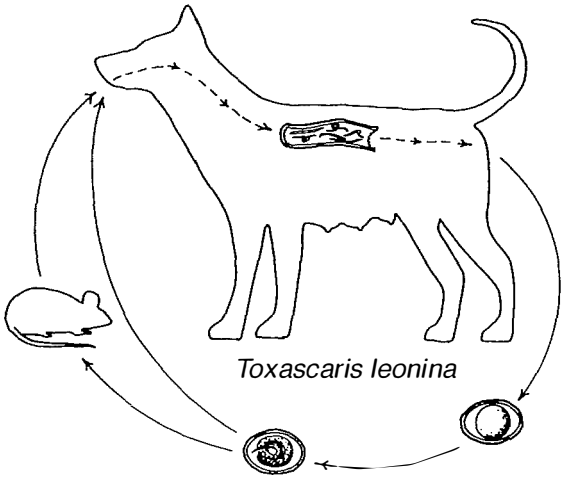


Fig. 12a. *Toxascaris leonina* prepatent period is 6 weeks.

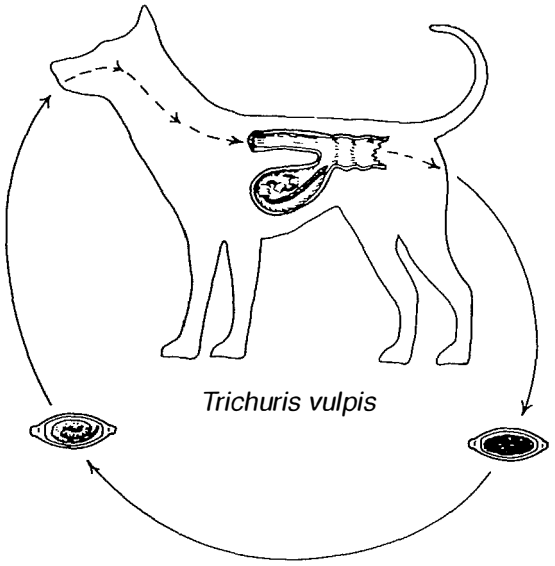


Fig. 13a. *Trichuris vulpis* prepatent period is 3 months.

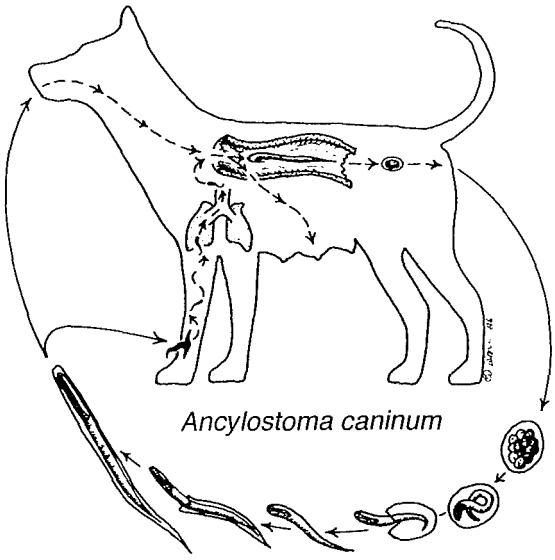


Fig. 14a. *Ancylostoma caninum* prepatent period is 2 weeks.

Toxascaris leonina

Common name: Ascarid or roundworm (Ascaridoidea).
Size of adult: 6–17 cm in small intestine.
Size of egg: 80 µm × 70 µm.
Importance: Chronic diarrhea and ill thrift, not a zoonotic disease.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat when any eggs are detected.
- Dichlorvos, 100 mg/kg PO
- Fenbendazole, 50 mg/kg PO q 24 h × 3 d
- Mebendazole, 22 mg/kg PO q 24 h × 5 d
- Piperazine, 110–200 mg/kg PO; repeat in 10 days.
- Pyrantel, 5–10 mg/kg PO, bitches prior to whelping.

Note: A 1% solution of sodium hypochlorite removes the albumin coat from ascarid eggs, and eggs can then be washed away with steam sterilization.

Trichuris vulpis

Common name: Whipworm (Trichuroidea).
Size of adult: 3–8 cm in cecum.
Size of egg: 75 µm × 40 µm.
Importance: Typhlitis, weight loss, diarrhea. Not a zoonotic disease.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat when any eggs are detected.
- Dichlorvos, 30 mg/kg PO
- Fenbendazole, 50 mg/kg PO q 24 h × 3 d
- Ivermectin, 0.1 mg/kg SC PO
- Mebendazole, 20 mg/kg PO q 24 h × 3–20 d

Note: Eggs in the environment are difficult to kill. (Bleach ×1%), steam sterilization, and direct sunlight are helpful in kennel situations.

Ancylostoma caninum

Common name: Southern hookworm (Strongyloidea).
Size of adult: 8–16 mm in small intestine.
Size of egg: 60 µm × 40 µm.
Importance: Anemia, weakness, poor growth.
Cutaneous larva migrans in humans.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat when eggs are detected.
- Butamisole, 2.4 mg/kg SC
- Dichlorvos, 30 mg/kg PO
- Disophenol, 2.2 mg/kg SC
- Fenbendazole, 50 mg/kg PO q 24 h × 3 d
- Ivermectin, 0.05 mg/kg SC or PO
- Mebendazole, 22 mg/kg PO q 24 h × 3–5 d
- Milbemycin oxime, 0.5 mg/kg PO
- Pyrantel, 5–10 mg/kg PO
- Thenium closylate, 50 mg/kg PO q 12 h × 1 d

Note: For larvicidal treatment of kennels use sodium borate (Borax) 10 lb. per 100 ft^2 or 1% bleach.

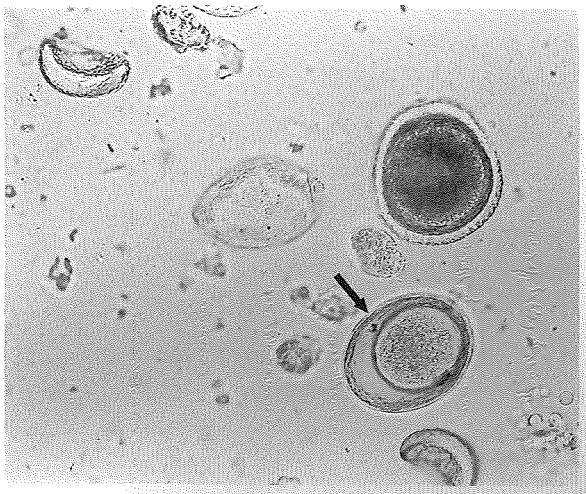


Fig. 12b. *Toxascaris* (arrow), *Toxocara*, *Nanophyetes*.

Fig. 12c. *Toxascaris leonina*.

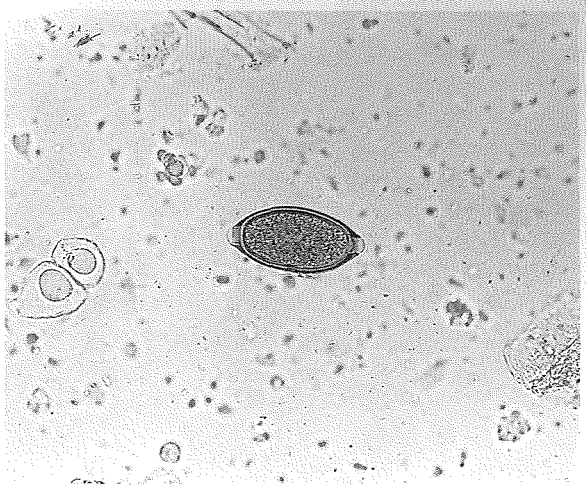


Fig. 13b. *Trichuris vulpis*.

Fig. 13c. *Trichuris vulpis*.

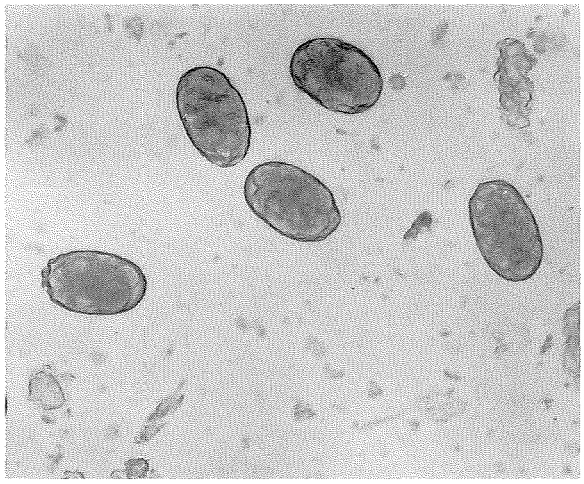


Fig. 14b. *Ancylostoma caninum*.

Fig. 14c. *Ancylostoma caninum*.

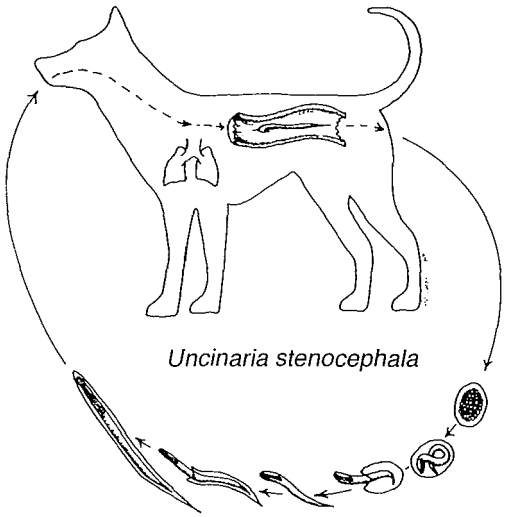


Fig. 15a. *Uncinaria stenocephala* prepatent period is 2 weeks.

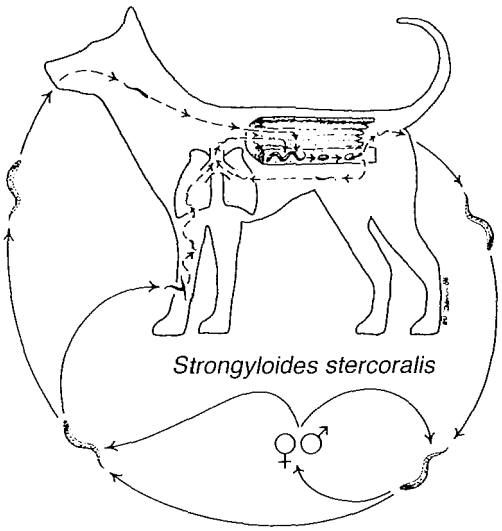


Fig. 16a. *Strongyloides stercoralis* prepatent period is 1 week.

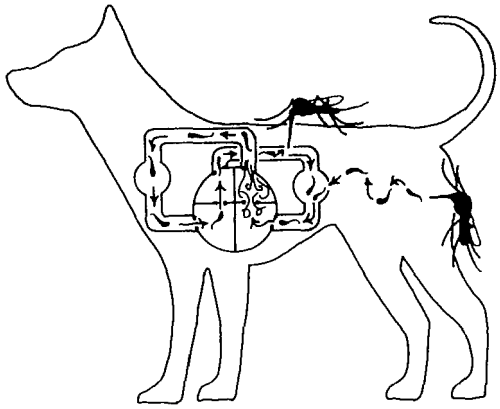


Fig. 17a. *Dirofilaria immitis* prepatent period is 6–7 months.

Uncinaria stenocephala

Common name: Northern hookworm (Strongyloidea).
Size of adult: 5–12 mm in small intestine.
Size of egg: 75 µm × 45 µm.
Importance: Less pathogenic than *Ancylostoma* spp. Worms have cutting plates rather than teeth. Not a zoonotic disease.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat when eggs are detected.
Butamisole, 2.4 mg/kg SC
Dichlorvos, 30 mg/kg PO
Disophenol, 2.2 mg/kg SC
Fenbendazole, 50 mg/kg PO q 24 h × 3 d
Ivermectin, 0.05 mg/kg SC or PO
Mebendazole, 22 mg/kg PO q 24 h × 3–5 d
Pyrantel, 5-10 mg/kg PO
Thenium closylate, 50 mg/kg PO q 12 h × 1 d

Strongyloides stercoralis

Common name: Threadworm (Rhabditoidea).
Size of adult: 0.7–2.2 mm in small intestine.
Size of egg: 55 µm × 30 µm.
Importance: Severe diarrhea, pneumonia and dermatitis. Causes severe illness and diarrhea in human infants.
Diagnosis: Fecal flotation (must be very fresh), larvated eggs and larvae in feces, Baermann technique for larvae, skin scraping when dermatitis is involved. No transplacental or transmammary infection.
Treatment: Treat when eggs or larvae are detected.
Diethylcarbamazine, 100 mg/kg PO
Ivermectin, 0.2 mg/kg PO
Mebendazole, 20 mg/kg PO q 24 h × 3–14 d

Dirofilaria immitis

Common name: Heartworm (Filarioidea).
Size of adult in heart: 12–30 cm microfilariae in blood.
Size of microfilaria: 270–325 µm × 6.7–7.0 µm.
Importance: Causes congestive heart failure in dogs, pulmonary and skin lesions in humans.
Diagnosis: Microfilariae in blood. Knott's test, buffy coat examination, direct blood smear, millipore filtration of blood, various serologic tests.
Note: Adult heartworms can live for 8 years.
Treatment for adults: Melarsomine dihydrochloride (Immidicide), 2.5 mg/kg IM, given twice 24 hours apart.
Treatment for microfilariae: Ivermectin, 0.05 mg/kg SC or PO
Levamisole, 11 mg/kg PO q 24 h × 7–10 d (given starting 2 weeks after caparsolate).
Milbemycin oxime, 0.5 mg/kg PO
Treatment as prophylaxis: Diethylcarbamazine, 1.2 mg/kg PO q 24 h during mosquito season.
Ivermectin, 0.006 mg/kg PO every 30 days.
Milbemycin oxime, 0.5 mg/kg every 30 days.
Moxidectin, 0.03 mg/kg PO every 30 days.
Selamectin, 6–12 mg/kg (topically) every 30 days.

Fig. 15b. *Uncinaria stenocephala.*

Fig. 15c. *Uncinaria stenocephala.*

Fig. 16b. *Strongyloides stercoralis.*

Fig. 16c. *Strongyloides stercoralis.* Photo courtesy of Dr. Linda Mansfield.

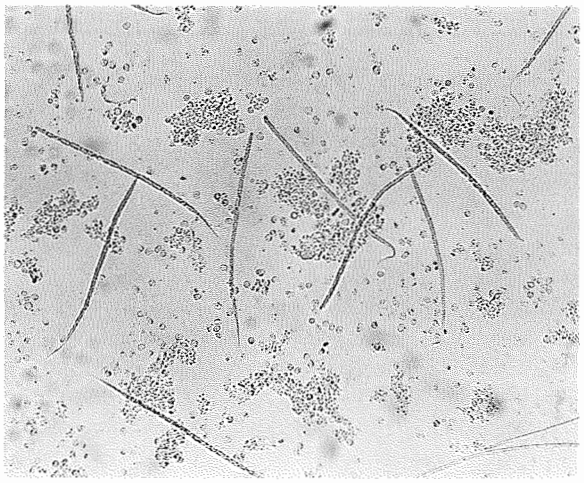


Fig. 17b. *Dirofilaria immitis.*

Fig. 17c. *Dirofilaria immitis.*

Table 14. Comparison of microfilariae of *Dirofilaria immitis* and *Dipetalonema reconditum*

Parameter	*Dirofilaria immitis*	*Dipetalonema reconditum*
Numbers present	Many	Very few
Motility	Nonprogressive	Progressive
Head shape	Tapered	Blunt
Acid phosphatase stain	Excretory, anal pores	Diffuse
Tail	Straight	Button hook
Body	Straight	Curved
Length by Knott's test (µm)	280–320	215–270
Length by filter test (µm)	235–285	215–240
Width by Knott's test (µm)	6.1–7.2	4.7–5.8
Width by filter test (µm)	5.8–7.0	4–5

Table 14a. Interpretation of heartworm tests

Heartworm Microfilariae Present in Knott's Test	Antigen Test	Results and [Recommendations]
Positive	Positive	Patent heartworm infection [Treat with adulticide, microfilaricide, use preventative]
Negative	Positive	False-negative Knott's test, no adults present, immature worms only, all male or female worms, treated with a microfilaricide, antibody against microfilariae [Treat with adulticide, use preventative]
Positive	Negative	False-positive Knott's test, few worms present, recent patent infection, immune response that removes or masks the antigens detected in the serological tests, misidentification of the microfilariae observed [Treat with microfilaricide, use preventative]
Negative	Negative	No heartworms present, low worm burden, immature worms present, immune mediated occult infection [Use preventative if in heartworm transmission area]

Note: Modified Knott's tests are generally used for microfilariae detection, and at this time antigen tests (ELISAs) are primarily recommended for serological tests. (See Blagburn, 1994; Henry and Dillon, 1994).

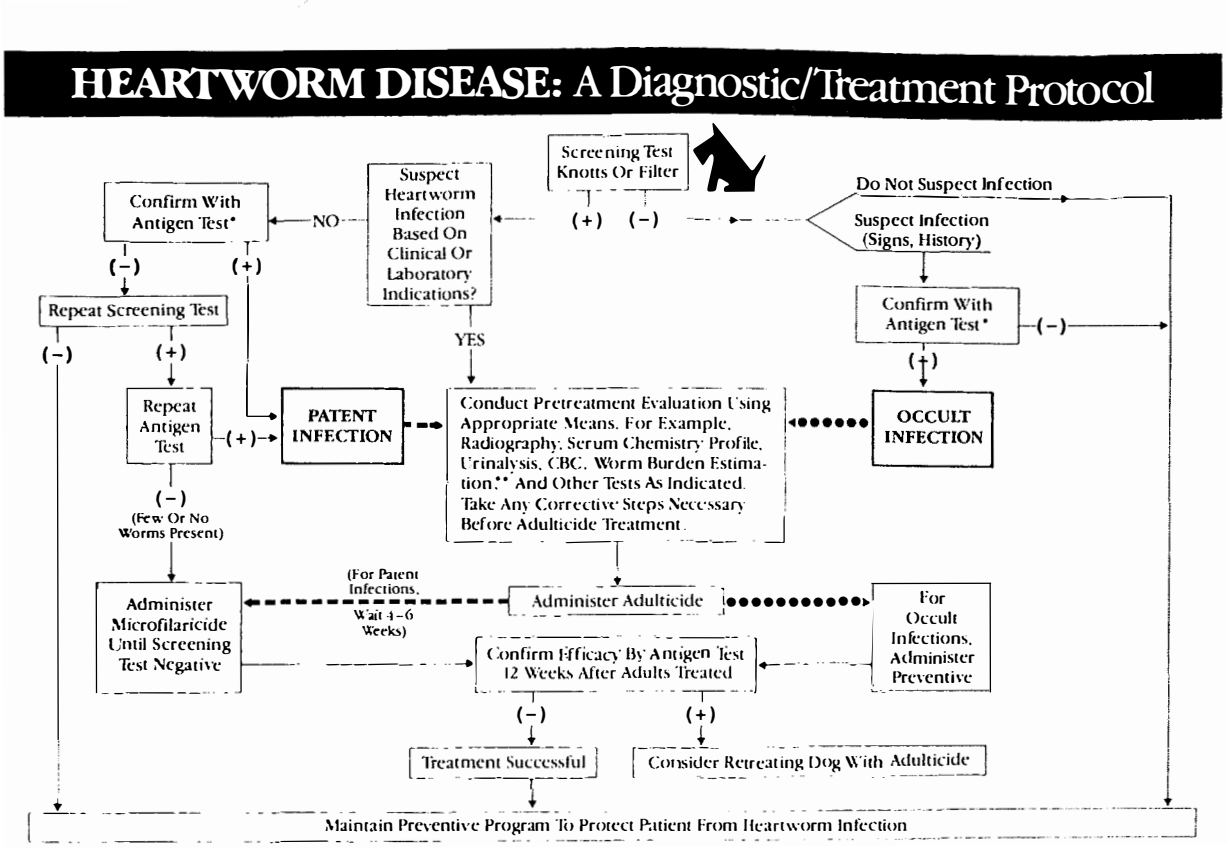


Fig. 18. Diagnostic protocol for diagnosis and treatment of heartworms (*Dirofilaria immitis*).

*In addition to antigen test, radiography, echocardiography, antibody, and other tests may be used to aid diagnosis.

**Experts believe that predicting worm burden could provide a useful guide for prognosis and treatment.

(With permission from Dr. Charles H. Courtney, University of Florida, Gainesville, Florida, and Agri Tech Systems, Inc., Portland, Maine.)

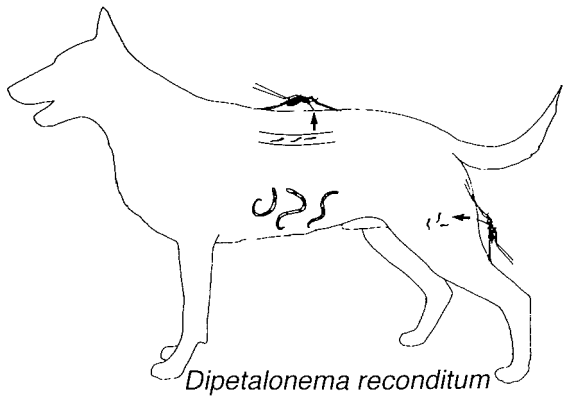


Fig. 19a. *Dipetalonema reconditum* prepatent period is 61–68 days.

Dipetalonema reconditum

Common name: (Filarioidea).
Size of adult: 4–8 cm in subcutaneous tissues.
Size of microfilariae: 215–270 µm × 4.7–5.8 µm. Slightly smaller than microfilariae of *Dirofilaria immitis* (See Table 14).
Importance: Nonpathogenic. Must be differentiated from *Dirofilaria immitis* because dogs infected with *Dipetalonema reconditum* are not treated.
Diagnosis: Microfilariae in blood (See Table 14).
Treatment: None needed; nonpathogenic.

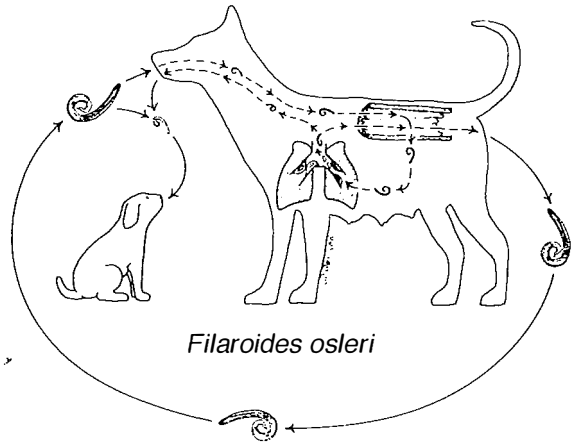


Fig. 20a. *Filaroides* (*Oslerus*) *osleri* in bronchi. *F. hirthi* in pulmonary parenchyma. Prepatent period is 10 weeks for *F. osleri* and 5 weeks for *F. hirthi*.

Filaroides osleri

Common name: Tracheal worm (Metastrongyloidea).
Size of adult: 5–15 mm. *F. osleri* coiled in nodules at bifurcation of trachea. Adult *F. hirthi* in pulmonary parenchyma.
Size of first stage larva: In trachea 237–267 µm in feces 325–378 µm.
Importance: Coughing, chronic tracheobronchitis.
Diagnosis: Larval in feces or sputum. Sputum smear, transtracheal wash, or fecal flotation.
Treatment: Treatment is experimental.
Albendazole, 25–50 mg/kg PO q 12 × 5 d (repeat in 21 days)
Fenbendazole, 50 mg/kg PO q 24 h × 7 d
Ivermectin, 0.4 mg/kg SC or PO

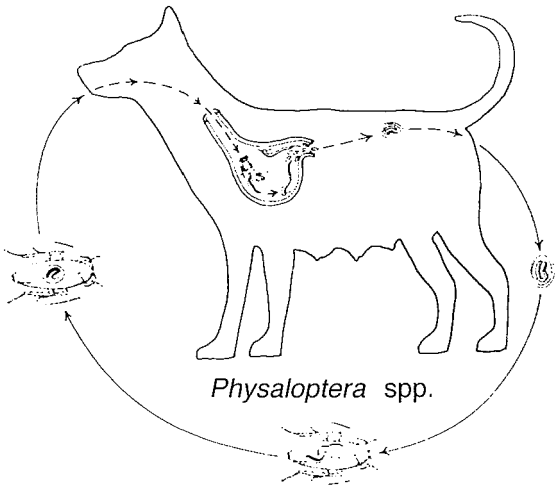


Fig. 21a. *Physaloptera* spp. prepatent period is 58–83 days.

Physaloptera spp.

Common name: Stomach worm (Spiruroidea).
Size of adult: 3–6 cm in stomach.
Size of egg: 40 µm × 30 µm.
Importance: Infrequently causes gastric mucosal erosion and gastritis; adults attach with mouth parts.
Diagnosis: Larvated eggs in feces. Fecal flotation or worms in vomitus.
Treatment: Treat when eggs are detected.
Dichlorvos, 27–33 mg/kg
Fenbendazole, 50 mg/kg PO q 24 h × 5 d
Ivermectin, 0.05–0.5 mg/kg SC or PO

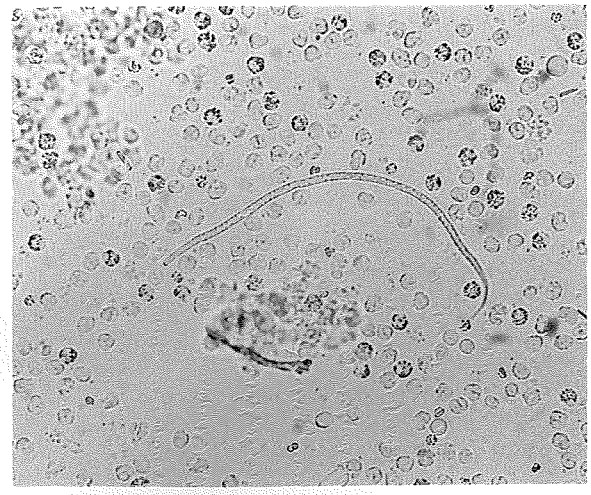


Fig. 19b. *Dipetalonema reconditum.*

Fig. 19c. *Dipetalonema reconditum* (arrow).

Fig. 20b. *Filaroides osleri,* first-stage larvae.

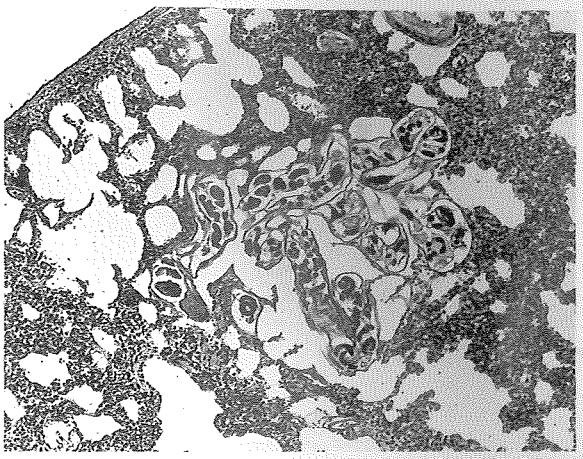


Fig. 20c. *Filaroides osleri* in lung section.

Fig. 21b. *Physaloptera* sp.

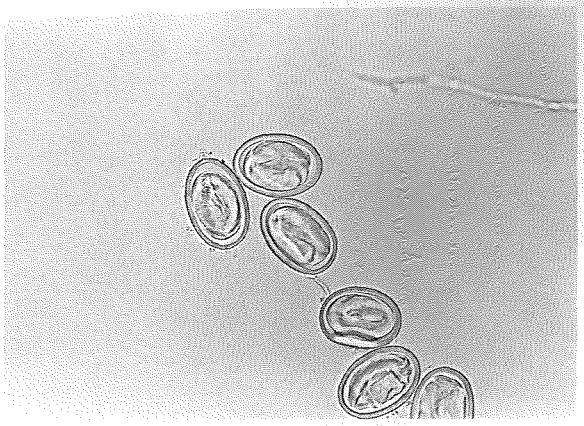


Fig. 21c. *Physaloptera* sp.

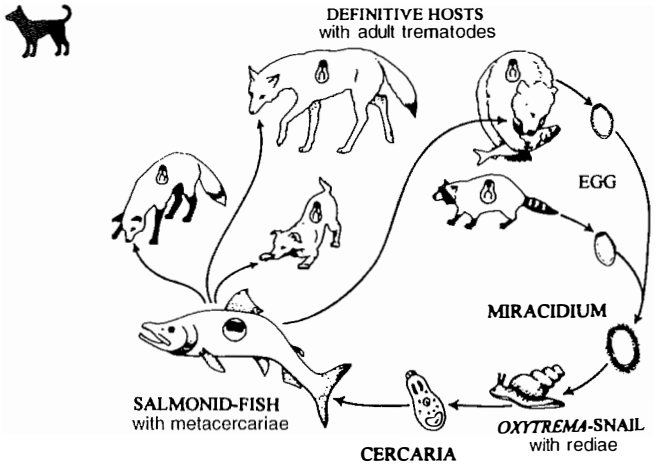


Fig. 22a. *Nanophyetus salmincola* prepatent period is 5–7 days. (See also Fig. 52j.)

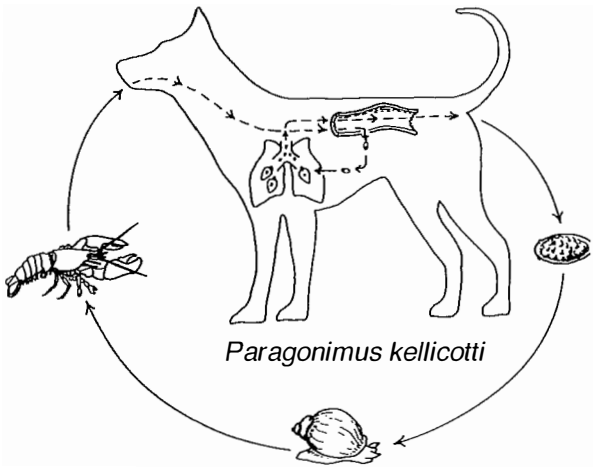


Fig. 23a. *Paragonimus kellicotti* prepatent period is 5–6 weeks.

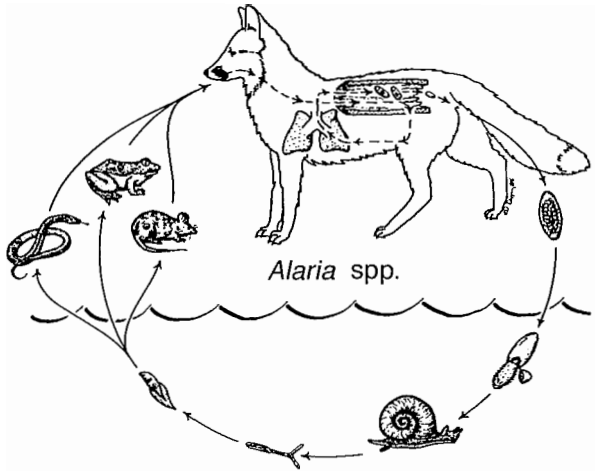


Fig. 24a. *Alaria* spp. prepatent period is 35 days.

Nanophyetus salmincola

Common name: Salmon poisoning fluke (Troglotrematidae).
Size of adult: 0.5–1.5 mm in small intestine.
Size of egg: 70 µm × 40 µm.
Importance: Vector for *Neorickettsia helmintheca*, etiological agent of salmon poisoning disease in dogs. Hemorrhagic enteritis with generalized lymphadenopathy, vomiting, diarrhea, lethargy, inappetence, fever, death.
Diagnosis: Gold, operculated eggs in feces. History, fecal flotation in sugar or fecal smear, clinical signs.
Treatment of salmon poisoning (rickettsial disease): Treatment is necessary.
Oxytetracycline, 7 mg/kg IV q 12 h × 3 d
Doxycycline, 10 mg/kg IV q 12 h × 7 d
Treatment of *Nanophyetus salmincola*: Treatment may be beneficial.
Praziquantel, 2.5–5 mg/kg PO or SC
Note: Freezing or cooking fish will kill metacercariae.

Paragonimus kellicotti

Common name: Lung fluke (Troglotrematidae).
Size of adult: 1.0–1.5 cm in lung.
Size of egg: 90 µm × 50 µm.
Importance: May cause chronic respiratory disease.
Diagnosis: Gold operculated eggs in feces or sputum. Fecal flotation in sugar or sputum smear.
Treatment: Treat when eggs are detected.
Albendazole, 25–50 mg/kg PO q 24 h × 14–21 d
Fenbendazole, 50 mg/kg PO q 24 h × 10–14 d
Praziquantel, 25 mg/kg PO q 24 h × 2 d

Alaria spp.

Common name: Intestinal fluke (Strigeidae).
Size of adult: 2–10 mm in small intestine.
Size of egg: 134 µm × 70 µm.
Importance: Mostly nonpathogenic. Lung migration may cause some damage. Minor zoonotic potential from larval stages from intermediate hosts.
Diagnosis: Eggs in sugar fecal flotation.
Treatment: Parasites are of minor significance unless large numbers are present.
Niclosamide, 157 mg/kg PO
Praziquantel, 10 mg/kg PO or SC

Fig. 22b. *Nanophyetus salmincola* (arrow). The other egg is *Toxascaris leonina*.

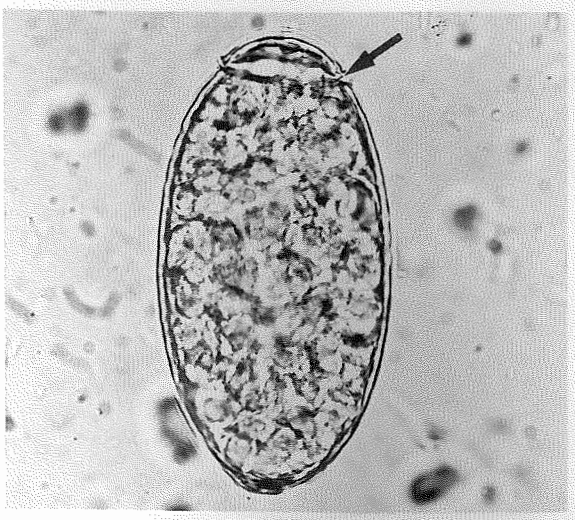


Fig. 22c. *Nanophyetus salmincola*. The operculum is at the arrow.

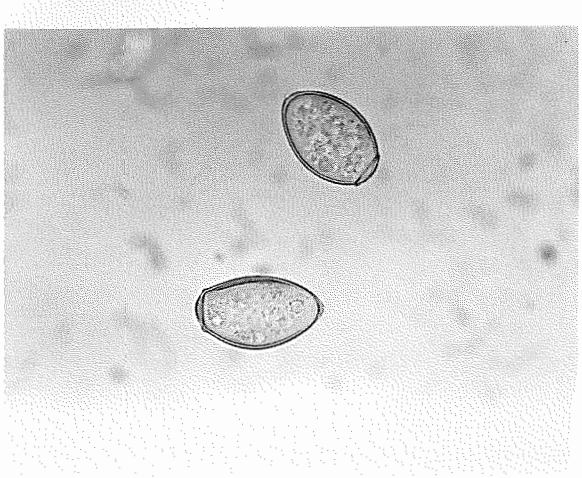


Fig. 23b. *Paragonimus kellicotti*.

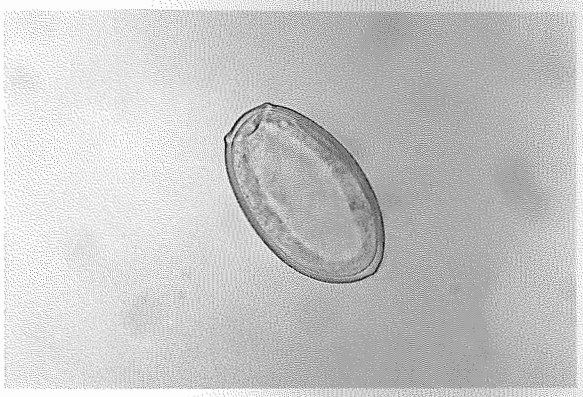


Fig. 23c. *Paragonimus kellicotti*.

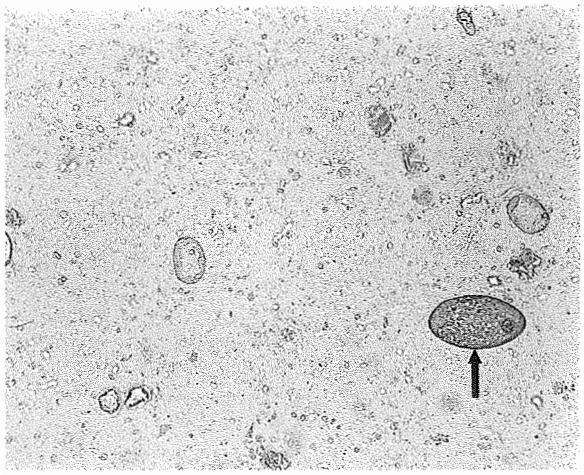


Fig. 24b. *Alaria* sp. (arrow), *Nanophyetus*.

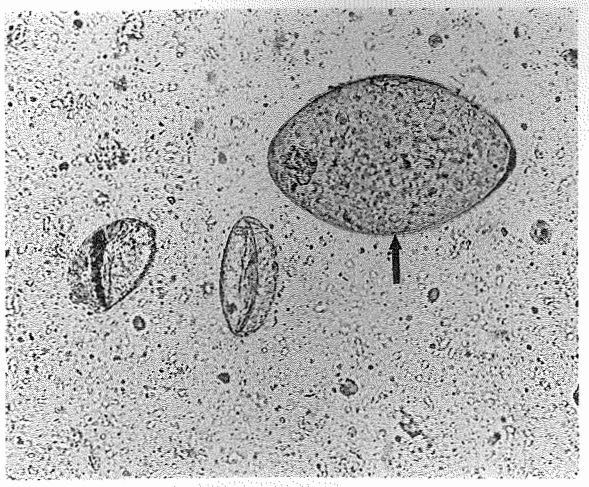


Fig. 24c. *Alaria* sp. (arrow). The other two eggs are *Nanophyetus*.

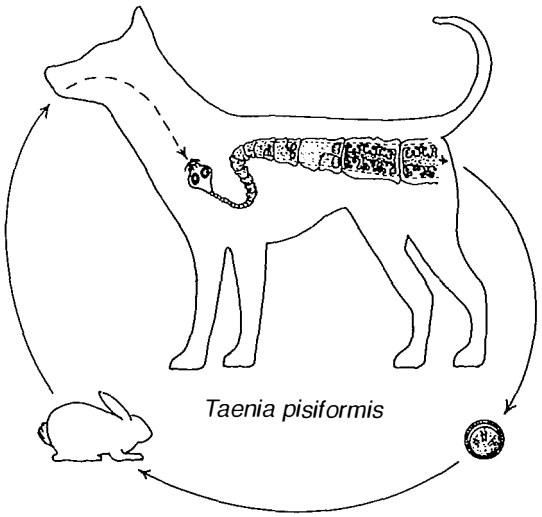


Fig. 25a. *Taenia pisiformis* prepatent period is 2 months.

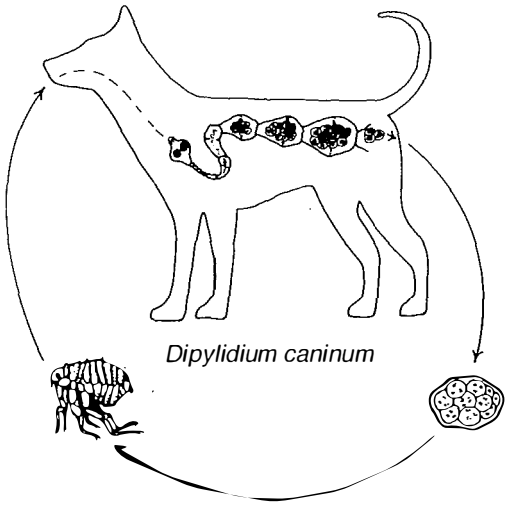


Fig. 26a. *Dipylidium caninum* prepatent period is 1 month.

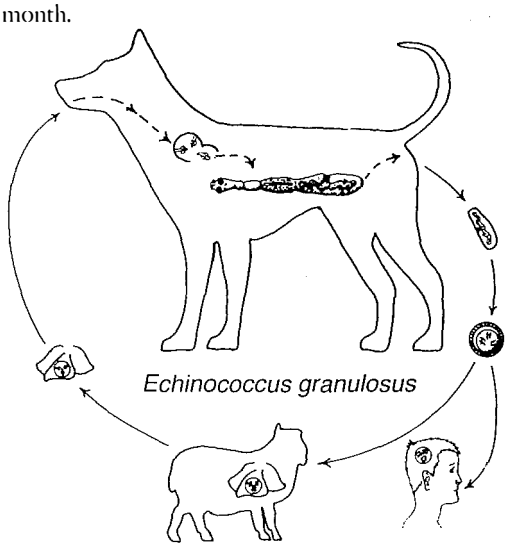


Fig. 27a. *Echinococcus granulosus* prepatent period is 50 days.

Taenia pisiformis

Common name: Tapeworm (Taeniidae).
Size of adult: Up to 20 m in small intestine.
Size of egg: 38 µm × 32 µm.
Importance: Possible intestinal obstructions with heavy infections. The usual *Taenia* in dogs is *Taenia pisiformis*, which is acquired by eating cysticerci in rabbits.
Diagnosis: Segments in feces or on perianal region, eggs in fecal flotation.
Treatment: Treat when eggs or segments are detected.
Bunamidine, 25–50 mg/kg PO
Dichlorophene, 220 mg/kg PO
Epsiprantel, 5.5 mg/kg PO
Fenbendazole, 50 mg/kg PO q 24 h × 3 d
Mebendazole, 22 mg/kg PO q 24 h × 3–5 d
Niclosamide, 157 mg/kg PO
Praziquantel, 2.5–5 mg/kg PO

Dipylidium caninum

Common name: Flea tapeworm (Dilepididae).
Size of adult: 15–75 cm in small intestine.
Size of egg: 25 µm–30 µm in oblong packets of 20 or fewer eggs. Eggs packets are 200 µm × 150 µm.
Importance: Indicates the presence of fleas. Anal pruritus, chronic enteritis, vomiting, or nervous disorders may result. Will infect humans.
Diagnosis: Segments on feces or perianal region, fecal flotation.
Treatment: Treat when eggs or segments are detected.
Bunamidine 25–50 mg/kg PO
Dichlorophene, 220 mg/kg PO
Epsiprantel, 5.5 mg/kg PO
Niclosamide, 157 mg/kg PO
Praziquantel, 2.5–5 mg/kg PO

Echinococcus granulosus (see also Figs. 52h and 52i)

Common name: Hydatid tapeworm (Taeniidae).
Size of adult: 2–9 mm in small intestine.
Size of egg: 35 µm × 30 µm.
Importance: Mild disease in carnivores; highly pathogenic or fatal in humans (hydatid cyst).
Diagnosis: Eggs in fecal flotation. Eggs are indistinguishable from *Taenia* spp. eggs.
Treatment: Treat all dogs if suspected.
Bunamidine, 20–50 mg/kg (repeat in 2 days and in 1 month).
Mebendazole, 22 mg/kg PO q 24 h × 3–5 d
Praziquantel, 25–50 mg/kg (preferred treatment).
Prevention: Do not feed infected sheep or wild ruminant viscera to dogs.

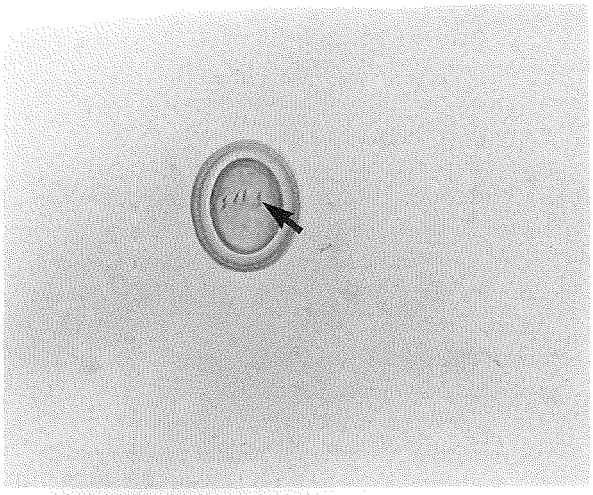


Fig. 25b. *Taenia* sp. Note hooks in egg (arrow).

Fig. 25c. *Taenia* sp. Note hooks in egg.

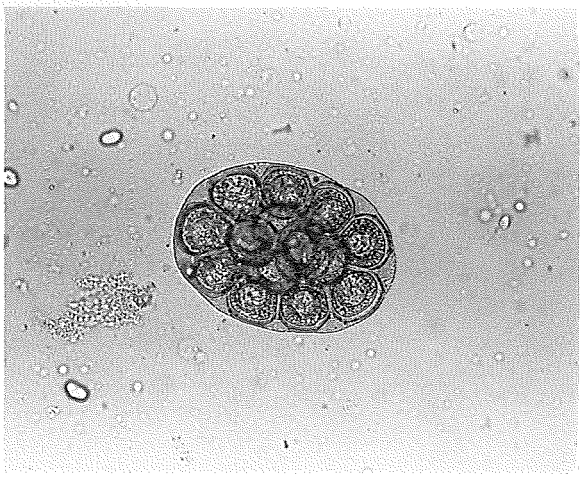


Fig. 26b. *Dipylidium caninum.*

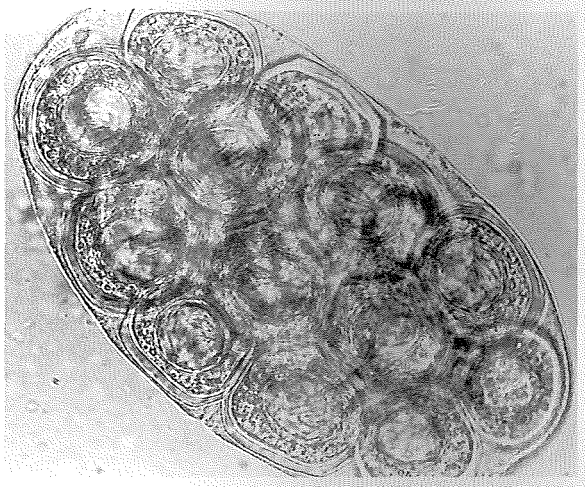


Fig. 26c. *Dipylidium caninum.*

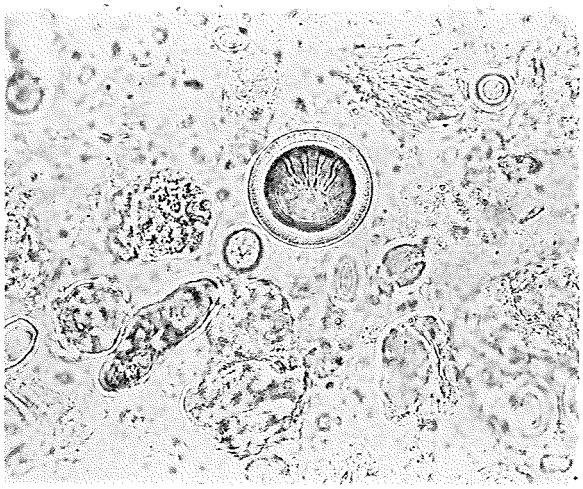


Fig. 27b. *Echinococcus granulosus.*

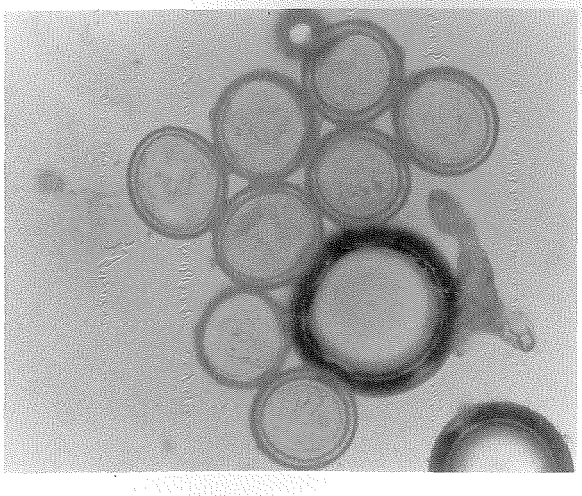


Fig. 27c. *Echinococcus granulosus.*

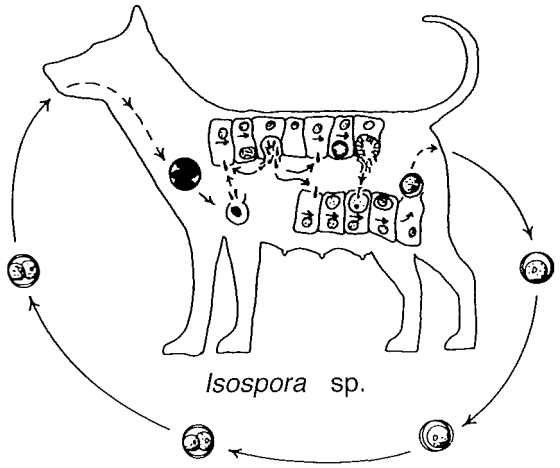


Fig. 28a. *Isospora* sp. prepatent period is 1 week.

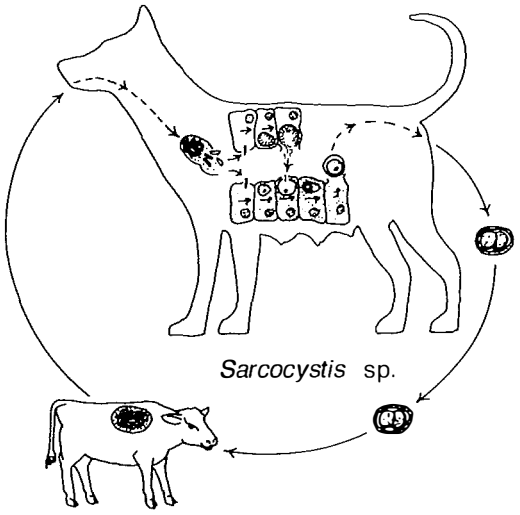


Fig. 29a. *Sarcocystis* sp. prepatent period is 9–10 days.

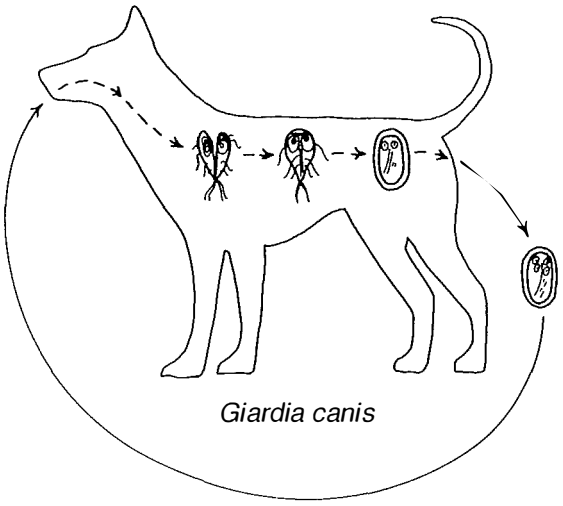


Fig. 30a. *Giardia canis* prepatent period is 1 week.

Isopora spp.

Common name: Coccidia (Apicomplexa).
Size of oocyst: *Isospora ohioensis* 24 µm × 21 µm; *Isospora biginina* 13 µm × 10 µm; *Isospora canis* 36 µm × 30 µm.
Importance: May cause hemorrhagic enteritis, diarrhea, poor growth. Primarily in puppies.
Diagnosis: Oocysts in fecal flotation; in small intestine.
Treatment: Treat if more than 1,000 oocyst/g and diarrhea is present.
Sulfadimethoxine, 55 mg/kg PO q 24 h × 10 days, or until asymptomatic for 2 days.
Prevention: Same as treatment.
Decoquinate, at 1 mg/kg PO is used experimentally.
Note: Ionophores can be toxic in dogs and cats.
Amprolium, 100–200 mg/kg q 24 h × 7 days (treatment or prevention).

Sarcocystis spp.

Common name: None (Apicomplexa).
Size of sporocyst: 16 µm × 11 µm in small intestine.
Importance: Usually nonpathogenic, but is economically important in intermediate hosts used for food animals.
Diagnosis: Oocysts or sporocysts in fecal flotation.
Treatment: None available.
Prevention: Do not feed raw meat to dogs.

Giardia canis

Common name: None (Mastigophora).
Size of cyst: 18 µm × 10 µm; trophozoite: 17 µm × 10 µm in small and large intestine.
Importance: Diarrhea, transmissible to humans.
Diagnosis: Trophozoites or cysts in fecal flotation or smear (must use fresh fecal material). Several ELISA tests are available.
Treatment: Treat if diarrhea and *Giardia* are present.
Carnidazole, 5 mg/kg q 24 h × 3 days
Metronidazole, 50 mg–70/kg PO q 24 h × 5 d
Quinacrine, PO or IM
Large dogs: 200 mg q 8 h × 1 d or 200 mg q 12 h × 6 d
Small dogs: 100 mg q 12 h × 1 d or 100 mg q 24 h × 6 d
Puppies: 50 mg q 12 h × 6 d
Cats: 10 mg/kg q 24 h × 12 d
Albendazole, 25 mg/kg q 12 h × 2 d (4 treatments)
Carnidazole, 5 mg/kg q 24 h × 3 d
Fenbendazole, 50 mg/kg q 24 h × 3 d
Prevention: *Giardia* vaccines may be useful in chronic cases.

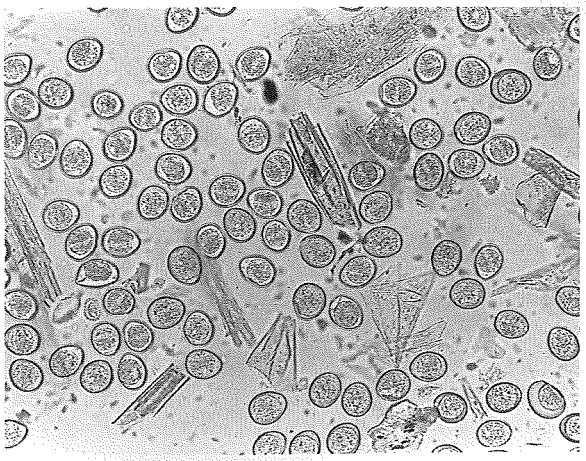


Fig. 28b. *Isospora* sp.

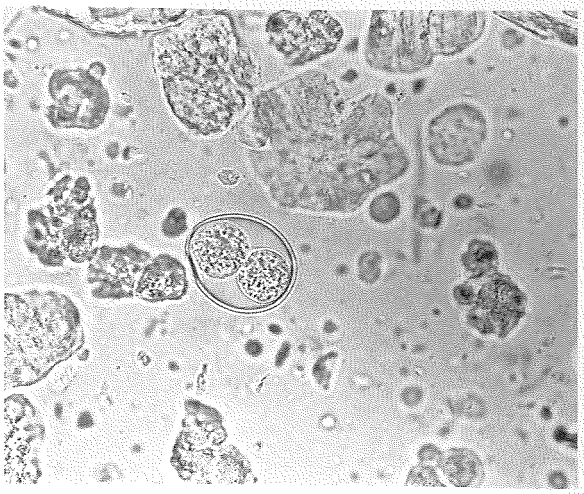


Fig. 28c. *Isospora* sp. (dividing).

Fig. 29b. *Sarcocystis* sp.

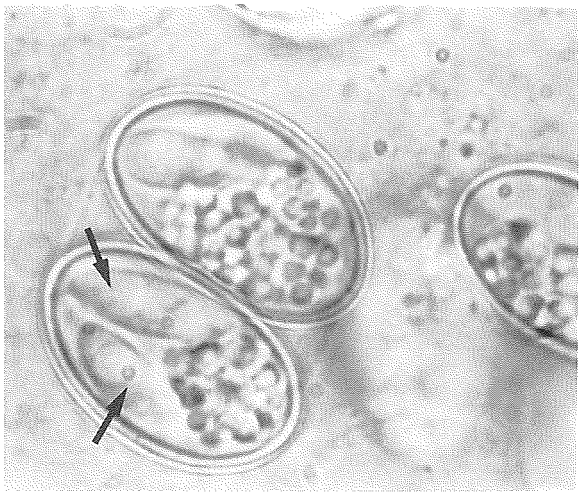


Fig. 29c. *Sarcocystis* sp. Note sporozoites (arrows).

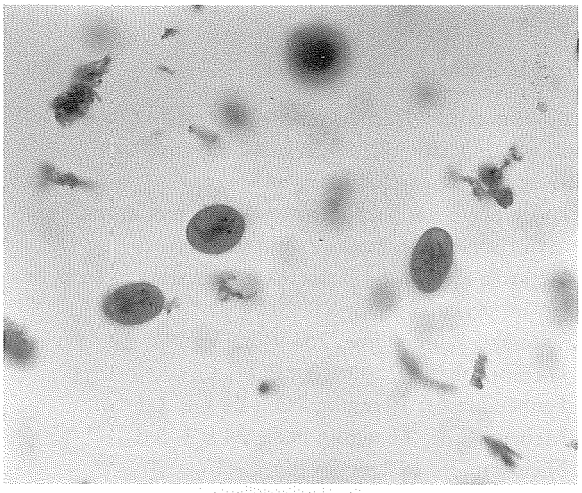


Fig. 30b. *Giardia canis* (cysts stained).

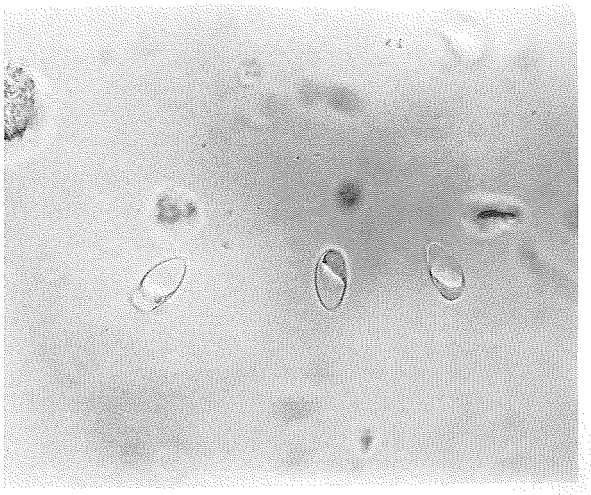


Fig. 30c. *Giardia canis* (cysts in sugar flotation). Cytoplasm is compressed at one end.

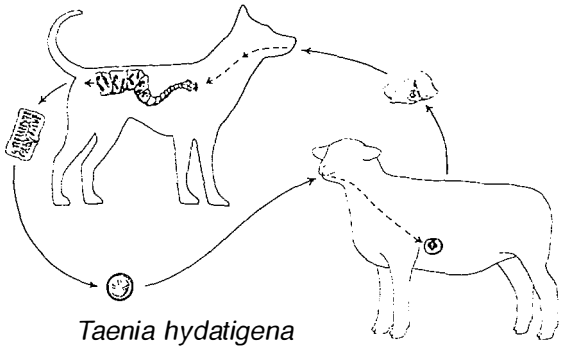


Fig. 31. *Taenia hydatigena* prepatent period is 7 weeks.

Taenia hydatigena

Common name: Sheep tapeworm (Taeniidae).
Size of adult: 75–500 cm in small intestine.
Size of egg: 38 µm x 32 µm. Essentially the same for most *Taenia* spp. in dogs. Cysticerci in peritoneal cavity of sheep.
Importance: Low pathogenicity, source of infection for sheep.
Diagnosis: Eggs in fecal flotation, segments in feces or on perianal region.
Treatment: Bunamidine, 25–50 mg/kg PO
Dichlorophene, 220 mg/kg PO
Fenbendazole, 50 mg/kg PO q 24 h × 3 d
Mebendazole, 22 mg/kg PO q 24 h × 3–5 d
Niclosamide, 157 mg/kg PO
Praziquantel, 2.5–5.0 mg/kg PO

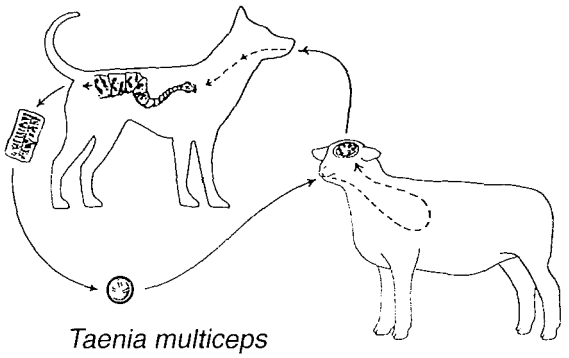


Fig. 32. *Taenia multiceps* prepatent period is 7–9 weeks.

Taenia multiceps

Common name: Gid tapeworm (Taeniidae).
Size of adult: 40–100 cm in small intestine.
Size of egg: 38 µm × 32 µm.
Importance: Low pathogenicity. In sheep, the Coenurus stage in the brain causes central nervous system disorders (gid).
Diagnosis: Eggs in fecal flotation, segments in feces or on perianal region.
Treatment: Bunamidine, 25–50 mg/kg PO
Dichlorophene, 220 mg/kg PO
Fenbendazole, 50 mg/kg PO q 24 h × 3 d
Mebendazole, 22 mg/kg PO q 24 h 3–5 d
Niclosamide, 157 mg/kg PO
Praziquantel, 2.5–5.0 mg/kg PO

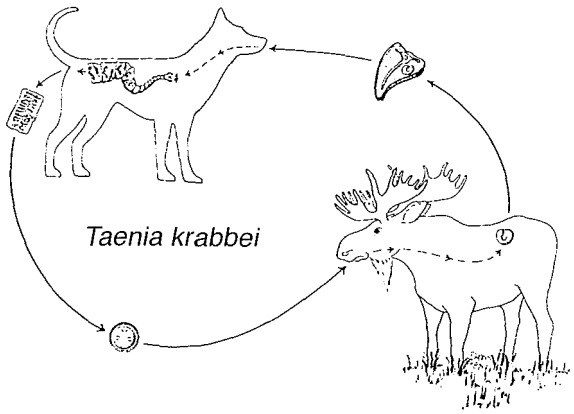


Fig. 33. *Taenia krabbei* prepatent period is 7–8 weeks.

Taenia krabbei

Common name: Deer or moose tapeworm (Taeniidae).
Size of adult: 26–100 cm in small intestine.
Size of egg: 38 µm × 32 µm.
Importance: Low pathogenicity. Cysticerci in muscles of mule deer, caribou, and moose.
Diagnosis: Eggs in fecal flotation, segments in feces or on perianal region.
Treatment: Bunamidine, 25–50 mg/kg PO
Dichlorophene, 220 mg/kg PO
Fenbendazole, 50 mg/kg PO q 24 h × 3 d
Mebendazole, 22 mg/kg PO q 24 h 3–5 d
Niclosamide, 157 mg/kg PO
Praziquantel, 2.5–5.0 mg/kg PO

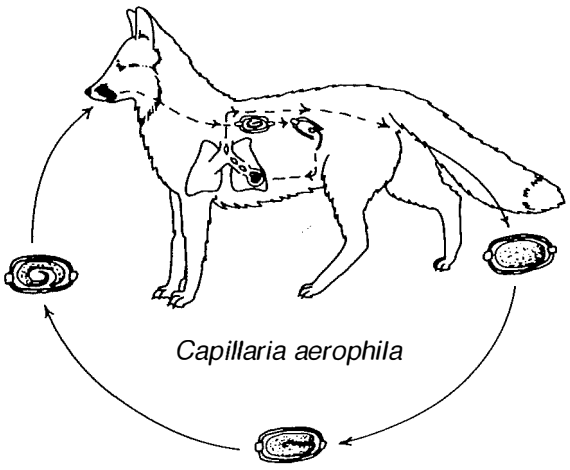


Fig. 34. *Capillaria (Eucoleus) aerophila* prepatent period is 40 days.

Capillaria aerophila

Common name: Fox lungworm (Trichuroidea).
Size of adult: 2.5–3.2 cm in lungs.
Size of egg: 70 µm × 35 µm.
Importance: May cause respiratory distress.
Diagnosis: Eggs in fecal flotation.
Treatment: Fenbendazole, 50 mg/kg PO q 24 h × 3–5 d
Ivermectin, 0.2 mg/kg PO or SC
Levamisole, 2.5 mg/kg PO q 24 h × 5 d

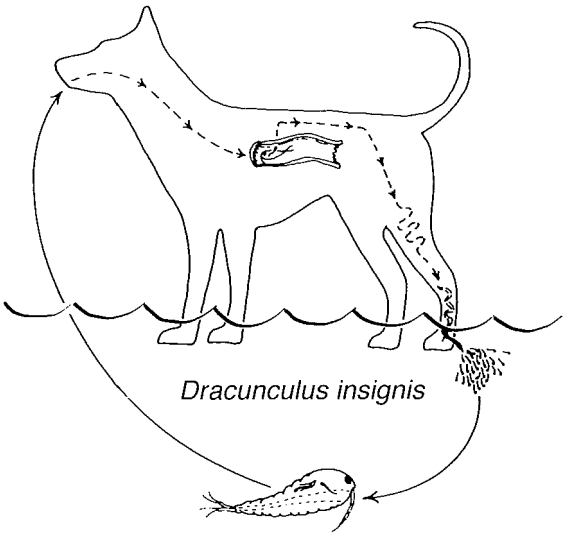


Fig. 35. *Dracunculus insignis* and *D. medinensis* prepatent period is 10–14 months.

Dracunculus insignis

Common name: Guinea worm, dragon worm, firey serpent (Dracunculoidea).
Size of adult: 1–200 cm in subcutaneous tissue.
Size of larvae: 500–750 µm.
Importance: Low pathogenicity, swellings on tibia and tarsus, nonhealing ulcers.
Diagnosis: Nonhealing skin ulcers, isolation of larvae from the ulcers.
Treatment: Bunamidine, 25-50 mg/kg PO
Dichlorophene, 220 mg/kg PO
Niclosamide, 157 mg/kg PO
Praziquantel, 2.5–5.0 mg/kg PO or SC
Surgical removal

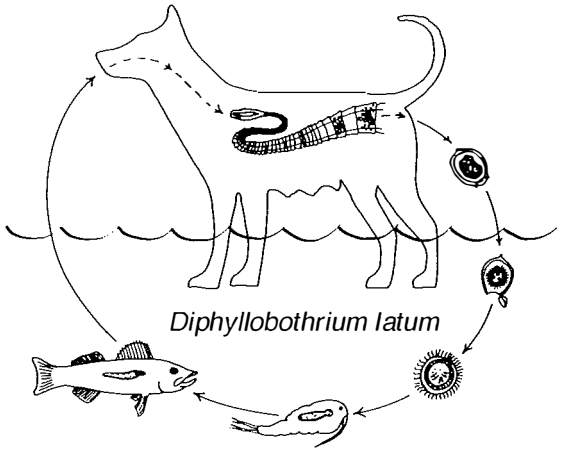


Fig. 36. *Diphyllobothrium latum* prepatent period is 3–4 weeks.

Diphyllobothrium latum

Common name: Broad fish tapeworm (Pseudophyllidea).
Size of adult: Up to 15 m in small intestine.
Size of egg: 75 µm × 45 µm.
Importance: Low pathogenicity. Reservoir of the infection for humans.
Diagnosis: Eggs in fecal flotation.
Treatment: Praziquantel, 7.5 mg/kg PO or SC q 24 h × 2 d
Praziquantel, 35 mg/kg PO
Humans: Niclosamide (Yomesan), 2 g PO (once)
Praziquantel, 5–20 mg/kg PO (once)

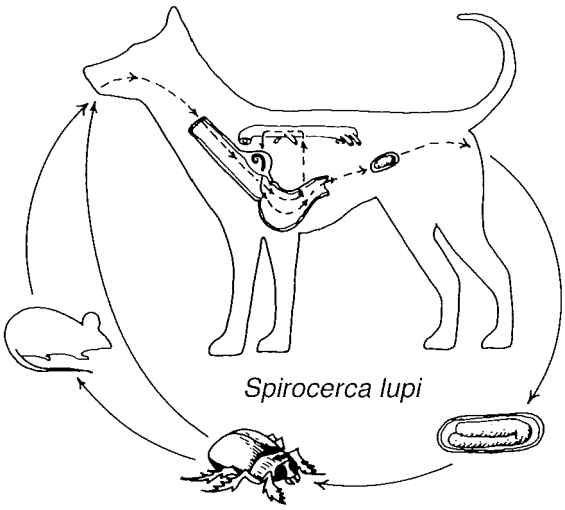


Fig. 37. *Spirocerca lupi* prepatent period is 5–6 months.

Spirocerca lupi (See also Fig. 52k)

Common name: Esophageal worm (Spiruroidea).
Size of adult: 3–8 cm in esophagus and stomach.
Size of egg: 40 µm × 12 µm, larvated.
Importance: May predispose to malignant tumors and dystrophic pulmonary osteoarthropathy.
Diagnosis: Eggs in feces in patent infections.
Treatment: Diethylcarbamazine, 500 mg/kg PO q 24 h × 10 d
Prevention: Do not feed raw chicken to dogs.

Fig. 38. *Thelazia californiensis* prepatent period is 16–20 days.

Thelazia californiensis

Common name: Eyeworm (Spiruroidea).
Size of adult: 10–40 mm in conjunctival sac.
Size of egg: 55 µm × 35 µm.
Importance: May cause conjunctivitis, lacrimation, photophobia.
Diagnosis: Eggs in lachrymal secretions. Parasites can be seen in conjunctival sac.
Treatment: Surgical removal of worms from the conjunctival sac under local anesthesia.
Ivermectin, 0.2 mg/kg SC or IM

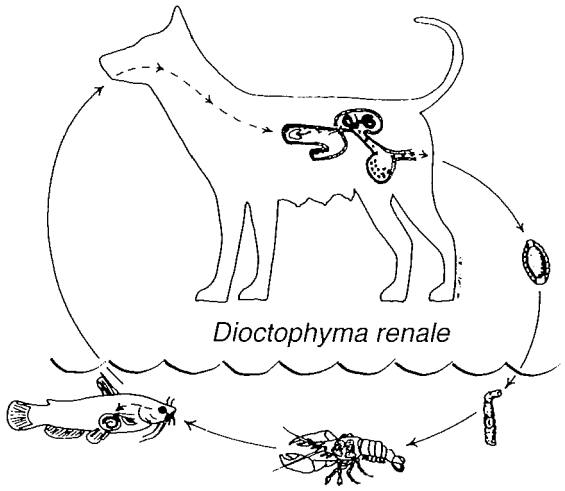


Fig. 39. *Dioctophyma renale* life cycle is up to 2 years.

Dioctophyma renale

Common name: Giant kidneyworm (Dioctophymoidea).
Size of adult: 35–105 cm in kidney.
Size of egg: 65 µm × 42 µm.
Importance: Destroy renal tissue, may cause peritonitis.
Diagnosis: Eggs in urine.
Treatment: Surgical removal.
Prevention: Do not feed raw crayfish or fish (the intermediate hosts).

External Parasites (See also page 48)

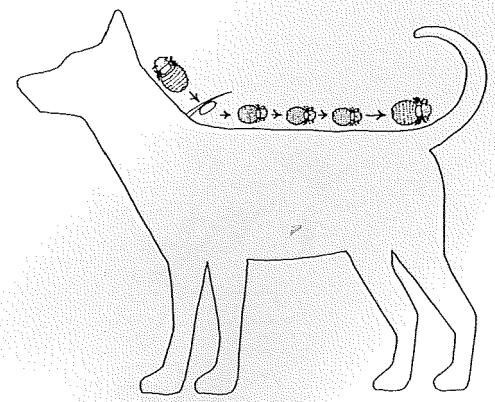


Fig. 40a. Life cycle of *Trichodectes canis.*

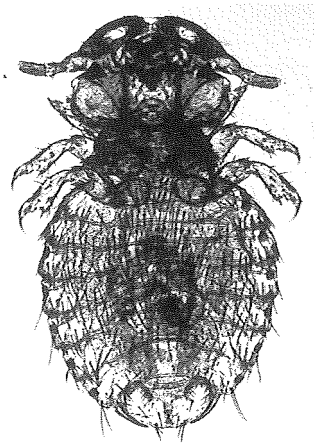


Fig. 40b. *Trichodectes canis.* (See also Fig. 52b.)

Trichodectes canis

Common name: Biting louse of dogs (Mallophaga). Adults, nymphs, eggs in hair. In cats, the biting louse is *Felicola substratus* (uncommon).
Size of adult: 2–4 mm. Life cycle is 3 weeks.
Importance: Cause roughened hair coat, itching, dermatitis. May act as intermediate host of *Dipylidium caninum.*
Diagnosis: Examination of the hair for adults, nymphs, and eggs (nits).
Treatment: Carbaryl, coumaphos, diazinon, dioxathion, fenchlorphos (ronnel), lindane, methoxychlor, rotenone, pyrethrins, pyrethroids: treat twice, 7 days apart.
Note: Many flea control products also kill lice and ticks.

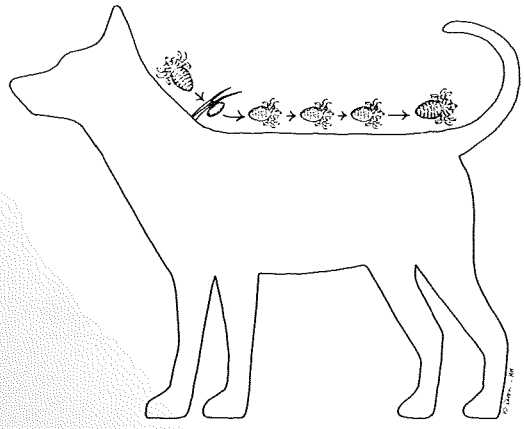


Fig. 41a. Life cycle of *Linognathus setosus.*

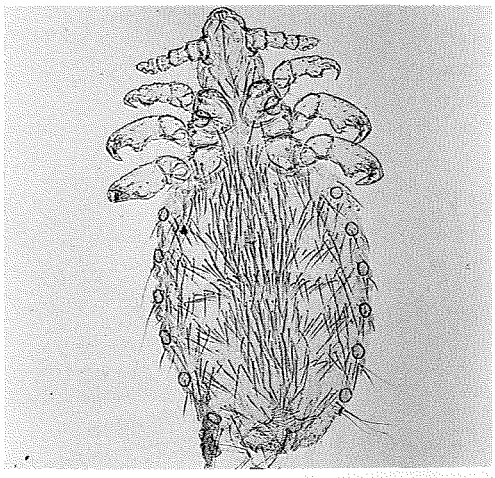


Fig. 41b. *Linognathus setosus.*

Linognathus setosus

Common name: Sucking louse of dogs (Anoplura).
Size of adult: 2–3 mm. Life cycle is 3 weeks.
Importance: Cause skin irritation, itching, dermatitis, alopecia, anemia, roughened hair coat.
Diagnosis: Examine hair for adults, nymphs, eggs (nits).
Treatment: Carbaryl, coumaphos, diazinon, dioxathion, fenchlorphos (ronnel), ivermectin, lindane, methoxychlor, rotenone, pyrethrins, pyrethroids.

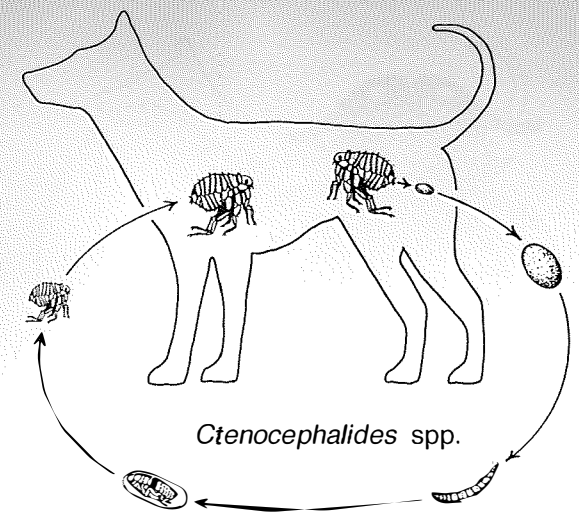


Fig. 42a. Life cycle of *Ctenocephalides canis* and *C. felis.*

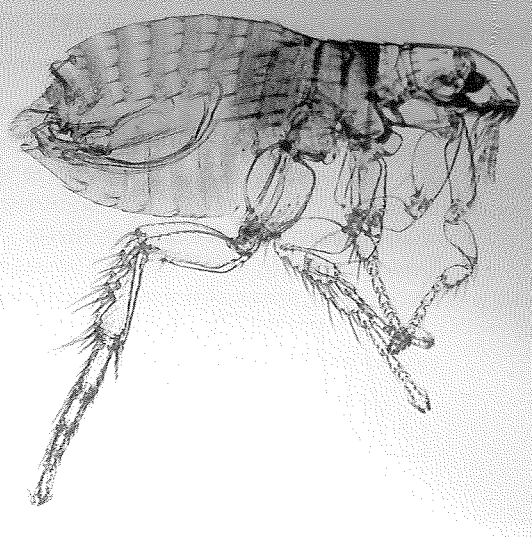


Fig. 42b. *Ctenocephalides felis.*

Ctenocephalides canis

Common name: Flea.
Size of adult: 3–4 mm. Life cycle is variable.
Size of egg: 0.5 mm.
Importance: Infest dogs and cats. Flea bite dermatitis, anemia, vector for *Dipylidium caninum,* tularemia, plague, etc. Adult fleas infest mammals transiently. Eggs, larvae, and pupae are in the environment.
Diagnosis: Examination of skin for adult fleas and "flea dirt", dermatitis.
Treatment: Major drugs used for flea control include fipronil (Frontline®) for adult fleas, ticks, and some mites and lice; imidocloprid (Advantage®) for adult fleas and some lice, but no mites or ticks; nitenpyram (Capstar®) for adult fleas only; and selamectin (Revolution®) for adult fleas, flea eggs, ear mites, sarcoptic mange, and some ticks. Other drugs that can be effective in a flea control program include: carbaryl, chlorfenvinphos, chlorpyrifos, dichlorvos, fipronil, imidocloprid, phosmet, propoxur, pyrethrins, pyrethroids, and insect growth regulators, such as methoprene and lufenuron. Use as sprays, dips, dab ons, collars, etc.
Note: Treat host and environment.
Additional methods for treating the home environment are sodium polyborate (Fleabusters)and nematode larvae (Steinernema carpocapsae).
Note: Fleas die when held below 20∞F for 48 hours or at 120∞F (dry heat) for several days.

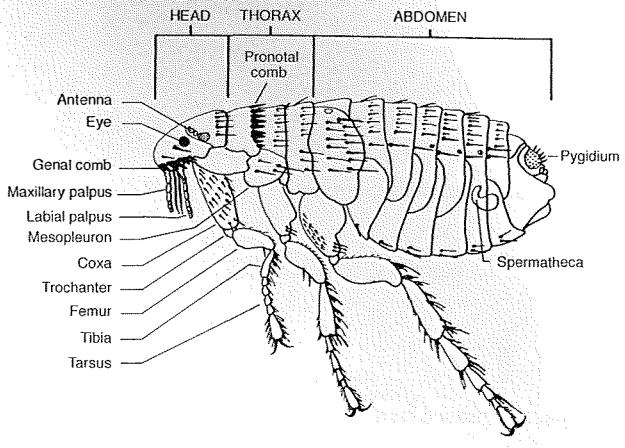


Fig. 43. Basic morphology of a flea.

Table 15. Fleas commonly encountered on animals and birds

Ctenocephalides canis	Dog flea
Ctenocephalides felis	Cat flea
Pulex irritans	Human flea
Echidnophaga gallinacea	Sticktight flea
Xenopsylla cheopis	Oriental rat flea
Cediopsylla simplex	Rabbit flea
Leptopsylla segnis	Mouse flea
Nosopsyllus fasciatus	Northern rat flea
Diamanus montanus	Ground squirrel flea
Orchopeas howardii	Squirrel flea
Ceratophyllus nige	Western hen flea

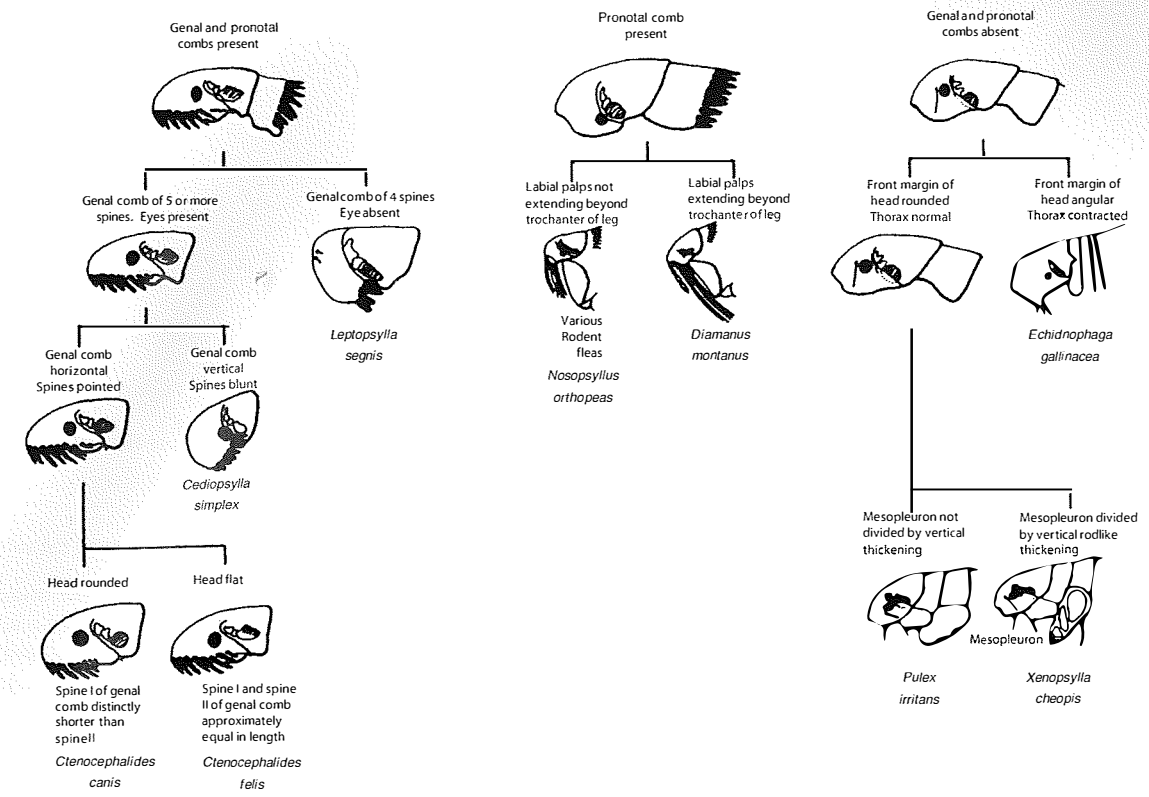


Fig. 44. Simplified key to the common fleas of animals and birds.

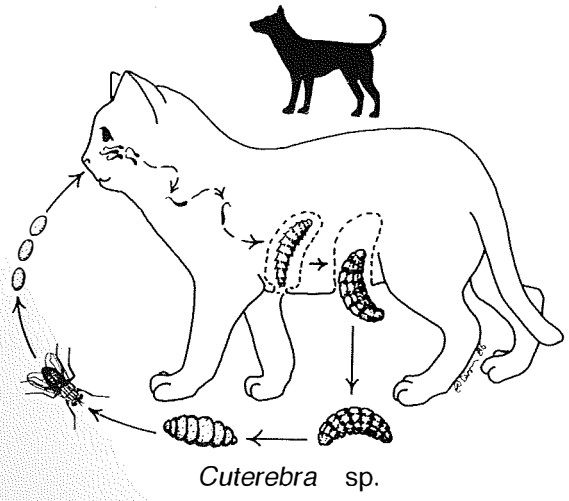


Fig. 45a. Life cycle of *Cuterebra* sp.

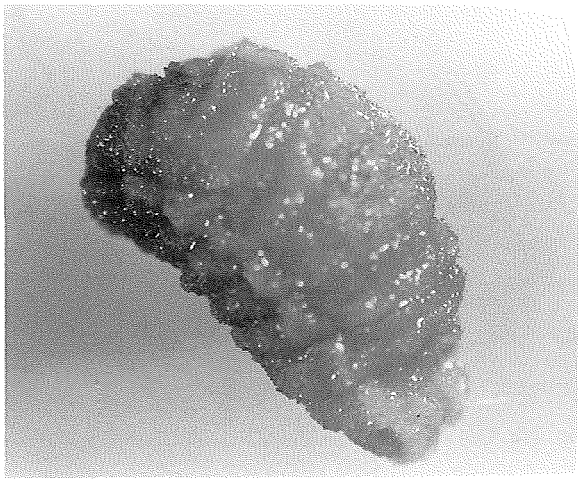


Fig. 45b. *Cuterebra* sp.

Cuterebra spp.

Common name: Rodent bot fly (Diptera).
Size of larvae: Up to 45 mm. Larvae are subcutaneous.
Importance: Infest dogs and cats. Larvae infest rodents, companion animals, and occasionally, humans. Act as an irritant; migration may be fatal. Only larvae infest mammals. Eggs, pupae, and adult flies are in the environment. Rodents are the usual host. Larvae are in host for 1–2 months.
Diagnosis: Cutaneous lump with a breathing hole, large light to dark-red larvae with dark spines.
Treatment: Careful extraction of larvae, antimicrobial treatment of wound.

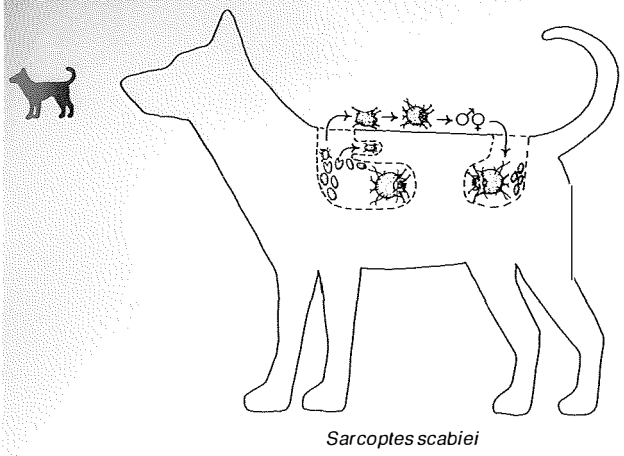


Fig. 46a. Life cycle of *Sarcoptes scabiei* (*canis*). The life cycle is 2–3 weeks.

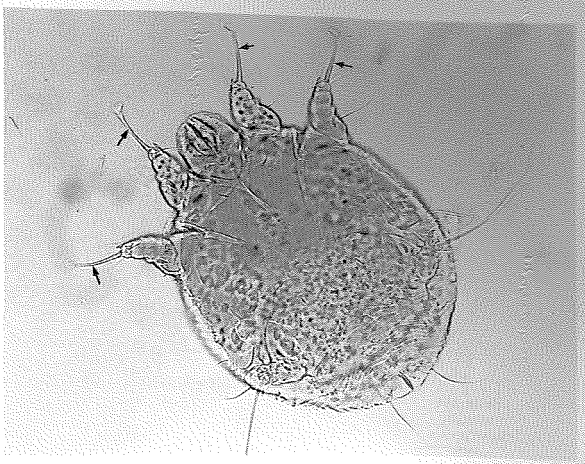


Fig. 46b. *Sarcoptes scabiei* (*canis*). Note the long, unjointed pedicels.

Sarcoptes scabiei

Common name: Mange mite (Sarcoptidae). Rare in cats; cats usually have *Notoedres cati*.
Size of adult: 400–600 µm. Larvae (6 legs) and nymphs (8 legs) are smaller.
Importance: Cause intense itching, dry and thickened skin that becomes crusty. Infestation usually starts on head and spreads.
Diagnosis: Deep skin scraping at periphery of lesions; adults, nymphs, larvae (6 legs), and eggs. The pedicels on the legs are long without joints (see arrows in figure). *Sarcoptes* is often difficult to diagnose. Mites are burrowing mites in skin.
Treatment: Clip hair and bathe.
Amitraz, benzyl benzoate, lime-sulfur, lindane, malathion, phosmet, ivermectin: 0.2 mg/kg PO, selamectin 6–12 mg/kg (topically)
Note: If you suspect *Sarcoptes*, treat for it.

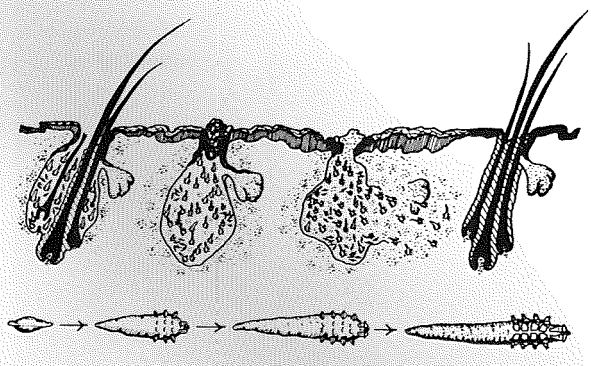


Fig. 47a. Life cycle of *Demodex canis*.

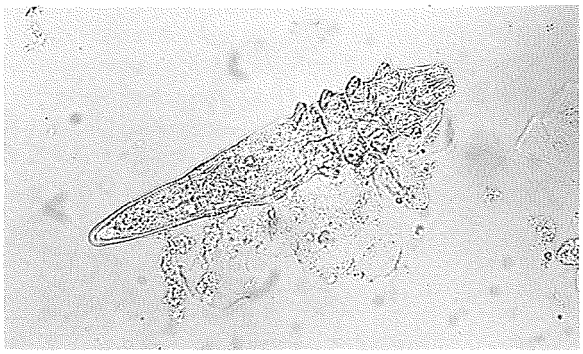


Fig. 47b. *Demodex canis*.

Demodex canis

Common name: Follicular mange mite (Demodecidae). In cats, *Demodex* spp. are rare.
Size of adult: 200–300 µm. Life cycle is approximately 21 days.
Importance: Areas of alopecia on head, neck, and forelimbs; pyoderma, pruritus. Infection may be localized or generalized.
Diagnosis: Deep skin scraping when skin is squeezed. Face and lips are best areas. Mites are in hair follicles and skin glands.
Treatment: Over 90% cure spontaneously.
Amitraz (0.025%) dip every 2 weeks
Rotenone dip (1%)
Experimental: Milbemycin, 2 mg/kg q 24 h for at least 3 months. Ivermectin, up to 0.6 mg/kg q 24 h until resolved. Start at 0.1 mg/kg the first day, 0.2 the second day, etc. Treatments may last for several months.

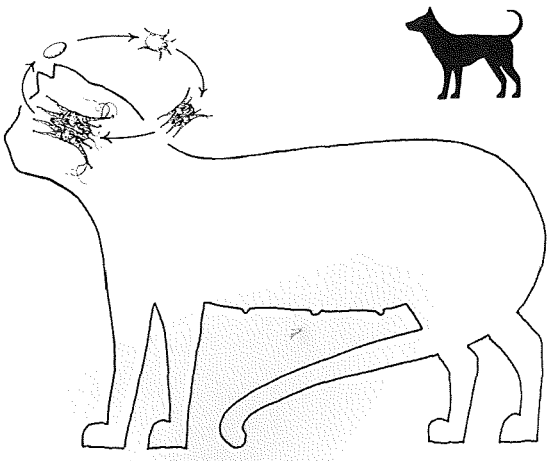


Fig. 48a. Life cycle of *Otodectes cynotis*.

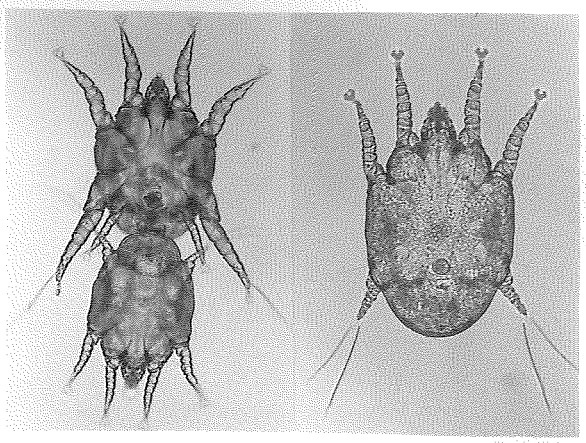


Fig. 48b. *Otodectes cynotis*.

Otodectes cynotis

Common name: Ear mite (Psoroptidae) of dogs and cats.
Size of adult: 500–800 µm. Life cycle is 18–21 days.
Importance: Intense pruritus of ear canal which may be followed by self-mutilation, otitis media, and bacterial infection.
Diagnosis: Viewing mites on otoscopic examination or on an ear swab. Mites can be seen under a dissecting microscope or placed on a slide under a microscope (adults, nymphs, larvae, and eggs). Mites in the ear; occasionally on body.
Treatment: Use a ceruminolytic agent first to remove crusty debris.
Carbaryl, cythioate, pyrethrins, rotenone: use 1 drop per ear weekly for 4 weeks.
Ivermectin, 0.2–0.4 mg/kg PO, SC, or diluted drop in the ear.
Selamectin, topically.

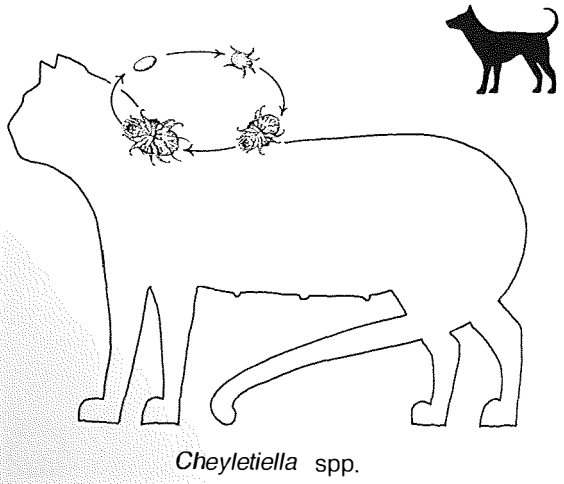


Fig. 49a. Life cycle of *Cheyletiella parasitovorax*.

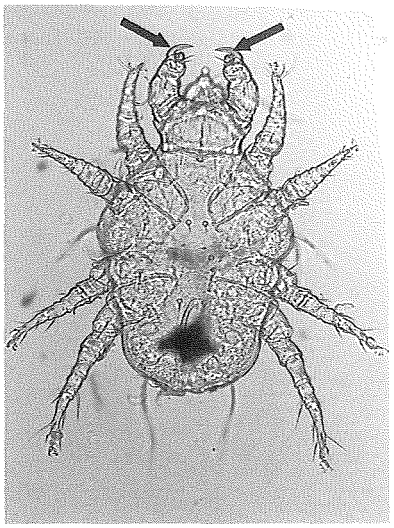


Fig. 49b. *Cheyletiella parasitovorax*.

Cheyletiella spp.

Common name: Fur mite of dogs and cats, walking dander (Cheyletidae). Surface mites. *C. parasitavorax* in rabbits, *C. yasguri* in dogs, *C. blakei* in cats.
Size of adult: 300–500 µm. Life cycle is 18–21 days.
Importance: Mild alopecia and pruritus; many animals asymptomatic; may cause dermatitis in humans.
Diagnosis: Superficial skin scraping, close visual examination of hair coat, rough brushing of animal, and examining dander.
Treatment: Carbaryl, dichlorvos collars, malathion, pyrethrins, pyrethroids. Treat host and environment.
Ivermectin, 0.3 mg/kg twice at 5-week intervals.
Lime sulfur dip for pregnant or debilitated animals (4 oz. per gal H_2O).

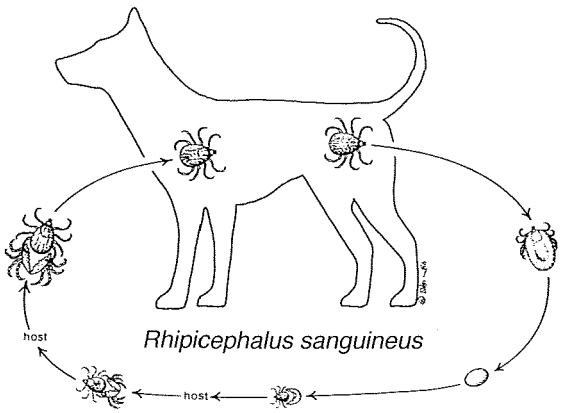


Fig. 50a. Life cycle of *Rhipicephalus sanguineus*.

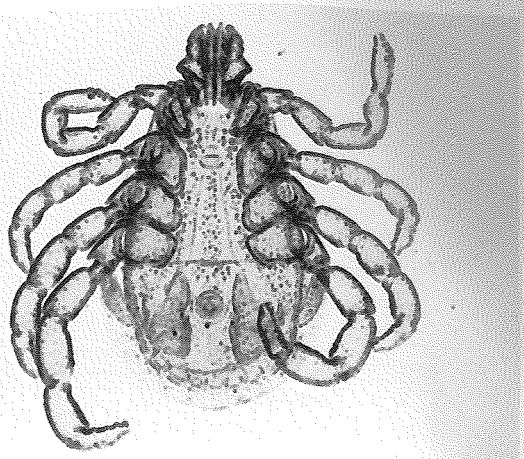


Fig. 50b. *Rhipicephalus sanguineus*.

Rhipicephalus sanguineus

Common name: Brown dog tick (Ixodidae).
Size of adult: 0.7–1.0 cm. Life cycle is 6 weeks to 1 year.
Importance: Irritant, may cause anemia and tick paralysis when present in large numbers. Vector for canine babesiosis and canine erlichiosis. Problem in dog kennels.
Diagnosis: Three-host tick; all motile stages (larva, nymph, adult) can be on the dog or in the environment. Ticks are only on dogs transiently to feed.
Treatment: Fipronil, carbaryl, chlorfenvinphos, dichlorvos, dioxathion, propoxur, pyrethrins, pyrethroids. Treat both the host and environment. Organophosphates, such as diazinon, are often used to treat the outside environment. Selamectin kills *Dermacentor* spp. and may be effective against *R. sanguineus*. Amitraz collars and dips control ticks.

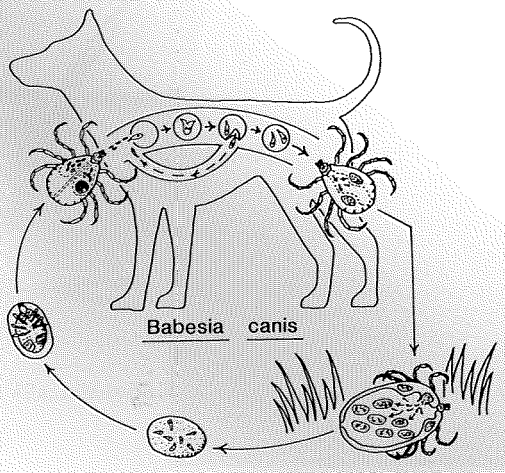


Fig. 51a. Life cycle of *Babesia canis*.

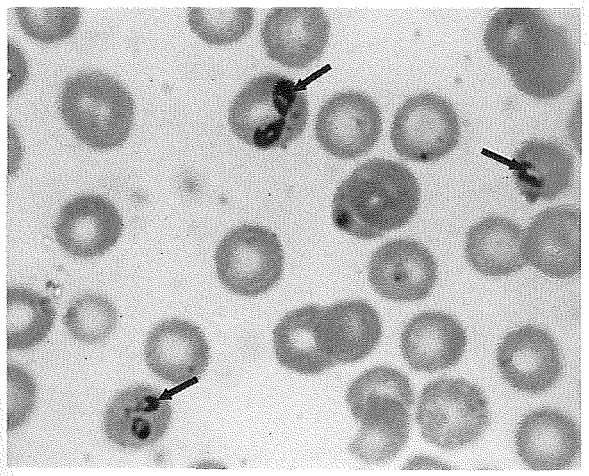


Fig. 51b. *Babesia canis* (arrows).

Babesia canis

Common name: None (Apicomplexa).
Size of organism: 2–4 μm. Incubation period is 10–21 days.
Importance: Hemolytic anemia, depression, anorexia, pyrexia, weight loss.
Diagnosis: Examination of a stained (Wright's stain) blood smear, serology. Trophozoites are in red blood cells of dogs.
Treatment: Diminazene aceturate, 3.5 mg/kg IM
Imidocarb dipropionate, 5 mg/kg once IM
Phenamidine isothionate, 15 mg/kg q 24 h × 2 d SC

Protozoan Parasite

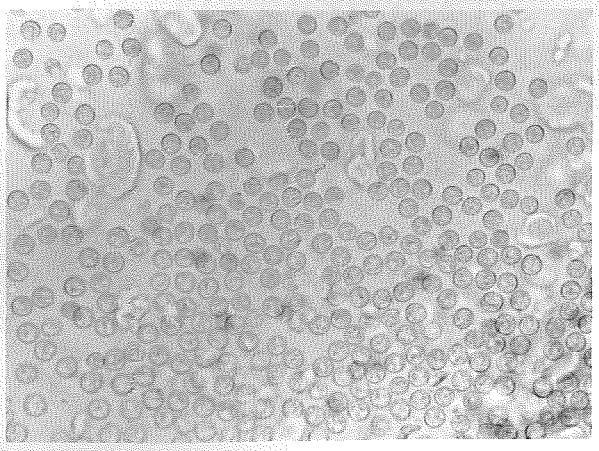


Fig. 51d. *Neospora* sp. oocysts in the feces of a dog. Oocysts are approximately 10 µm in diameter.

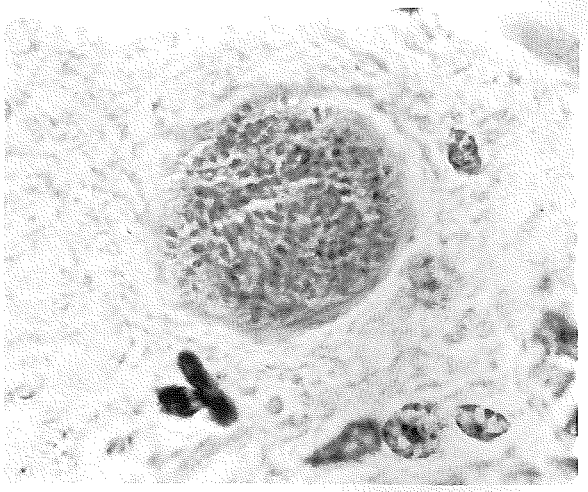


Fig. 51c. *Neospora caninum* pseudocyst in brain.

Neospora caninum

Common name: *Neospora caninum.*
Stages in dogs: Tissue cyst (pseudocyst), tachyzoites, and oocysts.
Size of pseudocyst and oocysts < 100 µm (pseudocyst), 10–11 µm (oocyst).
Importance: Transmitted transplacentally or orally. May cause ascending paralysis and rigid contraction of muscles. Lesions include necrosis, inflammation, encephalomyelitis, hepatitis, myocarditis, myositis, etc.
Diagnosis: Clinical signs and histologically.
Treatment: Drugs for the treatment or prevention of other coccidia may be helpful.
Note: Dogs are definitive hosts. Oocyts in dogs are 10–11 µm and sporulate in 3 days.

Bibliography (see pages 63–68)

Section 4

PARASITES OF CATS

Miscellaneous Parasites

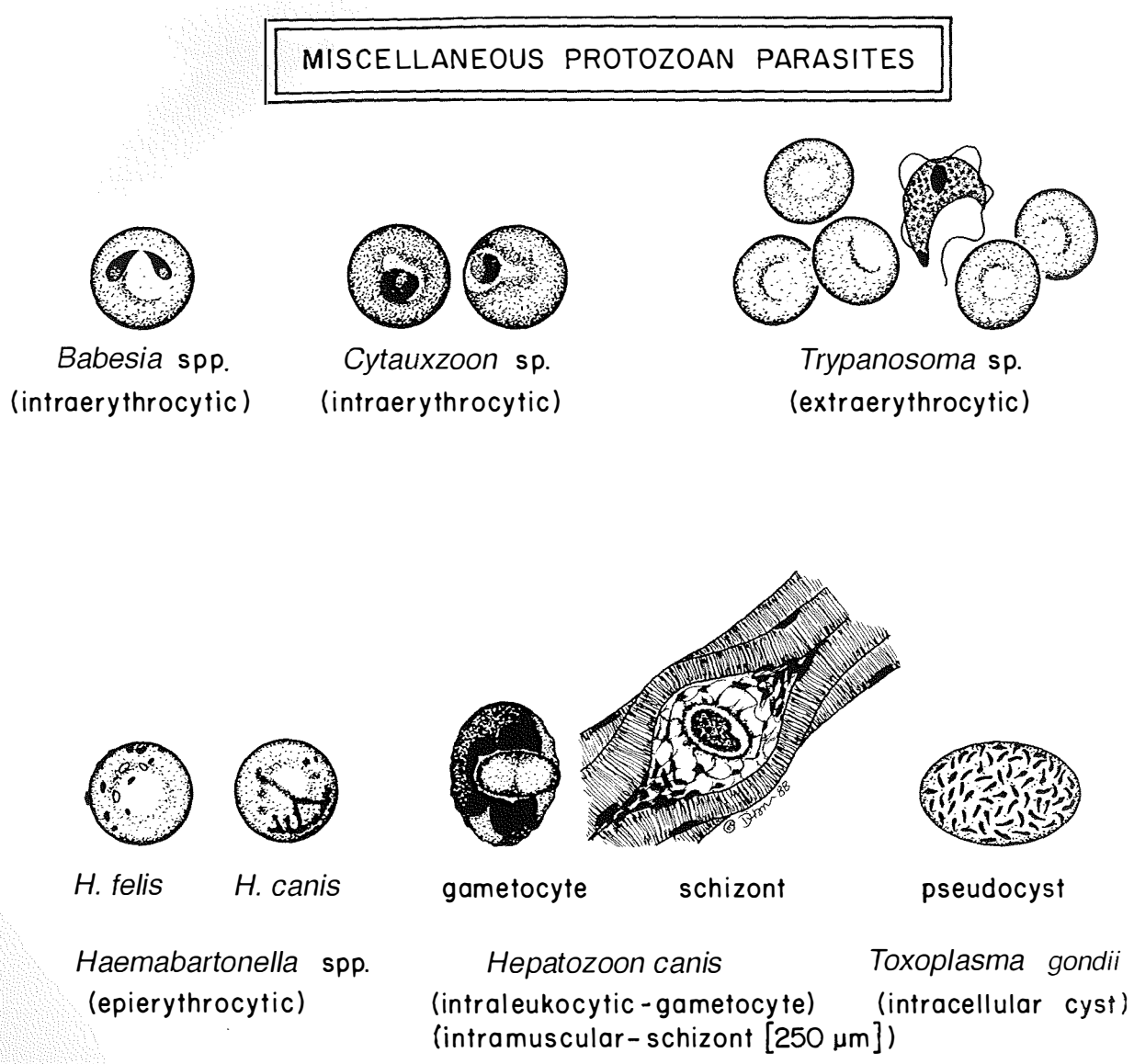


Fig. 52a. Miscellaneous protozoan parasites detected in blood and tissues of dogs and cats. Note: *Haemobartonella* spp. are rickettsiae.

Miscellaneous External Parasites of Cats and Dogs

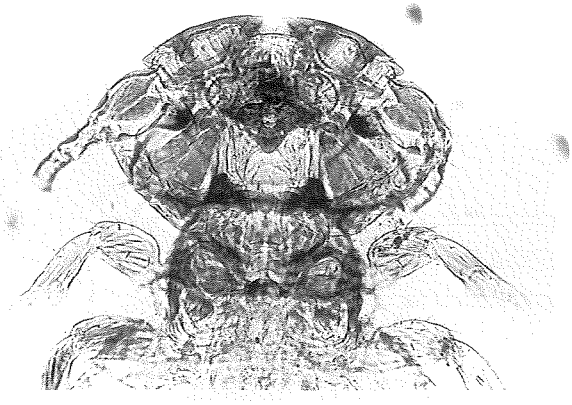


Fig. 52b. Broad head of the dog-biting louse *Trichodectes canis*.

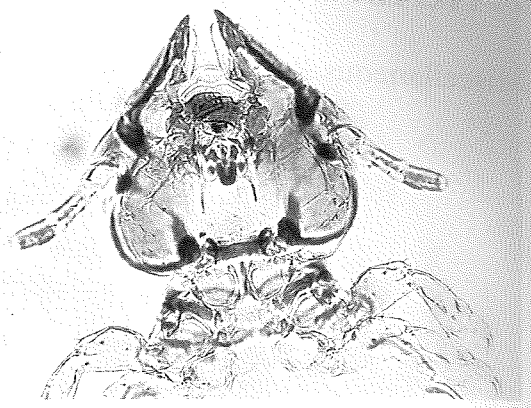


Fig. 52c. Unusual head of the cat-biting louse *Felicola subostratus*.

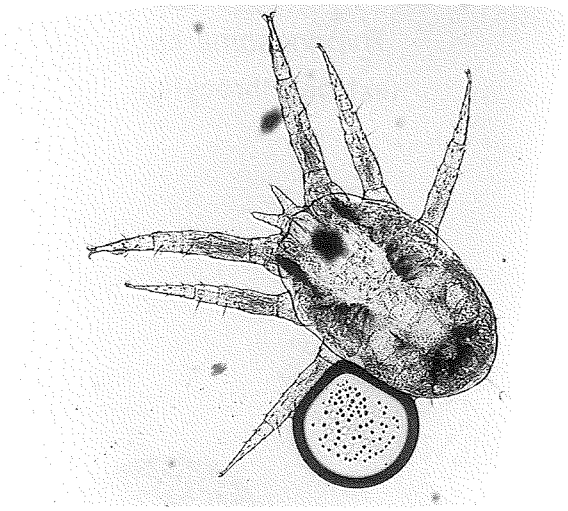


Fig. 52d. *Pneumonyssus caninum*, the nasal mite of dogs.

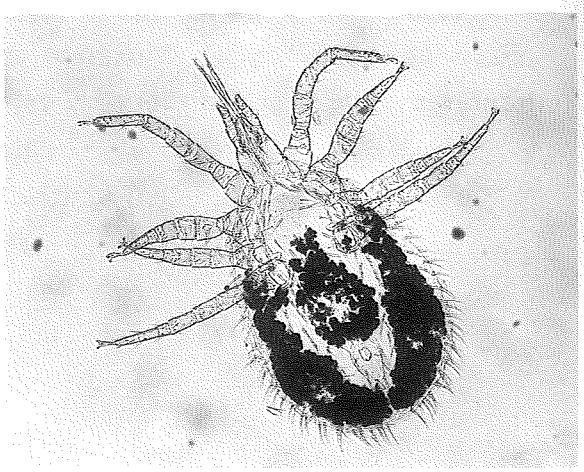


Fig. 52e. *Ornithonyssus* sp., a rodent and bird mite occasionally found on dogs and cats.

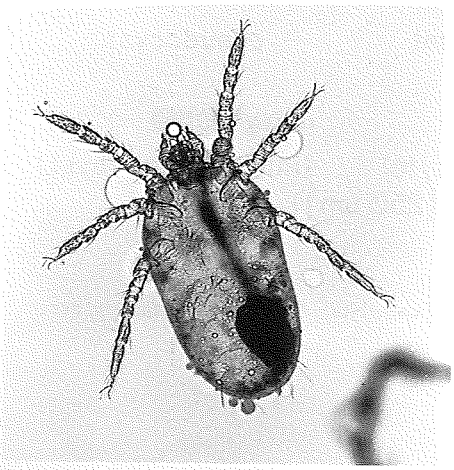


Fig. 52f. Larval chigger sometimes found on dogs and cats.

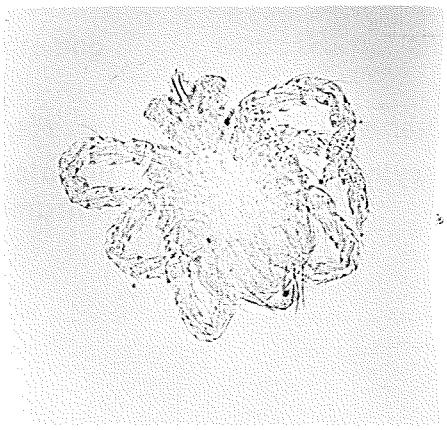


Fig. 52g. Another kind of larval chigger sometimes found on dogs and cats.

Fig. 52h. Adult *Echinococcus granulosus* (Cestoda) (2–3 mm) from the small intestine of a dog or cat.

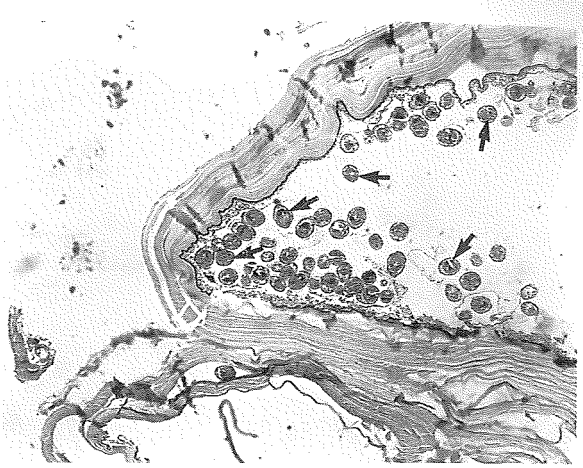


Fig. 52i. A section of a hydatid cyst of *E. granulosus* from a sheep, human, etc. Note the numerous scolices (arrows).

Fig. 52j. Adult *Nanophyetus salmincola* (Trematoda) (1–2 mm) from the small intestine of a dog.

Fig. 52k. Cross sections of *Spirocerca lupi* (Nematoda) from the esophagus of a dog.

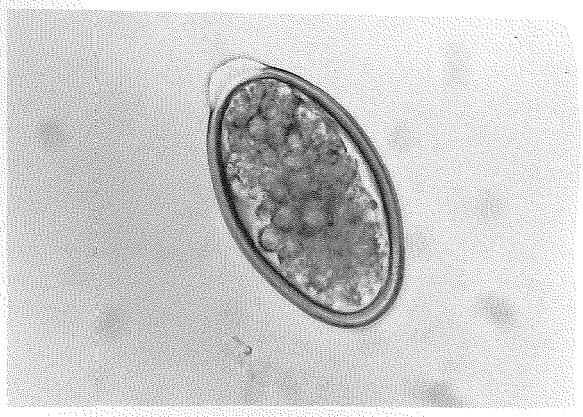


Fig. 52l. *Gnathostoma* sp. (Nematoda) egg from fecal flotation of a cat. Adults are in the stomach of carnivores.

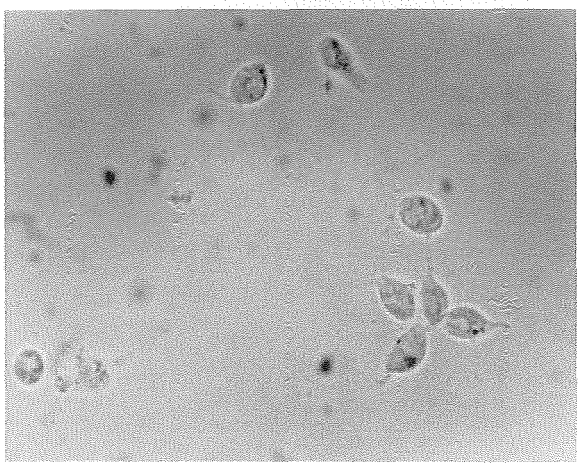


Fig. 52m. *Trichomonas* (*Tritrichomonas*) sp. (flagellated protozoan) from the feces of a dog. Pathogenicity is unknown.

Fecal Eggs and Oocysts

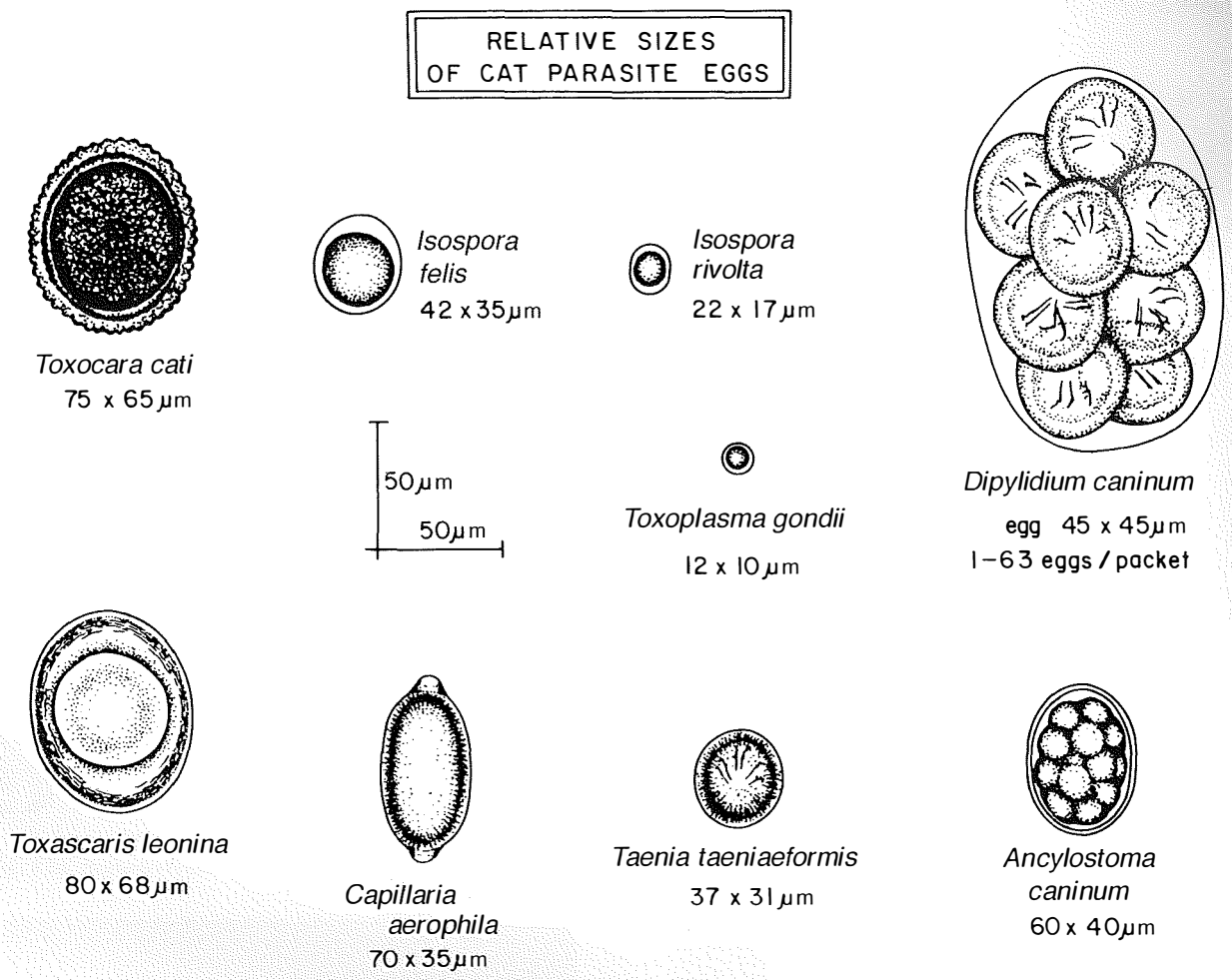


Fig. 53. Common parasite eggs and oocysts found in cat feces.

Location of Major Parasites

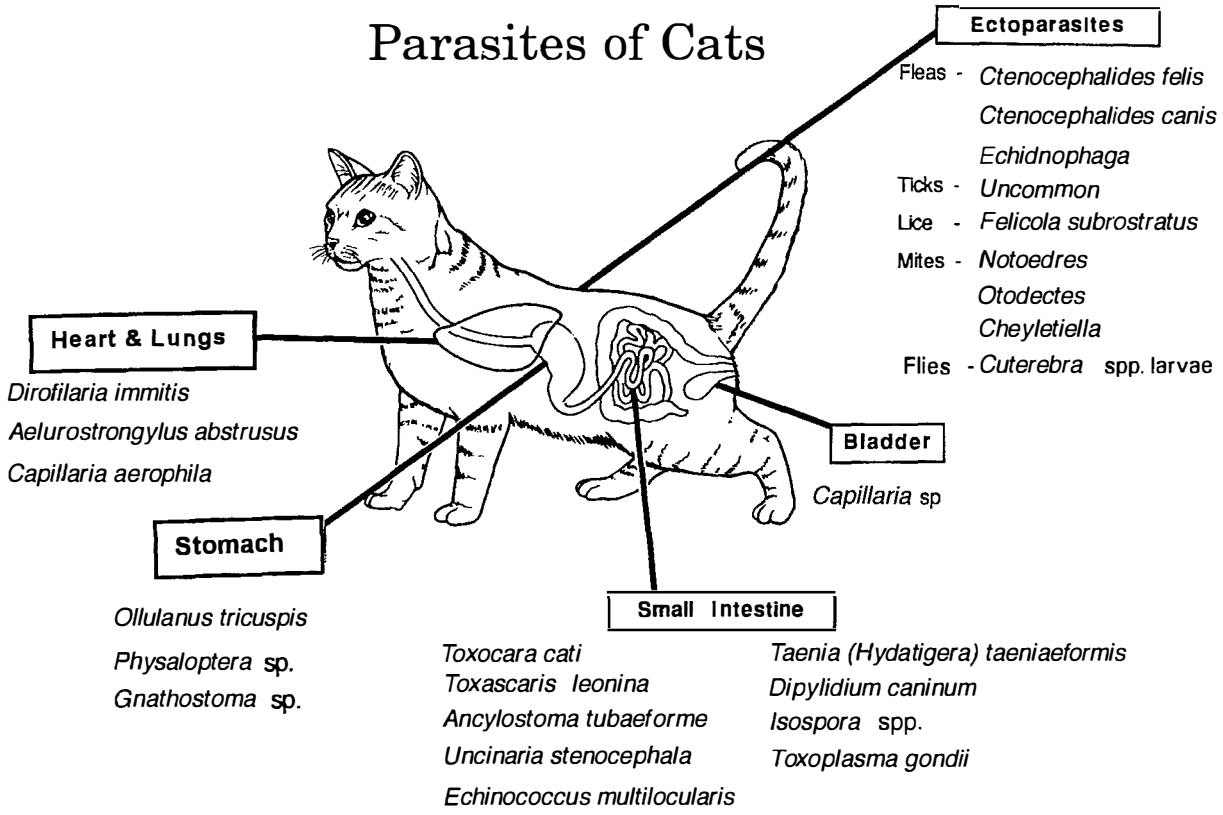
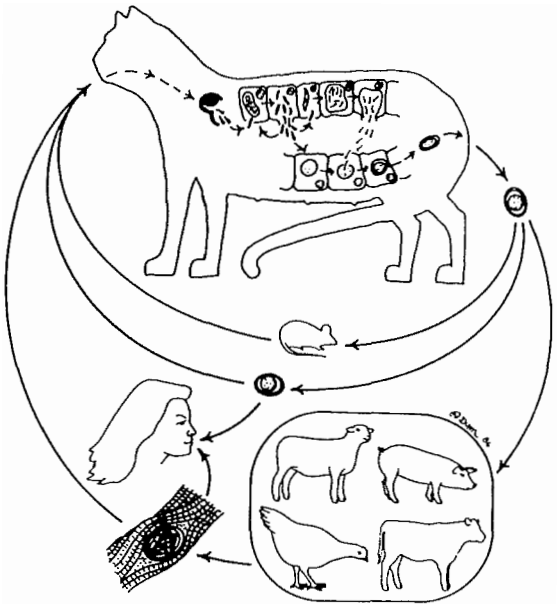


Fig. 54. Locations of the major parasites found in cats. Note: *Trichuris* spp. are very rare in cats. Heartworms are becoming more prevalent in cats (see dogs). *Tritrichomonas foetus* may cause large bowel disease (Levy et al. 2003. *J Parasitol* 89:99-104.)

Zoonotic Diseases

Table 16. Major zoonotic diseases associated with cats

Organism	Disease	Method of Infection
Protozoa		
Toxoplasma gondii	Toxoplasmosis	Ingestion of oocysts
Trypanosoma cruzi	Trypanosomiasis	Arthropod vector
Nematodes		
Ancylostoma spp.	Cutaneous larva migrans	Contact with larvae
Dirofilaria immitis	Dirofilariasis	Mosquito vector
Lagocheilascaris minor	Lagocheilascariasis	Ingestion of larvated eggs
Strongyloides spp.	Cutaneous larva migrans	Contact with larvae
Gnathostoma spinigerum	Visceral larva migrans	Ingestion of larvated eggs
Toxocara cati	Visceral larva migrans	Ingestion of larvated eggs
Trematodes		
Paragonimus spp.	Paragonimiasis	Ingestion of metacercariae
Cestodes		
Dipylidium caninum	Dipylidiasis	Ingestion of cysticercoid from fleas
Echinococcus multilocularis	Echinococcosis	Ingestion of eggs
Pseudophyllidian tapeworms	Sparganosis	Ingestion or contact with larvae
Arthropods		
Cheyletiella spp.	Acariasis	Contact with infected cat
Sarcoptes scabiei	Acariasis	Contact with infected cat
Notoedres cati	Acariasis	Contact with infected cat



Toxoplasma sp.

Fig. 55a. Life cycle of *Toxoplasma gondii*.

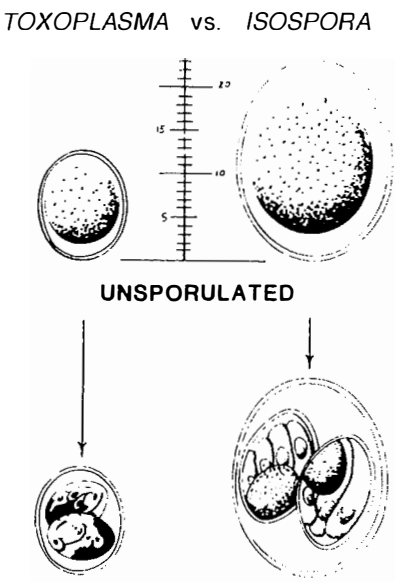


Fig. 55b. Comparison of *Toxoplasma* with *Isospora* oocysts.

Drugs

Table 17. Efficacy of anthelmintics against major internal parasites of cats and dogs

Drug	Common Trade Name	Dose (mg/kg PO)	Parasites Susceptible
Bunamidine HCL	Scolaban	25–50	Cestodes
Dichlorophene	Various	220	Cestodes
Dichlorvos	Task	5–33	Ascarids, hookworms, whipworms
Diethylcarbamazine	Caricide/Filaribits	3.0–6.6 daily	Heartworm prevention (L4)
		25–100	Ascarids
Disophenol	Various/DNP	7.5–10 (2nd dose in two weeks)	Hookworms
Dithiazanine	Dizan	20 q 24 h × 3–13 d	Miscellaneous nematodes, heartworm microfilariae
Epsiprantel	Cestex	5.5 (dogs) 2.8 (cats)	Tapeworms
		q 24 h × 3 d (dogs & cats)	Tapeworms
Febantel + praziquantel + pyrantel pamoate	Drontal Plus	Combination product	Ascarids, hookworms, whipworms, tapeworms
Fenbendazole	Panacur	50 q 24 h × 3 d	Ascarids, hookworms, *Giardia*, whipworms, *Taenia* spp tapeworms
Ivermectin	Ivomec	0.2 SC	Whipworm, many other nematodes
	Ivomec	0.05	Heartworm microfilariae
	Heartgard	0.006 (30-day intervals)	Heartworm prevention
Mebendazole	Telmintic	20 q 24 h × 3–20 d	Ascarids, hookworms, whipworms
Melarsomine	Immidicide	2.5 mg/kg IM, twice, 24 hours apart	Adult heartworms
Methylbenzene + dichlorophene	Various	200–275 mg/kg of each PO	Ascarids, hookworms, cestodes
Metronidazole	Flagyl	25 q 12 h x 5 d (dog)	*Giardia*
	10–25 q 12 h × 5 d (cat)		
Milbemycin oxime	Interceptor	0.5 (30-day intervals)	Heartworm preventative, hookworms
Niclosamide	Yomesan	100 (dog), 200 (cat)	Cestodes
n-butyl chloride is often mixed with toluene	Various	Read the label	Ascarids/hookworms
Piperazine	Various	100–250 (2nd dose after 10 days), or 100–150 q 24 h × 2 d	Ascarids
Praziquantel	Droncit	5–50	Cestodes
Praziquantal + pyrantel	Drontal	Combination product	Cestodes, ascarids, hookworms
Pyrantel pamoate	Nemex	15 (dog), 20–30 (cat)	Ascarids, hookworms
Selamectin	Revolution	6–12 (topical)	Heartworm prevention, hookworms, ascarids (cats), many arthrodpods
Thenium closylate + piperazine	Various	500 q 24 h × 1 d	Hookworms, ascarids
		250 q 24 h × 2 d	

Note: Read label directions carefully. The label is the most authoritative source of information (See Courtney and Sundlof, 1991).

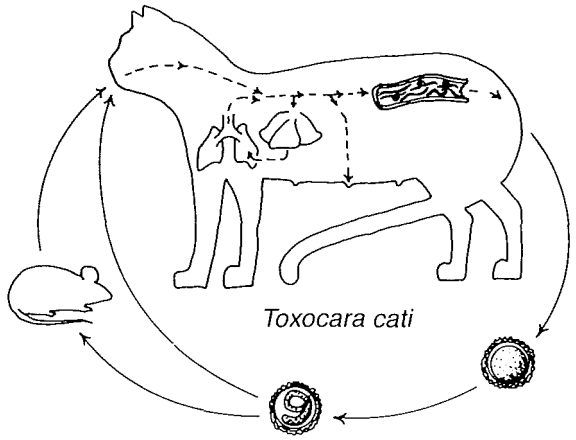


Fig. 56a. *Toxocara cati* prepatent period is 50 days.

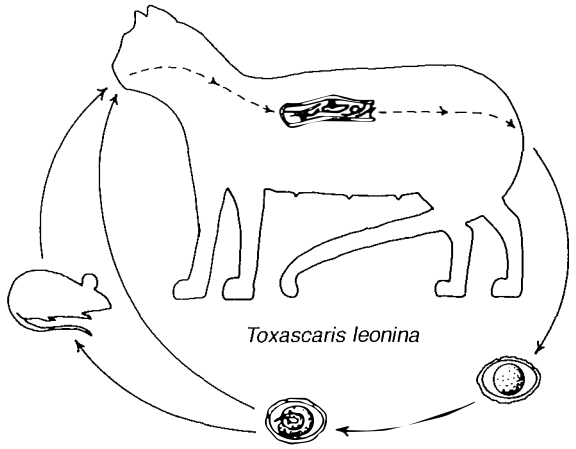


Fig. 57a. *Toxascaris leonina* prepatent period is 74 days.

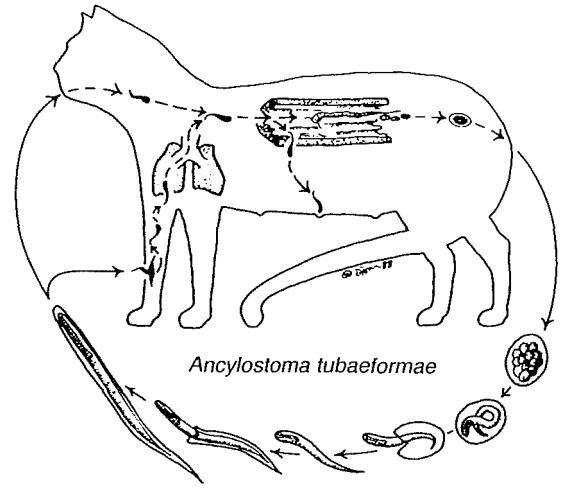


Fig. 58a. *Ancylostoma tubaeformae* prepatent period is 22–25 days.

Internal Parasites

Toxocara cati

Common name: Ascarid or roundworm (Ascaridoidea).
Adult size: 4–12 cm in small intestine.
Size of egg: 75 µm × 65 µm.
Importance: Stunted growth, damage due to migrations of larvae; possible cause of visceral larval migrans in humans.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat when eggs are detected.
Dichlorvos, 100 mg/kg PO
Fenbendazole, 50 mg/kg PO q 24 h × 3 d
Mebendazole, 22 mg/kg PO q 24 h × 5 d
Piperazine, 100–200 mg/kg PO, repeat in 10 days
Pyrantel, 10–20 mg/kg PO
Selamectin, 7–13 mg/kg topically

Toxascaris leonina

Common Name: Ascarid or roundworm (Ascaridoidea).
Adult size: 3–10 cm in small intestine.
Size of egg: 80 µm × 70 µm.
Importance: Unthriftiness in kittens.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat when eggs are detected.
Dichlorvos, 100 mg/kg PO
Fenbendazole, 50 mg/kg PO q 24 h × 3 d
Mebendazole, 22 mg/kg PO q 24 h × 5 d
Piperazine, 100–200 mg/kg PO, repeat in 10 days.
Pyrantel, 10–20 mg/kg PO

Ancylostoma tubaeformae

Common name: Hookworm (Strongyloidea).
Adult size: 9–15 mm in small intestine.
Size of egg: 60 µm × 40 µm.
Importance: Interdigital dermatitis, pulmonary lesions in heavy infestations, anemia, and poor hair coat.
Diagnosis: Eggs in fecal flotation.
Treatment: Treat when eggs are detected.
Dichlorvos, 11 mg/kg PO
Fenbendazole, 100 mg/kg PO or 50 mg/kg q 24 h × 3 d
Mebendazole, 25 mg/kg PO q 24 h × 3–5 d
Pyrantel, 20–30 mg/kg PO
Selamectin, 7–13 mg/kg topically
Thenium closylate, 100–200 mg/kg PO
Toluene, 0.22 mg/kg PO

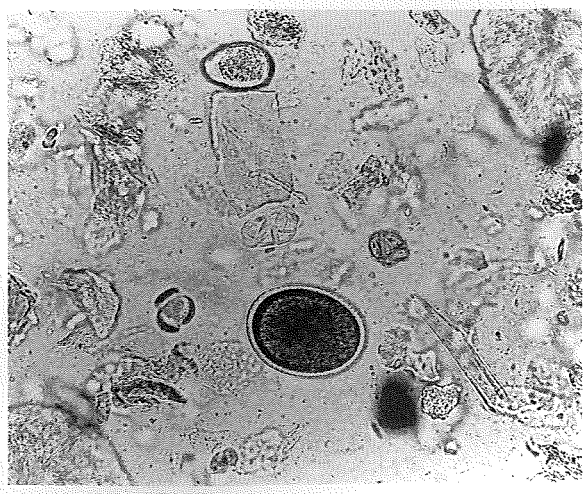


Fig. 56b. *Toxocara cati.*

Fig. 56c. *Toxocara cati.*

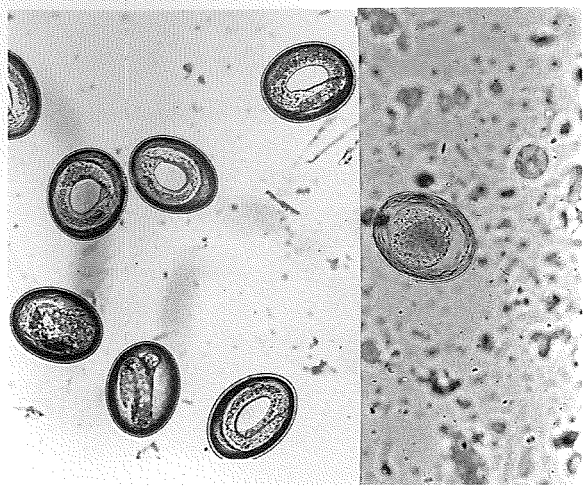


Fig. 57b. *Toxascaris leonina.* Larvated eggs (left), normal egg (right).

Fig. 57c. *Toxascaris leonina.*

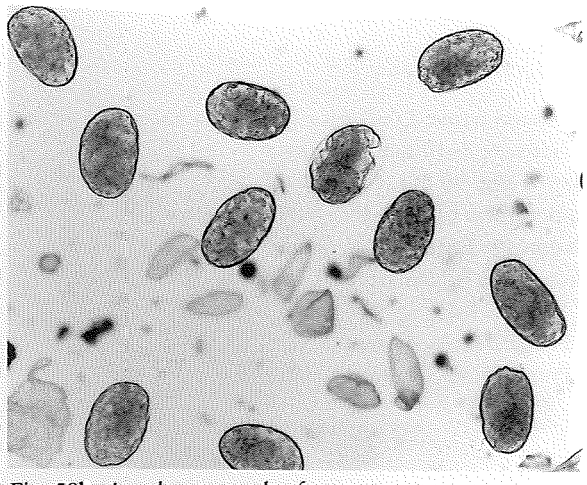


Fig. 58b. *Ancylostoma tubaeformae.*

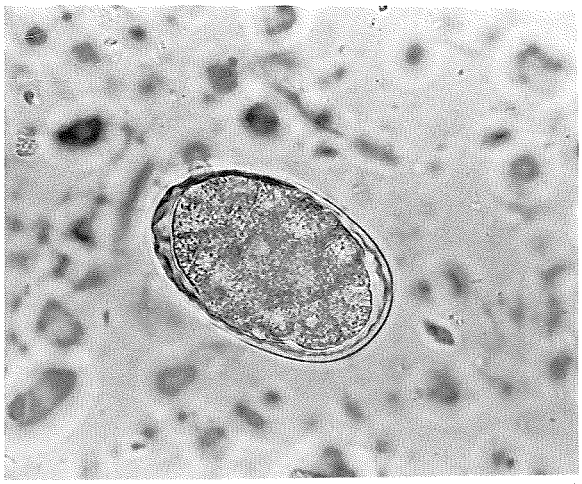


Fig. 58c. *Ancylostoma tubaeformae.*

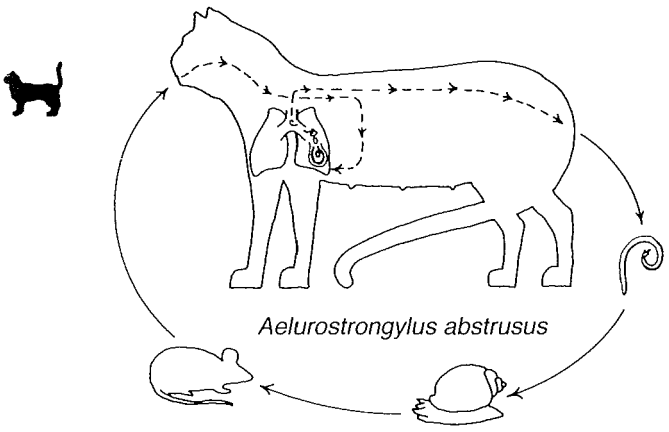


Fig. 59a. *Aelurostrongylus abstrusus* prepatent period is 5–6 weeks.

Aelurostrongylus abstrusus

Common name: Cat lungworm (Metastrongyloidea).
Adult size: 14–15 mm in lungs.
Importance: Chronic cough and weight loss, pulmonary consolidation; may be fatal.
Diagnosis: Larvae in fecal flotation, eggs or larvae in sputum.
Treatment: Fenbendazole, 20–50 mg/kg PO q 24 h × 10 d
Ivermectin, 0.2 mg/kg SC q 24 h × 3 d or PO q 24 h × 5 d
Levamisole, 40 mg/kg PO q 48 h × 6 d

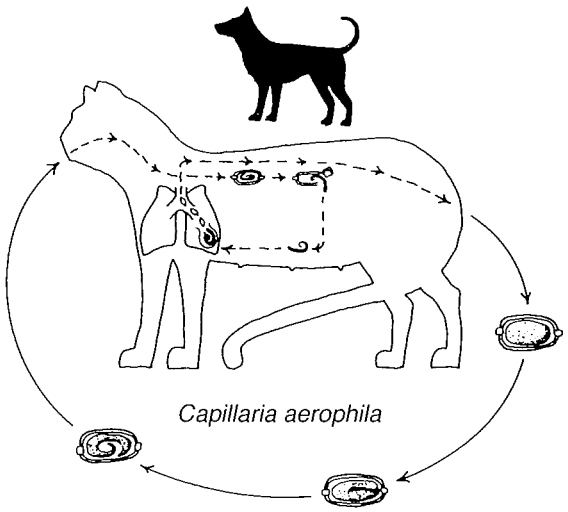


Fig. 60a. *Capillaria aerophila* prepatent period is 40 days.

Capillaria (Eucoleus) aerophila

Common name: Cat lungworm or bladderworm (Trichuroidea).
Adult size: 13–25 mm in lung (*C. aerophila*), *C. plica* in bladder. *C. (Anchotheca) putorii* in stomach.
Size of egg: 60 µm × 30 µm.
Importance: Relatively nonpathogenic; may cause coughing (*C. aerophila*).
Diagnosis: Eggs in fecal flotation in urine sediment or from bronchial swab.
Treatment: Fenbendazole, 100 mg/kg PO or 50 mg/kg q 24 h × 10 d

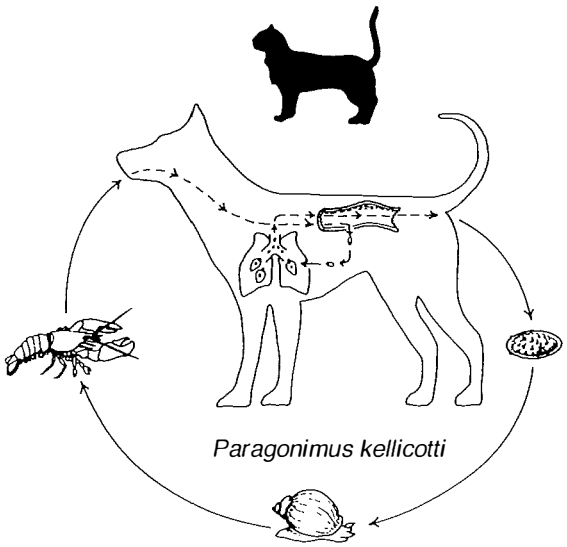


Fig. 61a. *Paragonimus kellicotti* prepatent period is 5–6 weeks.

Paragonimus kellicotti

Common name: Lung fluke (Troglotrematidae).
Adult size: 8–10 mm in lungs.
Size of egg: 90 µm × 50 µm.
Importance: Chronic respiratory diseases.
Diagnosis: Eggs in fecal flotation, sputum smear.
Treatment: Albendazole, 50–100 mg/kg PO q 24 h × 14–21 d
Fenbendazole, 50 mg/kg PO q 24 h × 10–14 d
Praziquantel, 25 mg/kg PO q 24 h × 3 d

Fig. 59b. *Aelurostrongylus abstrusus.*

Fig. 59c. *Aelurostrongylus abstrusus.* Close up of the characteristic kinky tail (arrow).

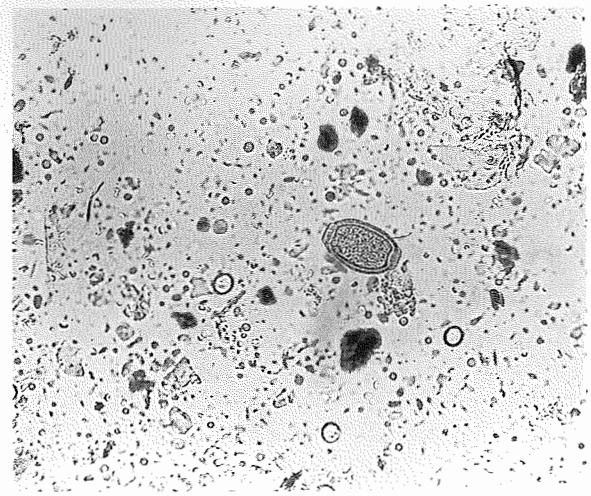


Fig. 60b. *Capillaria aerophila.*

Fig. 60c. *Capillaria aerophila.*

Fig. 61b. *Paragonimus kellicotti.*

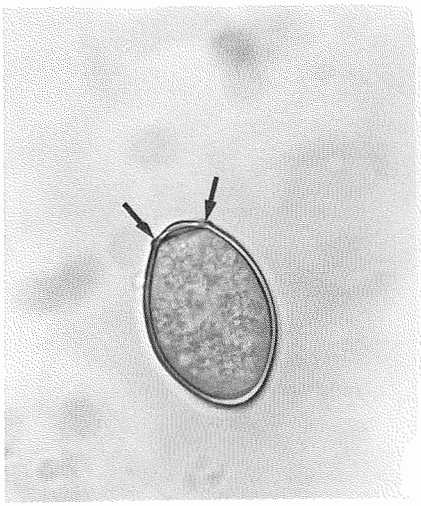


Fig. 61c. *Paragonimus kellicotti.* Note prominent operculum (arrows).

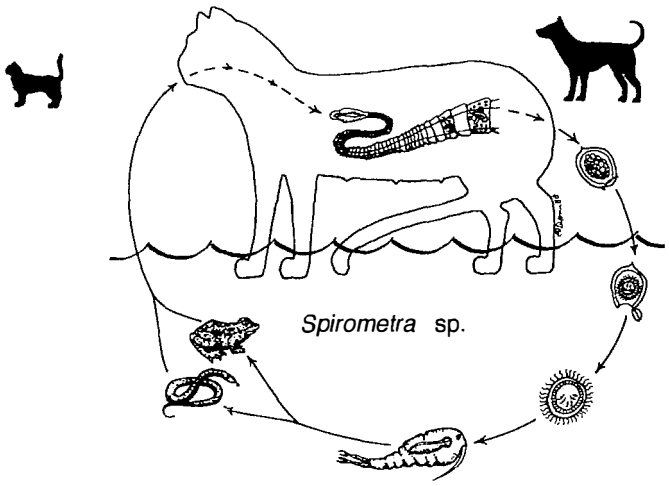


Fig. 62a. *Spirometra* sp. prepatent period is 10–30 days.

Spirometra sp.

Common name: Tapeworm (Taeniidae).
Adult size: 7–100 cm in small intestine.
Size of egg: 70 µm × 35 µm.
Importance: May cause diarrhea, secondary anemia, and sparganosis.
Diagnosis: Eggs in fecal flotation, segments in feces.
Treatment: Bunamidine, 25–50 mg/kg (600 mg maximum)
Praziquantel, 20–40 mg/kg PO or SC

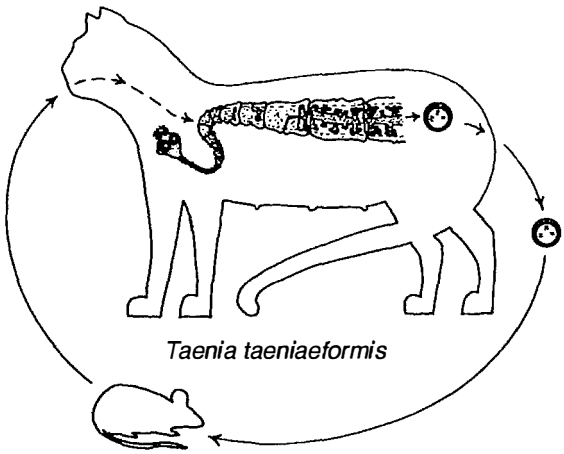


Fig. 63a. *Taenia taeniaeformis* prepatent period is 36–42 days.

Taenia taeniaeformis

Common name: Tapeworm (Taeniidae).
Adult size: 15–60 cm in small intestine.
Size of egg: 50 µm × 50 µm.
Importance: Heavy infection can cause diarrhea or intestinal obstruction.
Diagnosis: Segments (proglottids) in feces or on hairs in perianal region, eggs in fecal flotation, single genital pore per proglottid.
Treatment: Bunamidine, 25–50 mg/kg PO or SC, Epsiprantel, 2.8 mg/kg PO; Fenbendazole, 50 mg/kg PO q 24 h × 3 d; Mebendazole, 22 mg/kg PO q 24 h 3–5 d; Niclosamide, 157 mg/kg PO; Praziquantel, 2.5–5 mg/kg PO or SC

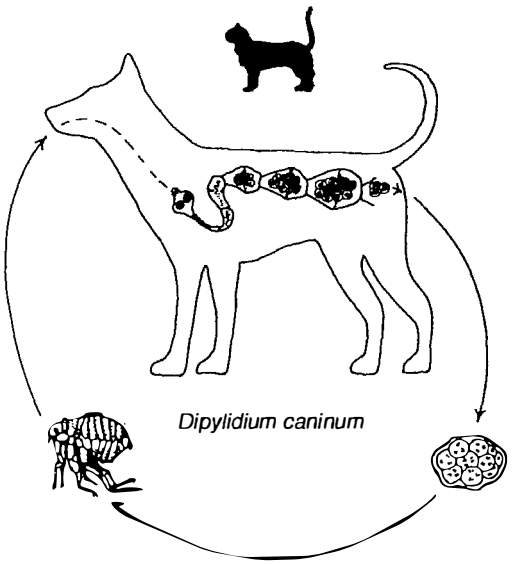


Fig. 64a. *Dipylidium caninum* prepatent period is 1 month.

Dipylidium caninum

Common name: Flea tapeworm (Dilepididae).
Adult: In small intestine.
Size of egg: 25 µm × 30 µm in oblong packets of 20 or fewer eggs. Egg packets are 200 × 150 µm.
Importance: Indicates the presence of fleas. Chronic enteritis, anal pruritus, vomiting, or nervous disorders may result.
Diagnosis: Segments on feces or perianal region, eggs in fecal flotation, two genital pores per proglottid.
Treatment: Bunamidine, 25–50 mg/kg PO; Dichlorophene, 220 mg/kg PO; Epsiprantel, 2.8 mg/kg PO; Fenbendazole, 50 mg/kg PO q 24 h × 3 d; Niclosamide, 157 mg/kg PO; Praziquantel, 2.5–5 mg/kg PO or SC

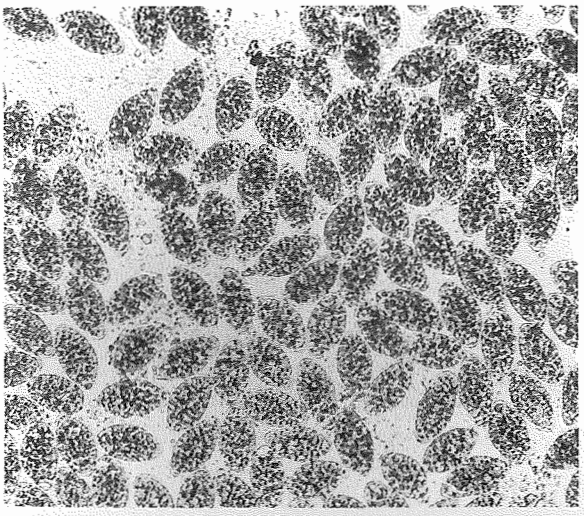


Fig. 62b. *Spirometra* sp.

Fig. 62c. *Spirometra* sp.

Fig. 63b. *Taenia taeniaeformis.*

Fig. 63c. *Taenia taeniaeformis.*

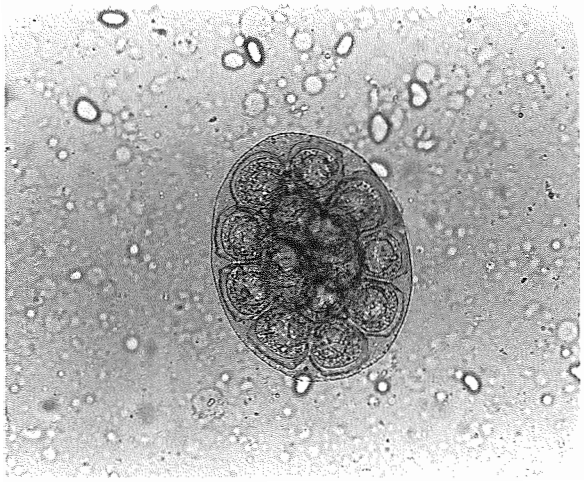


Fig. 64b. *Dipylidium caninum.*

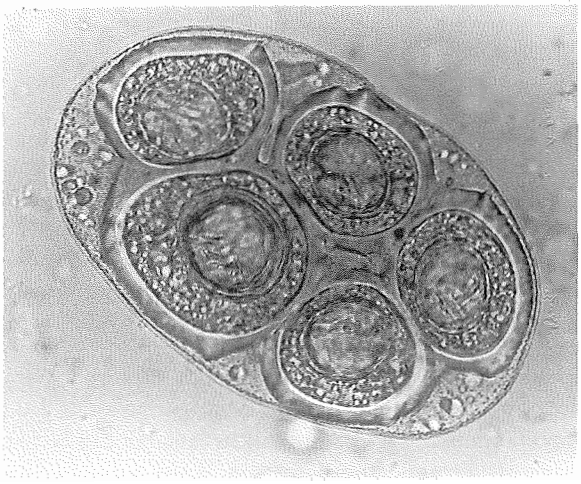


Fig. 64c. *Dipylidium caninum.*

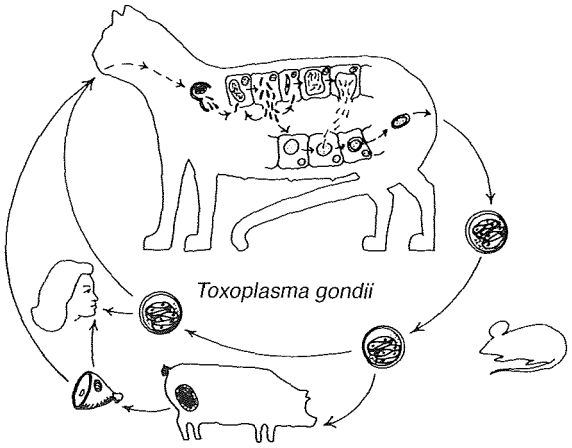


Fig. 65a. *Toxoplasma gondii.*

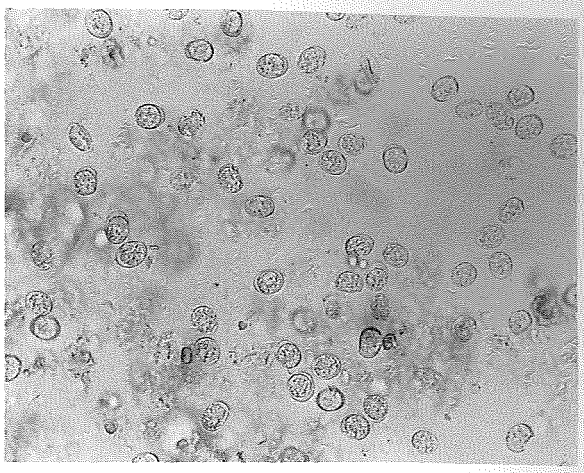


Fig. 65b. *Toxoplasma gondii* oocysts.

Toxoplasma gondii

Common name: Toxo (Apicomplexa), a protozoan parasite.
Size of oocyst: 12.5 µm × 11 µm in small intestine. Prepatent period is 3–10 days when tissue cysts are ingested and 18–44 days when oocysts are ingested.
Importance: May cause transient diarrhea in cats; highly pathogenic to humans, especially the fetus in utero (first two trimesters); pathogenic to other animals.
Diagnosis: Oocysts in fecal flotation, pseudocysts in tissues. Pseudocyst in dogs is similar to *Neospora caninum* (see Dubey and Lindsay, 1993). Note: Only cats (Felidae) shed oocysts in feces.
Treatment: Sulfadiazine, 15–60 mg/kg day divided into 4 doses and pyrimethamine 1 mg/kg q 24 h × 3 d, then 0.5 mg/kg q 24 h until oocyst shedding stops.
Clindamycin, PO 8–17 mg/kg for 2 weeks.
Prevention: Heat all meat to 160°F (70°C) to kill the cysts in the meat. Freezing is not a reliable method to kill tissue cysts.

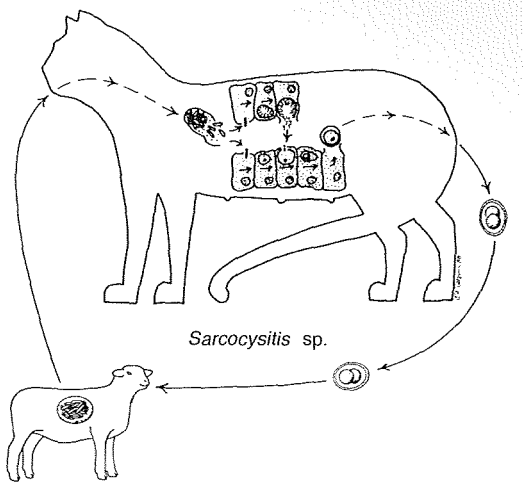


Fig. 66a. *Sarcocystis* sp.

Fig. 66b. *Sarcocystis* sp. oocyst and sporocyst. Note: A sporocyst is one-half of the oocyst.

Sarcocystis sp.

Common name: None (Apicomplexa), a protozoan parasite.
Size of oocyst: 18 µm × 15 µm. Prepatent period is 8–33 days.
Importance: Not very pathogenic in cats, but can be pathogenic in sheep.
Diagnosis: Fecal flotation—see sporulated oocysts or sporocysts. Sporulated oocysts passed in cat feces. Sheep are intermediate hosts for *S. ovifelis.* Pseudocyst (schizont, sarcocyst) in sheep muscles, especially esophagus.
Treatment: None needed.
Prevention: Do not feed cats raw meat.

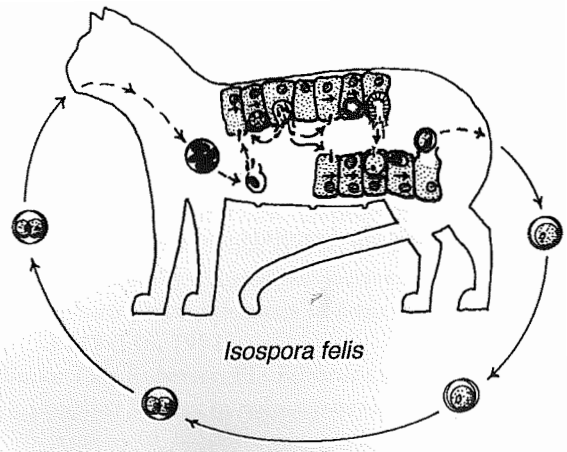


Fig. 67a. *Isospora* spp.

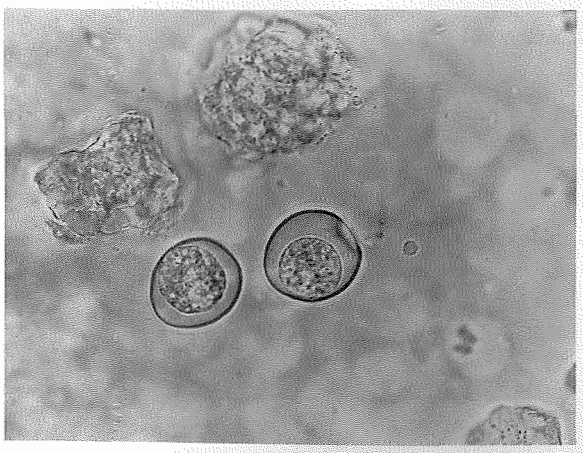


Fig. 67b. *Isospora felis* oocysts.

Isospora spp.

Common name: Coccidia (Apicomplexa), a protozoan parasite.
Size of oocyst: Oocysts in small intestine. *I. bigemina*, 13 μm × 10 μm; *I. felis*, 42 μm × 31 μm; *I. rivolta*, 23 μm × 19 μm. Prepatent period is 1 week.
Importance: Diarrhea in kittens; may be fatal.
Diagnosis: Oocysts in fecal flotation.
Treatment: Sulfadimethoxine (Albon), 55 mg/kg q 24 h, then 27.5 mg/kg q 24 h × 5 d.
Amprolium, 60–100 mg/kg q 24 h × 7 d. May not be palatable.

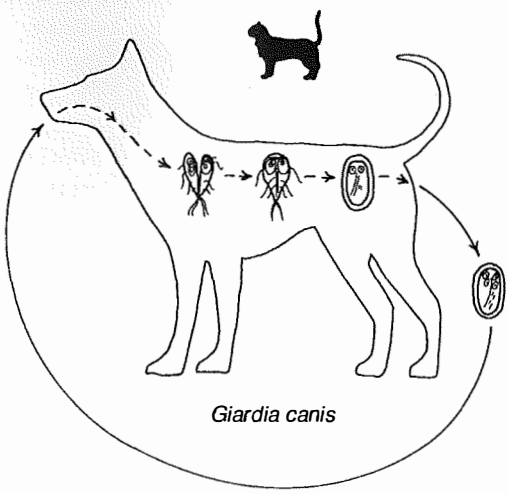


Fig. 68a. *Giardia* sp.

Fig. 68b. *Giardia* sp. trophozoite (arrow). (See also Figs. 30b and 30c.)

Giardia canis

Common name: None (Mastigophora), a flagellated protozoan parasite.
Size of organism: Cyst, 10 μm × 18 μm; trophozoite 10 μm × 17 μm. Incubation period is 1 week. Trophozoites and cysts in small and large intestine.
Importance: Diarrhea.
Diagnosis: Cysts or trophozoites in fecal flotation or direct smear (must use fresh fecal material).
Treatment: Furazolidone, 4 mg/kg PO q 12 h × 5 d
Metronidazole, 25 mg/kg PO q 12 h × 5 d
Fenbendazole, 50 mg/kg q 24 h × 3 d
Albendazole, 25 mg/kg q 12 h × 2 d

External Parasites

Notoedres cati

Common name: Mange mite (Sarcoptidae).
Size of adult: 300–400 μm. Life cycle is 17 days.
Importance: Persistent pruritus and alopecia on face, ears, and neck. Humans develop pruritic papular rash.
Diagnosis: Deep skin scraping at edge of lesion. Mites have long nonjointed pedicels like Sarcoptes. Adults, nymphs, larvae, eggs in dermal tissues.
Treatment: Ivermectin, 0.2 mg/kg SC
Lime sulfur solution, l:40 dip
Malathion, 0.5% dip

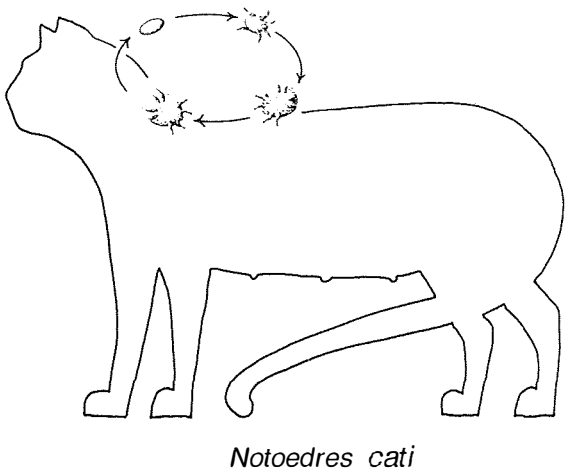


Fig. 69a. *Notoedres cati.*

Fig. 69b. *Notoedres cati.*

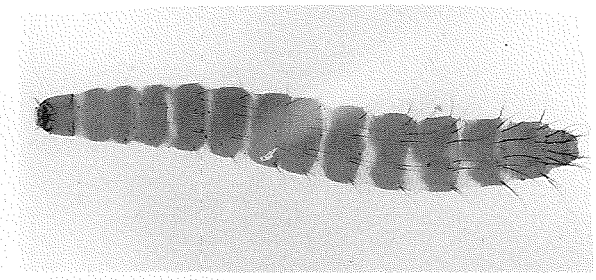


Fig. 69c. Typical flea larva.

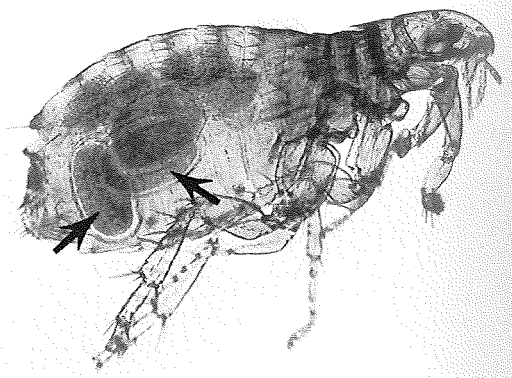


Fig. 69d. *Ctenocephalides felis* (adult female). Note eggs in flea (arrows).

Table 18. Common external parasites of cats

Cheyletiella blakei/parasitovorax	(See Fig. 49)
Ctenocephalides felis/canis	(See Figs. 42, 69c, 69d)
Cuterebra spp.	(See Fig. 45)
Demodex cati	(See Fig. 47; very rare in cats)
Dermanyssus gallinae	(From birds, see Fig. 195)
Eutrombicula alfreddugesi	(Larval chiggers, see Figs. 52f and 52g)
Felicola subrostratus	(See Fig. 52c)
Lynxacarus radovsky	(Very rare)
Ornithonyssus sp.	(From rodents and birds, see Fig. 52e)
Otodectes cynotis	(See Fig. 48)
Rhipicephalus sanguineus	(See Fig. 50)
Sarcoptes scabiei	(See Fig. 46; uncommon in cats)

Bibliography

Ascarids and Hookworms

Blaghurn BL, Hendrix CM, Lindsay DS, et al.: Efficacy of milbenmycin oxime against naturally acquired or experimentally induced *Ancylostoma* spp. and *Trichuris vulpis* infections in dogs. *Am J Vet Res* 53:513–516, 1992.

Burke TM, Roberson EL: Fenbendazole treatment of pregnant bitches to reduce parental and lactogenic infections of *Toxocara canis* and *Ancylostoma caninum* in pups. *J Am Vet Med Assoc* 183:987–990, 1983.

Burke TM, Roberson EL: Prenatal and lactational transmission of *Toxocara canis* and *Ancylostoma caninum*: Experimental infection of the bitch before pregnancy. *Int J Parasitol* 15:71–75, 1985.

Burke TM, Roberson EL: Prenatal and lactational transmission of *Toxocara canis* and *Ancylostoma caninum*: Experimental infection of the bitch at mid pregnancy and at parturition. *Int J Parasitol* 15:485–590, 1985.

Clapham PA: Pre-partum infestation of puppies with *Ancylostoma caninum*. *Vet Rec* 74:754–755, 1962.

Cornelius LM, Roberson EL: Treatment of gastrointestinal parasitism. In Kirk RW (ed): *Current Veterinary Therapy IX: Small Animal Practice*, Philadelphia, WB Saunders Co., 1986, pp 921–924.

Courtney CH, Sundlof SF: Veterinary Parasitic Drugs 1991, American Association of Veterinary Parasitologists, A comprehensive compendium of FDA-approved antiparasitic drugs, Publ SP96, University of Florida, 224 pages, 1991.

Dubey JP: Effect of fenbendazole on *Toxocara canis* larvae in tissues of infected dogs. *Am J Vet Res* 40:698–699, 1979.

Egerton JR, Eary CH, Suhayda D: Titration studies of ivermectin against experimental *Ancylostoma caninum* and *Uncinaria stenocephala* infections. *Am J Vet Res* 46:1057–1059, 1985.

Georgi JR, Lejamhre LF, Ratcliffe LH: *Ancylostoma caninum* burden in relationship to erythrocyte loss in dogs. *J Parasitol* 55:1205–1211, 1969.

Hayes FA, McDaniel HT: An evaluation of piperazine citrate for preventing prenatal infections with the common dog ascarid (*Toxocara canis*). *J Am Vet Med Assoc* 134:565–567, 1959.

Kirkpartrick CE, Megella C: Use of ivermectin in treatment of *Aelurostrongylus abstrusus* and *Toxocara cati* infections in a cat. *J Am Vet Med Assoc* 190:1309–1310, 1987.

Mark DL: Survival of *Ancylostoma caninum* on bare ground, pea gravel, and concrete. *Am J Vet Res* 36:1803–1807, 1975.

Marmor M, Glickman L, Shoffer F, et al.: *Toxocara canis* infection of children: Epidemiologic and neuropsychologic findings. *Am J Public Health* 77:54–559, 1987.

McTier TL, Shanks DJ, Wren JA, et al.: Efficacy and safety of selamectin against experimentally induced and naturally acquired infections of *Toxocara cati* and *Ancylostoma tubaeforme* in cats. *Vet Parasitol* 91:311–319, 2000.

McTier TL, Siedek EM, Clemence RG, et al.: Efficacy of selamectin against experimentally induced and naturally occurring ascarid (*Toxocara canis* and *Toxascaris leonina*) infections in dogs. *Vet Parasitol* 91:333–345, 2000.

Niamatali S, Bhopale V, Schad GA: Efficacy of milbemycin oxime against experimentally induced *Ancylostoma stenocephala* infections of dogs. *J Am Vet Med Assoc* 201:1385–1387, 1992.

Payne-Johnson M, Maitland TP, Sherington J, et al.: Efficacy of selamectin administered topically to pregnant and lactating female dogs in the treatment and prevention of adult roundworm (*Toxocara canis*) infections and flea (*Ctenocephalides felis felis*) infestations in the dams and the pups. *Vet Parasitol* 91:347–358, 2000.

Schacher JF: A contribution to the life history and larval morphology of *Toxocara canis*. *J Parasitol* 43:599–612, 1957.

Scothorn MW, Koutz FR, Groves HF: Prenatal *Toxocara canis* infection in pups. *J Am Vet Med Assoc* 145:45–48, 1965.

Six RH, Sture GH, Thomas CA, et al.: Efficacy and safety of selamectin against gastrointestinal nematodes in cats presented as veterinary patients. *Vet Parasitol* 91:321–331, 2000.

Sprent JFA: The life history and development of *Toxocara cati* (Schrank 1788) in the domestic cat. *Parasitology* 46:54–78, 1956.

Sprent JFA: Post-parturient infection of the bitch with *Toxocara canis*. *J Parasitol* 47:284, 1961.

Vinayak VK, Gupta NK, Chopra AK, et al.: Efficacies of vaccines against canine hookworm disease. *Parasitology* 82:375–382, 1981.

Heartworms

Atkins CE, DeFrancesco TC, Coats JR, Sidley JA, Keene BW: Heartworm infection in cats: 50 cases (1985–1997). *J Am Vet Med Assoc* 217:355–358, 2000.

Bauman PM, Otto GF: The relative number of microfilariae of *Dirofilaria immitis* and *Dipetalonema reconditum* in naturally infected dogs. *J Am Anim*

Hosp Assoc 10:379–382, 1974.

Blair LS, Camphell WC: Efficacy of ivermectin against *Dirofilaria immitis* larvae in dogs 31, 60, and 90 days after infection. *Am J Vet Res* 41:2108, 1980.

Blair LS, Malatesta PL, Ewanciw DV: Dose-response study of ivermectin against *Dirofilaria immitis* microfilariae in dogs with naturally acquired infections. *Am J Vet Res* 44:476–477, 1983.

Boy MG, Six RH, Thomas CA, et al.: Efficacy and safety of selamectin against fleas and heartworms in dogs and cats presented as veterinary patients in North America. *Vet Parasitol* 91:233–250, 2000.

Christensen BM, Hollander AL: Effect of temperature on vector-parasite relationships of *Aedes trivitattus* and *Dirofilaria immitis*. Proceedings of the Helminthological Society of Washington 45:115–119, 1978.

Church EM, Georgi JR, Robson DS: Analysis of the microfilarial periodicity of *Dirofilaria immitis*. *Cornell Vet* 55:333–346, 1976.

Grieve RB, Glickman LT, Bater AK, et al.: Canine *Dirofilaria immitis* infection in a hyperenzootic area: Examination by parasitologic findings at necropsy and by serodiagnostic methods. *Am J Vet Res* 47:329–332, 1986.

Holmes RA: Feline heartworm disease. *Small Animal Parasitology* 15:687–695, 1993.

Jackson RF: Surgical treatment of heartworm disease. *J Am Vet Med Assoc* 154:383–384, 1969.

Kotani T, Powers KG: Developmental stages of *Dirofilaria immitis* in the dog. *Am J Vet Res* 43:2199–2206, 1982.

Lewis RE: Radiographic findings in feline dirofilariasis. In Otto GF (ed): *Proceedings of the Heartworm Symposium '86*. Washington, DC, American Heartworm Society, 1986, pp. 155–158.

McCall JW, McTier TL, Ryan WG, et al.: Evaluation of ivermectin and milhemycin oxime efficacy against *Dirofilaria immitis* infections of three or four months' duration in dogs. *Am J Vet Res* 57:1189–1192, 1996.

McTier TL, Shanks DJ, Watston P, et al.: Prevention of experimentally induced heartworm (*Dirofilaria immitis*) infection in dogs and cats with a single topical application of selamectin. *Vet Parasitol* 91:259–268, 2000.

Merrill JR, Otis J, Logan WD, et al.: The dog heartworm (*Dirofilaria immitis*) in man. *J Am Med Assoc* 243:1066–1068, 1980.

Otto GF, Jachowski LA: Mosquitoes and canine heartworm disease. In Otto GF (ed): *Proceedings of the Heartworm Symposium '80*. Edwardsville, Kansas, Veterinary Medicine Publishing Co., 1981, pp. 17–32.

Otto GF, Jackson RF, Bauman PM, et al.: Variability in the ratio between the numbers of microfilariae and adult heartworms. *J Am Vet Med Assoc* 168:605–607, 1976.

Paul AJ, Todd KS, Sundberg JP, et al.: Efficacy of ivermectin against *Dirofilaria immitis* larvae in dogs 30 and 45 days after induced infection. *Am J Vet Res* 47:883–884, 1986.

Pulliam JD, Seward RD, Henry RT, et al.: Investigating ivermectin toxicity in collies. *Vet Med* 6:33–40, 1985.

Snyder PS, Levy JK, Salute ME, et al.: Performance of serologic tests used to detect heartworm infection in cats. *J Am Vet Med Assoc* 216:693–700, 2000.

Taylor AER: The development of *Dirofilaria immitis* in the mosquito *Aedes aegypti*. *J Helminthol* 34:27–38, 1960.

Whiteley HE: Your diagnostic protocol for *Dirofilaria immitis* infection in dogs. *Vet Med* 8:328–345, 1988.

Miscellaneous Parasites and Drugs in Dogs and Cats

Anderson DL, Roberson EL: Activity of ivermectin against canine intestinal helminths. *Am J Vet Res* 43:1681–168.3, 1982.

Anderson FL, Condor GA, Marsland WP: Efficacy of injectable and tablet formulations of praziquantel against mature *Echinococcus granulosus*. *Am J Vet Res* 39:1861–1862; 15:256–260, 1978.

Anderson WI, Georgi ME, Car BD: Pancreatic atrophy and fibrosis associated with *Eurytrema procyonis* in a domestic cat. *Vet Rec* 120:235–236, 1987.

August JR, Powers RD, Bailey WS, et al.: *Filaroides birthi* in a dog: Fatal hyperinfection suggestive of autoinfection. *J Am Vet Med Assoc* 176:331–334, 1980.

Bauer C, Gey A: Efficacy of six anthelmintics against luminal stages of *Baylisascaris procyonis* in naturally infected raccoons (*Procyon lotor*). *Vet Parasitol* 60:155–159, 1995.

Beal MW, Poppenga RH, Birdsall WJ, Hughes D: Respiratory failure attributable to moxidectin intoxication in a dog. *J Am Vet Med Assoc* 215:1813–1817, 1999.

Blagburn BL, Hendrix CM, Lindsay DS, Vaughan JL: Anthelminthic efficacy of ivermectin in naturally parasitized cats. *Am J Vet Res* 48:670–672, 1987.

Bowman DD, Frongillo MK, Johnson RC, et al.: Evaluation of praziquantel for treatment of experimentally induced paragonimiasis in dogs and cats. *Am J Vet Res* 52:68–71, 1991.

Burke TM, Roberson EL: Critical studies of fenbendazole suspension (10%) against naturally occurring

helminth infections in dogs. *Am J Vet Res* 39:987–990, 1983.

Burke TM, Roberson EL: Use of fenbendazole suspension (10%) against experimental infections of *Toxocara canis* and *Ancylostoma caninum* in beagle pups. *Am J Vet Res* 40:552–554, 1979.

Campbell WC (ed): *Ivermectin and Abamectin*. New York, Springer-Verlag, 1989.

Clarkson MJ, Owen LN: The species of *Trichuris* in the domestic cat. *J Helminthol* 34:319–322, 1960.

Corwin RM, Pratt SE, McCurdy HD: Anthelmintic effect of febantel/praziquantel paste in dogs and cats. *Am J Vet Res* 45:154–155, 1984.

Corwin RM, Green SP, Keefe TJ: Dose titration and confirmation tests for determination of cesticidal efficacy of epsiprantel in dogs. *Am J Vet Res* 50:1076–1077, 1989.

Dubey JP, Miller TB, Sharma SP: Fenbendazole for treatment of *Paragonimus kellicotti* infection in dogs. *J Am Vet Med Assoc* 174:835–837, 1979.

Dunsmore JD, Spratt DM: The life history of *Filaroides osleri* in wild and domestic canids in Australia. *Vet Parasitol* 5:275–286, 1979.

Foreyt WJ, Gorham JR: Evaluation of praziquantel against induced *Nanophyetus salmincola* infections in coyotes and dogs. *Am J Vet Res* 49:563–565, 1988.

Fox SM, Burns J, Hawkins J: Spirocercosis in dogs. *Compend Cont Ed* 10:807–822, 1988.

Georgi JR, Georgi ME, Gahnestock GR, et al.: Transmission and control of *Filaroides hirthi* lungworm infection in dogs. *Am J Vet Res* 40:829–831, 1979.

Hargis AM, Prieur DJ, Blanchard JL: Prevalence, lesions and differential diagnosis of *Ollulanus tricuspis* infection in cats. *Vet Pathol* 20:71–79, 1983.

Hollins JD, Marlow BP, Hatherell PJ: Ingestion of equine moxidectin in dogs. *Vet Rec* 147:227–228, 2000.

Kirkpatrick CE, Shelly EA: Paragonimiasis in a dog: Treatment with praziquantel. *J Am Vet Med Assoc* 187:75–76, 1985.

Lynn RC: Antiparasitic drugs. In Bowman DD (ed): *Georgis' Parastiology for Veterinarians*. 7th edition, Philadelphia, W.B. Saunders Co., 1999, pp. 235–283.

Paul AJ, Tranquilli WJ, Hutchens DE: Safety of moxidectin in avermectin-sensitive collies. *Am J Vet Res* 61:428–483, 2000.

Poole JB, Dooley KL, Rollins LD: Efficacy of niclosamide for the removal of tapeworms (*Dipylidium caninum* and *Taenia pisiformis*) from dogs. *JAVMA* 159:78–80, 1971.

Reinemeyer CR, DeNovo RC: Evaluation of the efficacy and safety of two formulations of pyrantel pamoate in cats. *Am J Vet Res* 51:932–934, 1990.

Roberson EL, Burke TM: Evaluation of a granulated fenbendazole (22.2%) against induced and naturally occurring helminth infections in cats. *Am J Vet Res* 41:149–1502, 1980.

Roberson EL, Burke TM: Evaluation of granulated fenbendazole as a treatment for helminth infections in dogs. *J Am Vet Med Assoc* 180:53–55, 1982.

Stokol T, Randolph JF, Nachbar S, et al.: Development of bone marrow toxicosis after albendazole administration in a dog and cat. *J Am Vet Med Assoc* 210:1753–1756, 1997.

Thomas H, Gonnert R: The efficacy of praziquantel against cestodes in cats dogs, and sheep. *Res Vet Sci* 24:20–25, 1978.

Verster A: A taxonomic revision of the genus *Taenia* (Linnaeus, 1758). *Onderstepoort J Vet Res* 36:3–58, 1969.

Visco RJ, Corwin RM, Selby LA: Effect of age and sex on the prevalence of intestinal parasitism in dogs. *J Am Vet Med Assoc* 170:835–837, 1977.

Yazwinski TA, Tilley W, Greenway T: Efficacy of ivermectin in the treatment of artificially induced canine, mixed, gastrointestinal helminthiasis. *Vet Med Small Anim Clin* 77:225–226, 1982.

Protozoan Parasites

Abbitt B, Huey RL, Eugster AK, et al.: Treatment of giardiasis in adult greyhounds using ipronidazole-medicated water. *J Am Vet Med Assoc* 188:67–69, 1986.

Abdullahi SU, Sannusi A: Canine babesiosis. In Kirk RW (ed): *Veterinary Therapy IX. Small Animal Practice*. Philadelphia, W.B. Saunders Co., 1986, pp. 1096–1098.

Barr SC: American trypanosomiasis in dogs. *Comp Cont Educ Pract Vet* 13:745–755, 1991.

Barr SC, Bowman DD, Heller RL, Erb, HN: Efficacy of albendazole against giardiasis in dogs. *Am J Vet Res* 54:926–928, 1993.

Barr SC, Bowman DD, Heller RL: Efficacy of fenbendazole against giardiasis in dogs. *Proc Am Assoc Vet Parasitol* San Francisco, California, 1994.

Bemrick WJ: Some perspectives on the transmission of giardiasis. In Erlandsen SL, Meyer EA (eds): *Giardia and Giardiasis: Biology, Pathogenesis, and Epidemiology*. New York, Plenum Press, 1984, pp. 379–400.

Benjamin MM, Lumb WV: *Haemobartonella canis* infection in a dog. *J Am Vet Med Assoc* 135:388–390, 1959.

Bennett M, Baxby D, Blundell N, et al.: Cryptosporidiosis in the domestic cat. *Vet Rec* 116:73–74, 1985.

Blouin EF, Kocan AA, Glen BL, et al.: Transmission of *Cytauxzoon felis* (Kier, 1979) from bobcats, *Felix rufus* (Schreber), to domestic cats by *Dermacentor variabilis* (Say). *J Wildl Dis* 20:241–242, 1984.

Breitschwerdt EB: Babesiosis. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, W.B. Saunders Co., 1990, pp. 796–803.

Craig TM: Hepatozoonosis. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, W.B. Saunders Co., 1990, pp. 778–785.

Dubey JP: A review of *Sarcocystis* of domestic animals and other coccidia of cats and dogs. *J Am Vet Med Assoc* 169:1061–1078, 1976

Dubey JP: Infectivity and pathogenicity of *Toxoplasma gondii* for cats. *J Parasitol* 82:957–961, 1996.

Dubey JP: Reshedding of *Toxoplasma* oocysts by chronically infected cats. *Nature* 262:213–314, 1976.

Dubey JP: *Toxoplasma*, *Hammondia*, *Besnoitia*, *Sarcocystis*, and other tissue cyst-forming coccidia of man and animals. In Kreir JP (eds): *Parasitic Protozoa.* Volume 3. New York, Academic Press, 1977, pp. 101–237.

Dubey JP: Pathogenicity of *Isospora ohioensis* infection in dogs. *J Am Vet Med Assoc* 173:192–197, 1978.

Dubey JP Beattie CP: *Toxoplasmosis of animals and man.* Boca Raton, Florida, CRC Press, Inc., 1988.

Dubey JP, Carpenter JL, Speer CA, et al.: Newly recognized fatal protozoan disease of dogs. *J Am Vet Med Assoc* 192:1269–1285, 1988.

Dubey JP, Greene CE: Enteric coccidiosis. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, W.B. Saunders Co., 1990, pp. 835–846.

Dubey JP, Greene CE, Lappin MR: Toxoplasmosis and Neosporosis. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, W.B. Saunders Co., 1990, pp. 818–834.

Dubey JP, Hattel AL, Lindsay DS, et al.: Neonatal *Neospora caninum* infection in dogs: Isolation of the causative agent and experimental transmission. *J Am Vet Med Assoc* 193: 1259–1263, 1988.

Dubey JP, Lindsay DS: Neosporosis. *Parasitol Today* 9:452–457, 1993.

Dubey JP, Speer CA, Fayer R: *Sarcocystosis of Animals and Man.* Boca Raton, Florida, CRC Press, Inc., 1989.

Dunbar MR, Foreyt WJ: Prevention of coccidiosis in domestic dogs and captive coyotes (*Canis latrans*) with sulfadimethoxine-ormetoprin combination. *Am J Vet Res* 46:1899–1902, 1985.

Farwell GE, LeGrand EK, Cobb CC: Clinical observations on *Babesia gibsoni* and *Babesia canis* infections in dogs. *J Am Vet Med Assoc* 180:507–511, 1982.

Fayer R, Ungar BLP: *Cryptosporidium* spp. and cryptosporidiosis. *Microbiol Rev* 50:458–483, 1986.

Frenkel JK, Dubey JP: Rodents as vectors for feline coccidia, *Isospora felis* and *Isospora rivolta*. *J Infect Dis* 125:69–72, 1972.

Frenkel JK, Smith DD: Inhibitory effects of monensin on shedding of *Toxoplasma* oocysts by cats. *J Parasitol* 68:851–855, 1982.

Glenn BL, Stair EL: Cytauxzoonosis in domestic cats: Report of two cases in Oklahoma, with a review and discussion of the disease. *J Am Vet Med Assoc* 184:822–825, 1984.

Gookin JL, Riviere JE, Gilger BC, Papich MG: Acute renal failure in four cats treated with paromomycin. *J Am Vet Med Assoc* 215:1821–1823, 1999.

Harvey JW: Haemobartonellosis. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, WB Saunders Co., 1990, pp. 434–442.

Hay WH, Shell LG, Lindsay DS, Dubey JP: Diagnosis and treatment of *Neospora caninum* infection of a dog. *J Am Vet Med Assoc* 197:87–89, 1990.

Hill SL, Cheney JM, Taton-Allen GF, Reif JS, Bruns C, Lappin MR: Prevalence of enteric zoonotic organisms in cats. *J Am Vet Med Assoc* 216:687–692, 2000.

Kier AB: Cytauxzoonosis. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, WB Saunders Co., 1990, pp. 792–795.

Kirkpatrick CE: Enteric protozoal infections. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, W.B. Saunders Co., 1990, pp. 804–814.

Kirkpatrick CE, Dubey JP, Goldschmidt MH, et al.: *Sarcocystis* sp. in muscles of domestic cats. *Vet Pathol* 23:88–90, 1986.

Kirkpatrick CE, Green GA, IV: Susceptibility of domestic cats to infections with *Giardia lamblia* cysts and trophozoites from human sources. *J Clin Microbiol* 21:678–680, 1985.

Kirkpatrick CE, Laczak JP: Giardiasis in a cattery. *J Am Vet Med Assoc* 187: 161–162, 1985.

Levine ND, Ivens V: *The coccidian parasites (Protozoa, Apicomplexa) of carnivores.* Illinois Biology Monograph no. 51. Urbana, University of Illinois Press, 1981.

Lindsay DS, Blagburn BL: Coccidial parasites of cats and dogs. *Comp Cont Educ Pract Vet* 13:759–765:1991.

Lindsay DS, Dubey JP, Duncan RB: Confirmation that the dog is a definitive host for *Neospora caninum*. *Vet Parasitol* 82:327,

Olson ME: Coccidiosis caused by *Isospora ohioensis*-like organisms in three dogs. *Can Vet J* 26:112–114, 1985.

Olson ME, Ceri H, Morck DW: Giardia vaccination.

Parasitol Today 16:213–217, 2000.

Pitts RP, Twedt DC, Mallie KA: Comparison of duodenal aspiration with fecal flotation for diagnosis of giardiasis in dogs. *J Am Vet Med Assoc* 182:1210–1211, 1983.

Prestwood AK: Cryptosporidiosis. In Greene CE (ed): *Infectious Diseases of the Dog and Cat.* Philadelphia, W.B. Saunders Co., 1990, pp. 847–853.

Roher DP, Anderson JF, Nielsen SW: Experimental babesiosis in coyotes and coydogs. *Am J Vet Res* 46:256–262, 1985.

Small E, Ristic M: Haemobartonellosis. In Holzworth J (ed): *Diseases of the Cat: Medicine and Surgery.* Philadelphia, W.B. Saunders Co., 1987, pp. 301–308.

Smart J: Amprolium for canine coccidiosis. *Med Vet Pract* 52:41, 1971.

Swenson CL, Silverman J, Stromberg PC, et al.: Visceral leishmaniasis in an English foxhound from an Ohio research colony. *J Am Vet Med Assoc* 193:1089–1092, 1988.

Taboada J, Harvey JW, Levy MG, et al.: Seroprevalence of babesiosis in greyhounds in Florida. *J Am Vet Med Assoc* 200:47–50, 1992.

Upton SJ, Current WL: The species of *Cryptosporidum* (Apicomplexa: Cryptosporidiidae) infecting mammals. *J Parasitol* 71:625–629, 1985.

Woo PTK, Paterson WB: *Giardia lamblia* in children in day care centres in southern Ontario, Canada, and susceptibility of animals to *G. lamblia*. *Trans R Soc Trop Med Hyg* 80:56–59, 1986.

Zajac AM: Giardiasis. *Compend Continuing Ed* 14:604–611, 1992.

Fleas

Arther RG, Cunningham J, Dorn H, et al.: Efficacy of imidacloprid for removal and control of fleas (*Ctenocephalides felis*) on dogs. *Am J Vet Res* 58:848–850, 1997.

Baker NF, Farver TB: Failure of brewer's yeast as a repellant to fleas on dogs. *J Am Vet Med Assoc* 183:212–214, 1983.

Benton AH: *An Atlas of the Fleas of the Eastern United States.* Fredonia, New York, Marginal Media, 1980.

Blagburn BL, Vaughan JL, Lindsay DS, et al.: Efficacy dosage titration of lufenuron against developmental stages of fleas (*Ctenocephlides felis felis*) in cats. *Am J Vet Res* 55:98–101, 1994.

Cunningham J, Everett R: Efficacy of imidacloprid on large dogs. *Comp Cont Educ Pract Vet* 19:28, 1997.

Dryden MW, Long GR, Gaafar SM: Effects of ultrasonic collars on *Ctenocephalides felis* on cats. *J Am Vet Med Assoc* 195:1717–1718, 1989.

Halliwell REW: Factors in the development of flea-bite allergy. *Vet Med Small Anim Clin* 79:1273–1278, 1984.

Hink WF, Fee BJ: Toxicity of d-Limonene, the major component of citrus peel oil, to all life stages of the cat flea, *Ctenocephalides felis* (Siphonoptera: Pulicidae). *J Med Entomol* 23:400–404, 1986.

MacDonald JM, Miller TA: Parasiticide therapy in small animal dermatology. In Kirk RW (ed): *Current Veterinary Therapy IX.* Philadelphia, W.B. Saunders Co., 1986.

McTier TL, Shanks DJ, Jernigan AD: Evaluation of the effects of selamectin against adult and immature stages of fleas (*Ctenocephalides felis felis*) on dogs and cats. *Vet Parasitol* 91:201–212, 2000.

Ritzhaupt LK, Rowan TG, Jones RL: Evaluation of efficacy of selamectin, fipronil, and imidacloprid against *Ctenocephalides felis* in dogs. *J Am Vet Med Assoc* 217:1669–1671, 2000.

Ritzhaupt LK, Rowan TG, Jones RL: Evaluation of efficacy of selamectin and fipronil against *Ctenocephalides felis* in cats. *J Am Vet Med Assoc* 217:1666–1668, 2000.

Shanks DJ, Rowan TG, Jones RL: Efficacy of selamectin in the treatment and prevention of flea (*Ctenocephalides felis felis*) infestations on dogs and cats housed in simulated home environment. *Vet Parasitol* 91:213–222, 2000.

Mites

Alexander MM, Ihrke PJ: *Cheyletiella* dermatitis in small animal practice: A review. *Calif Vet* 36(3):9–12, 1982.

Alrian LG, Morgan MS, Rapp CM, Vyszenski-Moher DL: Some effects of sarcoptic mange on dogs. *J Parasitol* 81:698–702, 1995.

Auger P, Nantel J, Meunier N, et al.: Skin acariasis caused by *Dermanyssus gallinae* de Geer: An in-hospital outbreak. *Can Med Assoc J* 120:700–703, 1979.

Batey RG, Thompson RCA: Demodectic mange in a cat. *Aust Vet J* 57:49, 1981.

Bowman DD, Fogelson ML, Carbone LG: Effect of ivermectin on the control of ear mites (*Psoroptes cuniculi*) in naturally infested rabbits. *J Am Vet Med Assoc* 53:105–109, 1992.

Cannon RW: Amitraz in treatment of canine demodicosis. *Mod Vet Pract* 64:899–900, 1983.

Folz SD: Demodicosis (*Demodex canis*). *Compend Continuing Ed* 5:116–124, 1983.

Folz SD, Kakuk TJ, Henke CL, et al.: Clinical evaluation of amitraz as a treatment for canine demodicosis. *Vet Parasitol* 16:335–341, 1984.

Folz SD, Kakuk TJ, Henke CL, et al.: Clinical evalua-

tion of amitraz for treatment of canine scabies. *Mod Vet Pract* 65:597–600, 1984.

Greve JH, Gerrish RR: Fur mites (*Lynxacarus*) from cats in Florida. *Feline Pract* 11(6):28–30, 1981.

Hutchinson MD, Jacobs DE, Fox MT, et al.: Evaluation of flea control strategies using fipronil on cats in a controlled simulated home environment. *Vet Rec* 142:356–357, 1998.

Kunkle GA, Miller WH: *Cheyletiella* infestation in humans. *Arch Dermatol* 115: 1345, 1980.

Kwochka KW: Canine demodicosis. In Kirk RW (ed): *Current Veterinary Therapy IX*. Philadelphia, WB. Saunders Co., 1986.

MacDonald JM: Ectoparasites. In Kirk RW (ed): *Current Veterinary Therapy VIII*. Philadelphia, W.B. Saunders Co., 1983.

Miller WH, Scott DW, Wellington JR, et al.: Clinical efficacy of milbemycin oxime in the treatment of generalized demodicosis in adult dogs. *J Am Vet Med Assoc* 204:1426–1429, 1993.

Nuttall TJ, French AT, Cheetham HC, et al.: Treatment of *Trombicula autumnalis* infestation in dogs and cats with a 0.25 percent fipronil pump spray. *J Small Anim Pract* 39:237–239, 1998.

Paradis M: New approaches to the treatment of canine demodicosis. *Vet Clin North Am Small Anim Pract* 29:1425–1436, 1999.

Scheidt VJ, Medleau L, Seward RL, et al.: An evaluation of ivermectin in the treatment of sarcoptic mange in dogs. *Am J Vet Res* 45:1201–1202, 1984.

Scott DW, Walton DK: Experiences with the use of amitraz and ivermectin for the treatment of generalized demodicosis in dogs. *J Am Anim Hosp Assoc* 21:535–541, 1985.

Shanks DJ, McTier TL, Rowan TG, et al.: The efficacy of selamectin in the treatment of naturally acquired aural infestations of *Otodectes cynotis* on dogs and cats. *Vet Parasitol* 91:283–290, 2000.

Shaw SE, Foster AP: Treatment of canine adult-onset demodicosis. *Aust Vet J* 78:243–244, 2000.

Shelley ED, Shelley WB, Pula JF, et al.: The diagnostic challenge of non-burrowing mite bites *Cheyletiella yasguri*. *J Am Med Assoc* 251:2690–2691, 1984.

Shipstone M: Generalised demodicosis in dogs, clinical perspective. *Aust Vet J* 78:240–242, 2000.

Six R, Clemence RG, Thomas CA, et al.: Efficacy and safety of selamectin against *Sarcoptes scabiei* on dogs and *Otodectes cynotis* on dogs and cats presented as veterinary patients. *Vet Parasitol* 91:291–309, 2000.

Wagner R, Wendlberger U: Field efficacy of moxidectin in dogs and rabbits naturally infested by *Sacroptes* spp., *Demodex* spp., and *Psoroptes* spp. mites. *Vet Parasitol* 93:149–158, 2000.

White SD, Stannard AA: Canine demodicosis. In Kirk RW (ed): *Current Veterinary Therapy VIII*. Philadelphia, W.B. Saunders Co., 1983.

Yazwinski TA, Pote L, Tilley W, et al.: Efficacy of ivermectin against *Sarcoptes scabiei* and *Otodectes cynotis* infestations of dogs. *Vet Med Small Anim Clin* 76:1749–1751, 1981.

Ticks

Anderson JF: Epizootiology of *Borrelia* in *Ixodes* tick vectors and reservoir hosts. *Rev Infect Dis II* (Suppl 6):1451–1459, 1989.

Appel, MJG: Lyme disease in dogs and cats. *Compend Continuing Education* 12:617–626, 1990.

Bowman DD, Giovengo SL: Identification of adult and nymphal ticks. *Vet Tech* 12:505–509, 1991.

Eng TR, Wilson ML, Spielman A, et al.: Greater risk of *Borrelia burgdorferi* infection in dogs than in people. *J Infect Dis* 158:1410–1411, 1988.

Estrada-Pena A, Ascher F: Comparison of an amitraz-impregnated collar with topical administration of fipronil for prevention of experimental and natural infestations by the brown dog tick (*Rhipicephalus sanguineus*). *J Am Vet Med Assoc* 214:1799–17803, 1999.

Jernigan AD, McTier TL, Chieffo C, et al.: Efficacy of selamectin against experimentally induced tick (*Rhipicephalus sanguineus* and *Dermacentor variabilis*) infestations on dogs. *Vet Parasitol* 91:359–375, 2000.

Magnarelli LA, Anderson JF: Ticks and biting insects infected with the etiologic agent of Lyme disease, *Borrelia burgdorferi*. *J Clin Microbiol* 26:1482–1486, 1988.

Spielman A, Clifford CM, Piesman J, Corwin MD: Human babesiosis on Nantucket Island, USA: Description of vector *Ixodes dammini*. *J Med Entomol* 15:218–232, 1979.

Section 5

PARASITES OF CATTLE, SHEEP, AND GOATS

Fecal Eggs and Oocysts in Cattle

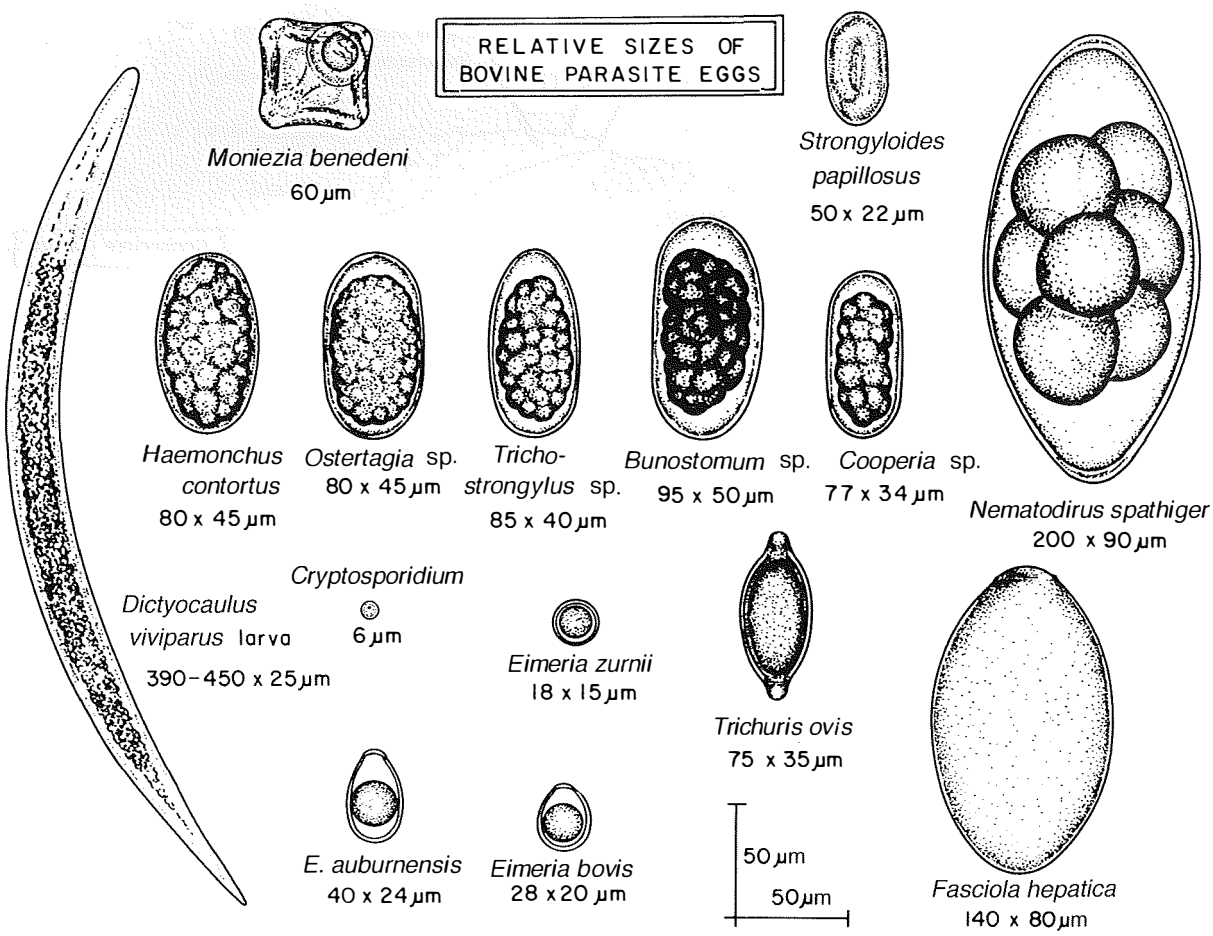


Fig. 70. Common parasite eggs and oocysts found in cattle feces.

Coccidia in Cattle

Table 19. Major species of coccidia of cattle

Species	Average size (µm)	Prepatent Period
Eimeria bukidnonensis	44 × 32	15–17 days
Eimeria auburnensis	39 × 23	18–20 days
Eimeria bovis	28 × 20	15–20 days
Eimeria cylindrica	23 × 14	11 days
Eimeria alabamensis	19 × 13	7 days
Eimeria zurnii	18 × 16	15–17 days
Eimeria ellipsoidalis	17 × 13	8–13 days

Location of Major Parasites in Cattle

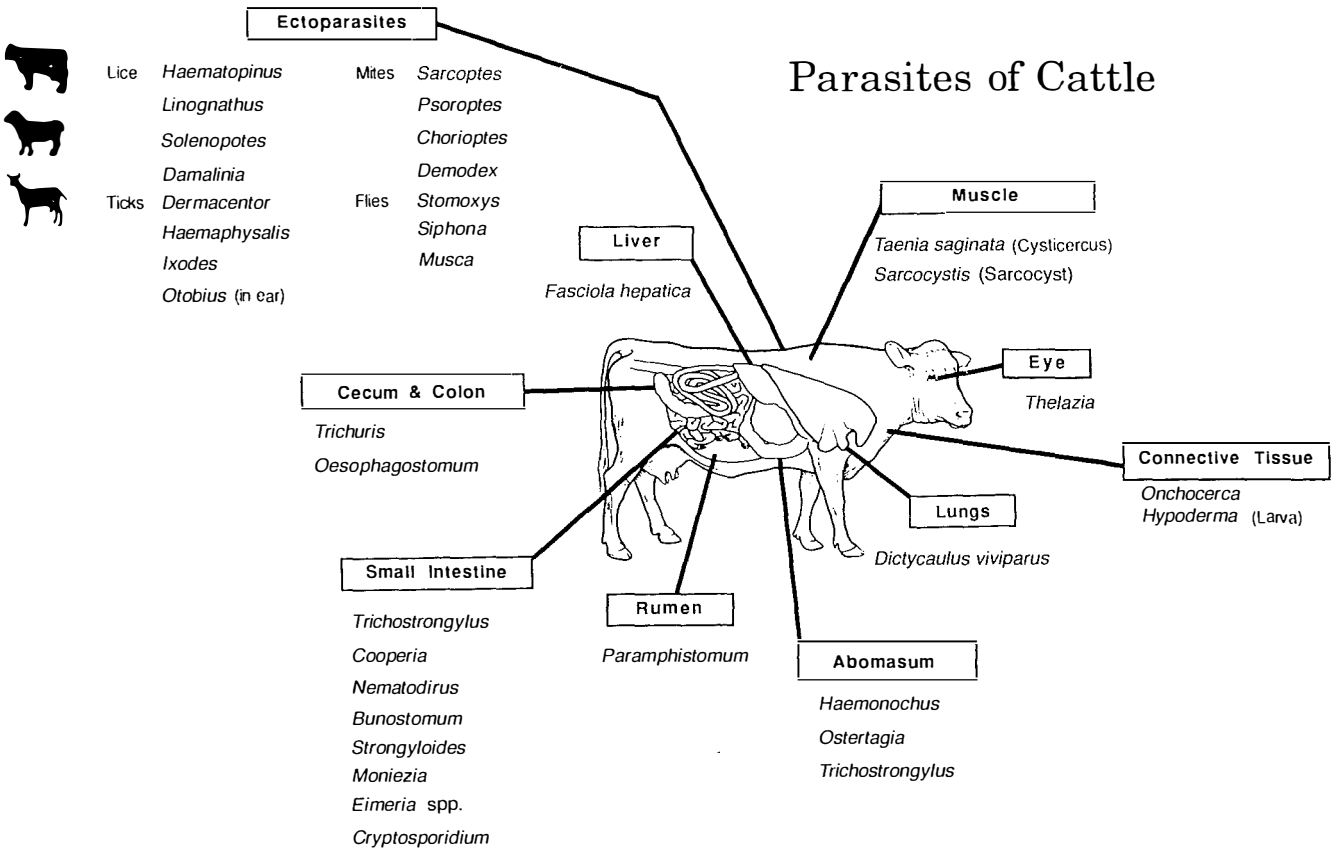


Fig. 71. Locations of the major parasites found in cattle.

Zoonotic Diseases in Cattle

Table 20. Major zoonotic diseases associated with cattle

Organism	Disease	Method of Infection
Protozoa		
Sarcocystis hominis	Intestinal sarcosporidiosis	Ingestion of raw beef
Trypanosoma rhodesiense	African trypanosomiasis	Bite of tsetse fly
Cryptosporidium sp.	Cryptosporidiosis	Ingestion of oocysts
Nematodes		
Thelazia spp.	Thelaziasis	Ocular contact with fly vector
Trichostrongylus spp.	Trichostrongyliasis	Ingestion of larvae
Trematodes		
Fasciola hepatica	Fascioliasis	Ingestion of metacercariae
Cestodes		
Taenia saginata	Taeniasis	Ingestion of cysticerci in meat

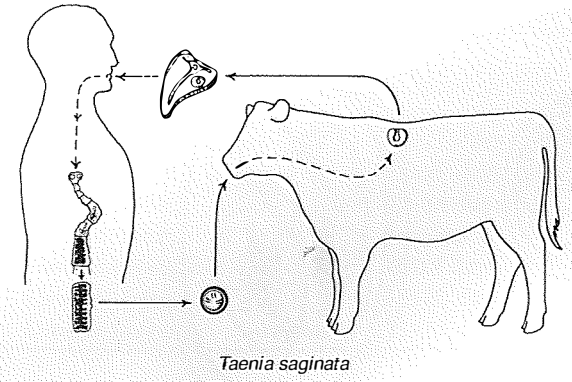


Fig. 72a. Life cycle of *Taenia saginata*.

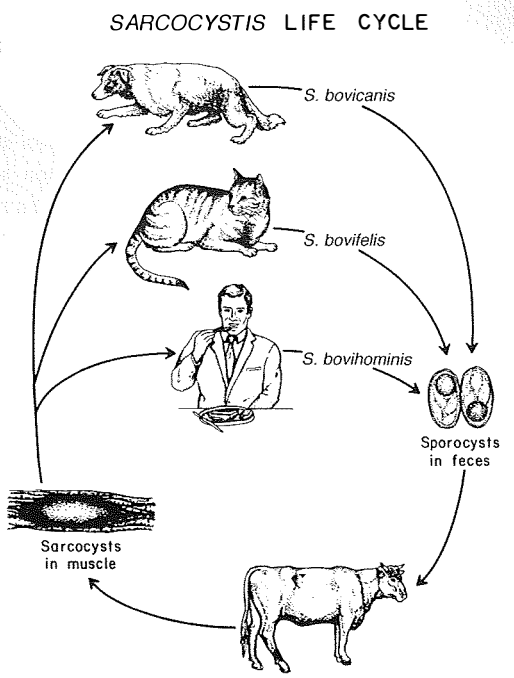


Fig. 72b. Life cycle of *Sarcocystis hominis*.
S. bovicanis is *S. cruzi*
S. bovifelis is *S. hirsuta*
S. bovihominis is *S. hominis*

Fecal Eggs and Oocysts in Sheep and Goats

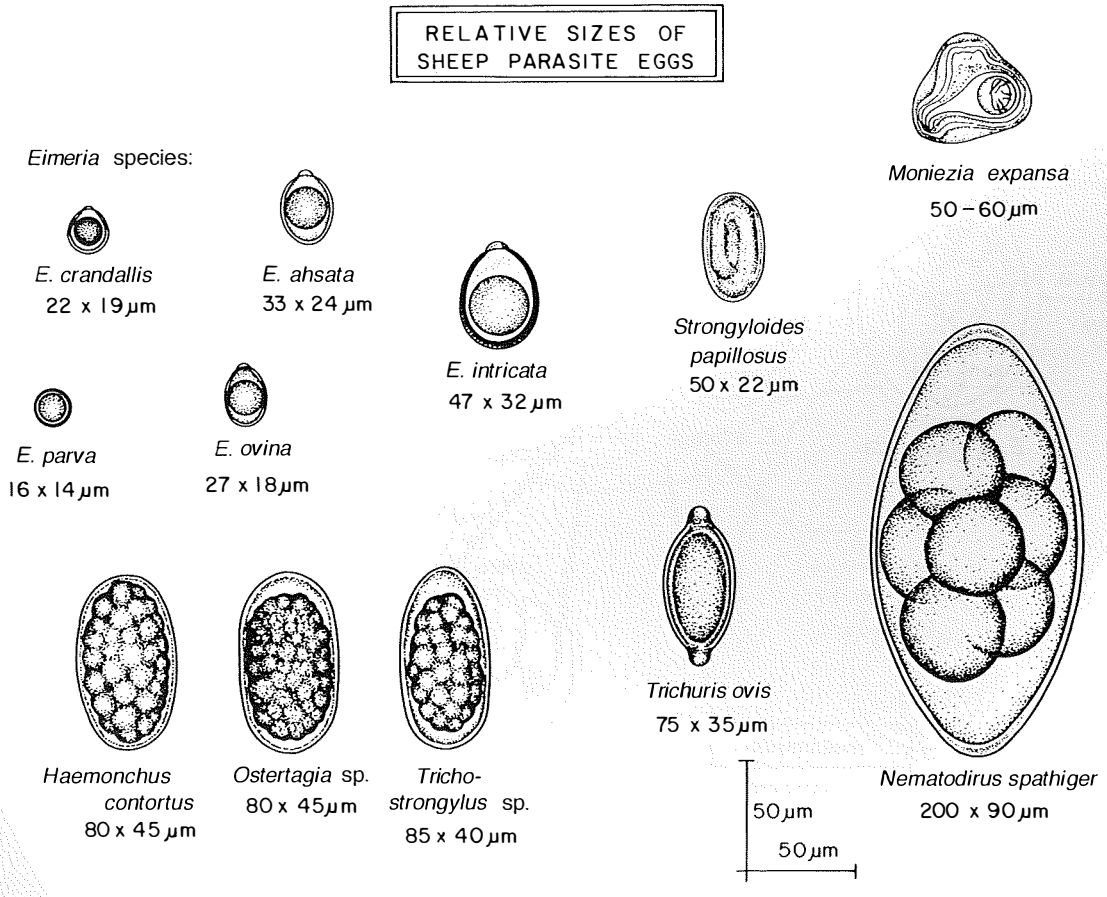


Fig. 73. Common parasite eggs and oocysts found in sheep feces.

Coccidia in Sheep and Goats

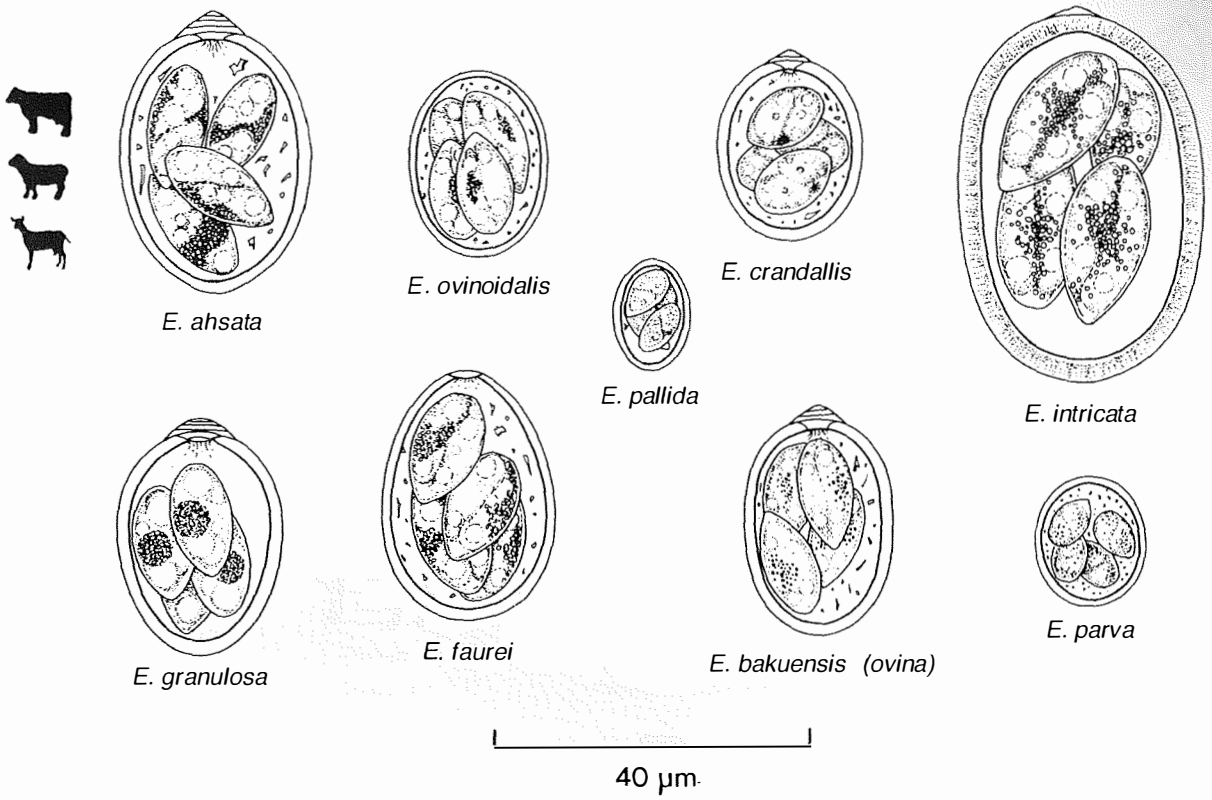


Fig. 74. Sporulated *Eimeria* species found in sheep.

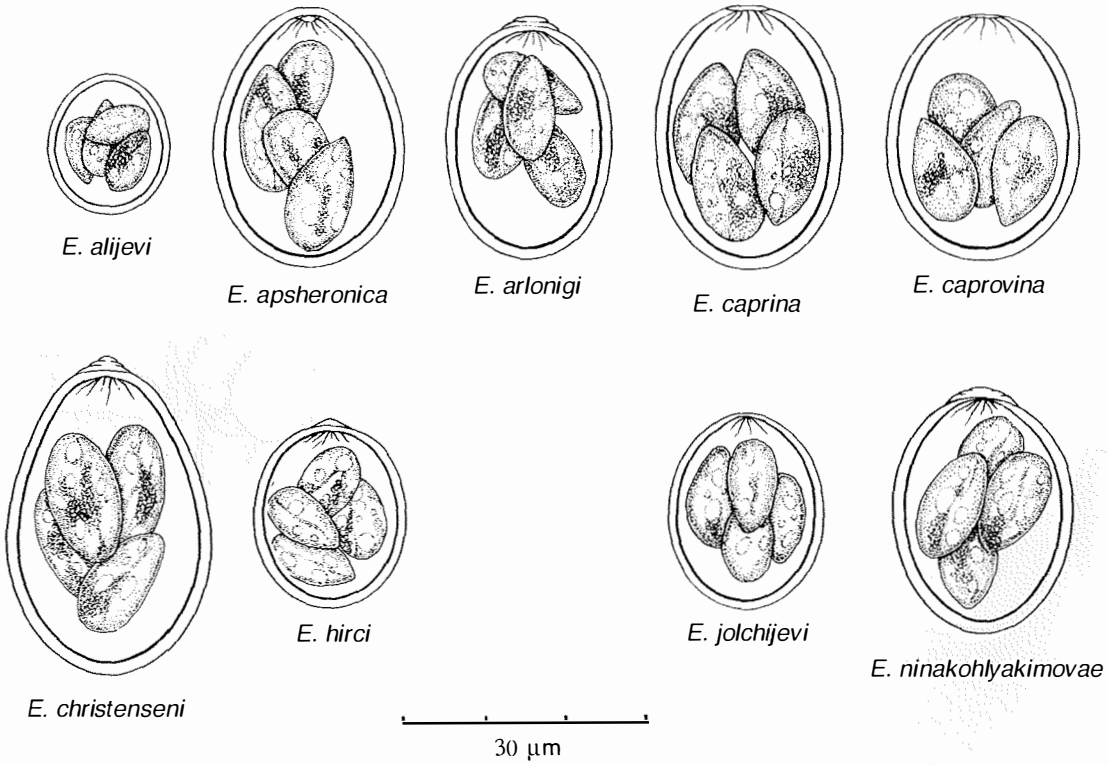


Fig. 75. Sporulated *Eimeria* species found in goats.

Table 21. Major species of coccidia in sheep and goats

Species	Size (μm)	Prepatent Period	Species	Size (μm)	Prepatent Period
Sheep			Goats		
Eimeria intricata	47 × 32	20–27 days	*Eimeria christenseni*	38 × 25	14–23 days
Eimeria ahsata	33 × 24	18–21 days	*Eimeria caprina*	32 × 23	17–20 days
Eimeria faurei	29 × 21	12–14 days	*Eimeria arloingi*	27 × 18	19 days
Eimeria ovina	29 × 21	19 days	*Eimeria hirci*	23 × 19	15–20 days
Eimeria ovinoidalis	23 × 18	9–15 days	*Eimeria ninakohlyakimovae*	23 × 18	10–13 days
Eimeria crandallis	22 × 19	15–20 days	*Eimeria aligevi*	16 × 14	7–12 days
Eimeria parva	16 × 14	11–15 days			

Location of Major Parasites in Sheep and Goats

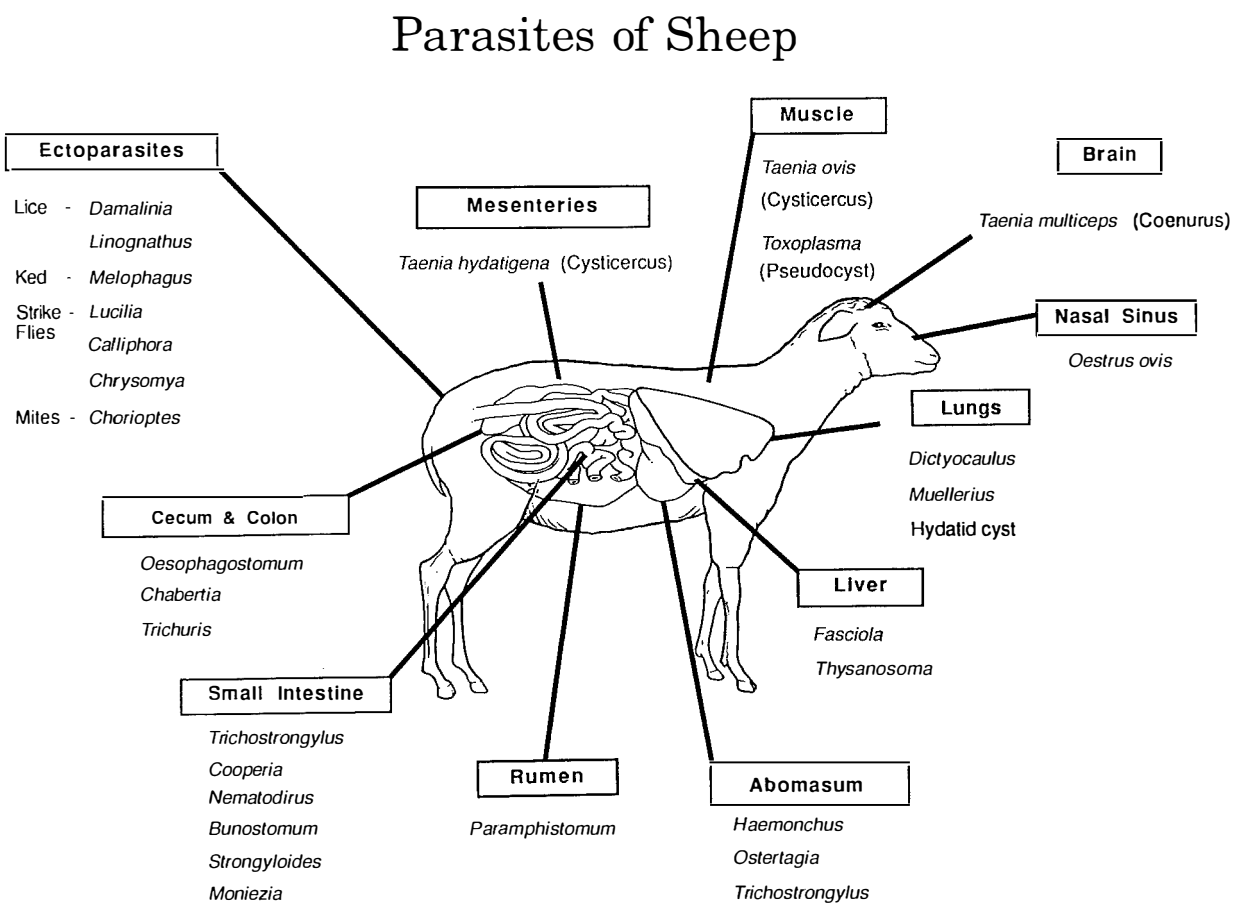


Fig. 76. Locations of the major parasites found in sheep. (Most of these are also in goats.)

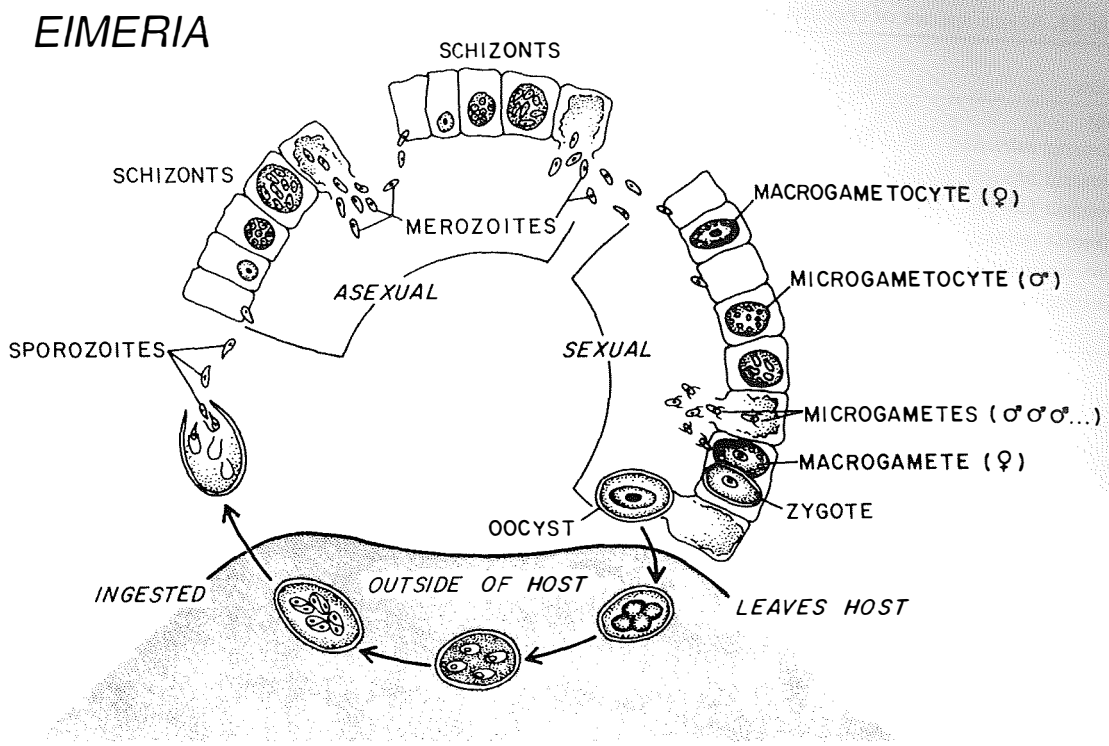


Fig. 77. Life cycle of *Eimeria* spp. in sheep and other ruminants.

Zoonotic Diseases in Sheep and Goats

Table 22. Major zoonotic diseases associated with sheep

Organism	Disease	Method of Infection
Protozoa		
Toxoplasma gondii	Toxoplasmosis	Ingestion of raw meat
Cryptosporidium sp.	Cryptosporidiosis	Ingestion of oocysts
Sarcocystis bovihominis	Diarrhea	Ingestion of raw meat
Nematodes		
Strongyloides spp.	Strongyloidiasis	Ingestion of larvae
Trichostrongylus spp.	Trichostrongyliasis	Ingestion of larvae
Trematodes		
Fasciola hepatica	Fascioliasis	Ingestion of metacercariae
Arthropods		
Calliphora spp.	Myiasis	Contact with adult flies
Oestrus ovis	Myiasis	Contact with adult flies

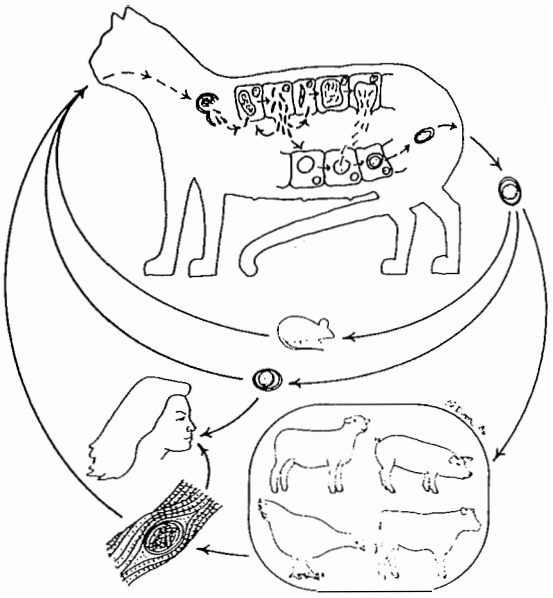


Fig. 78. *Toxoplasma gondii*. (Pseudocyst in the brain of a sheep).

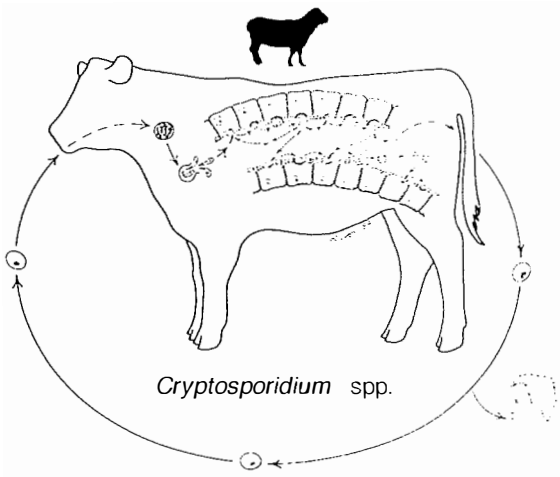


Fig. 79. *Cryptosporidium* spp. (Oocysts in feces.)

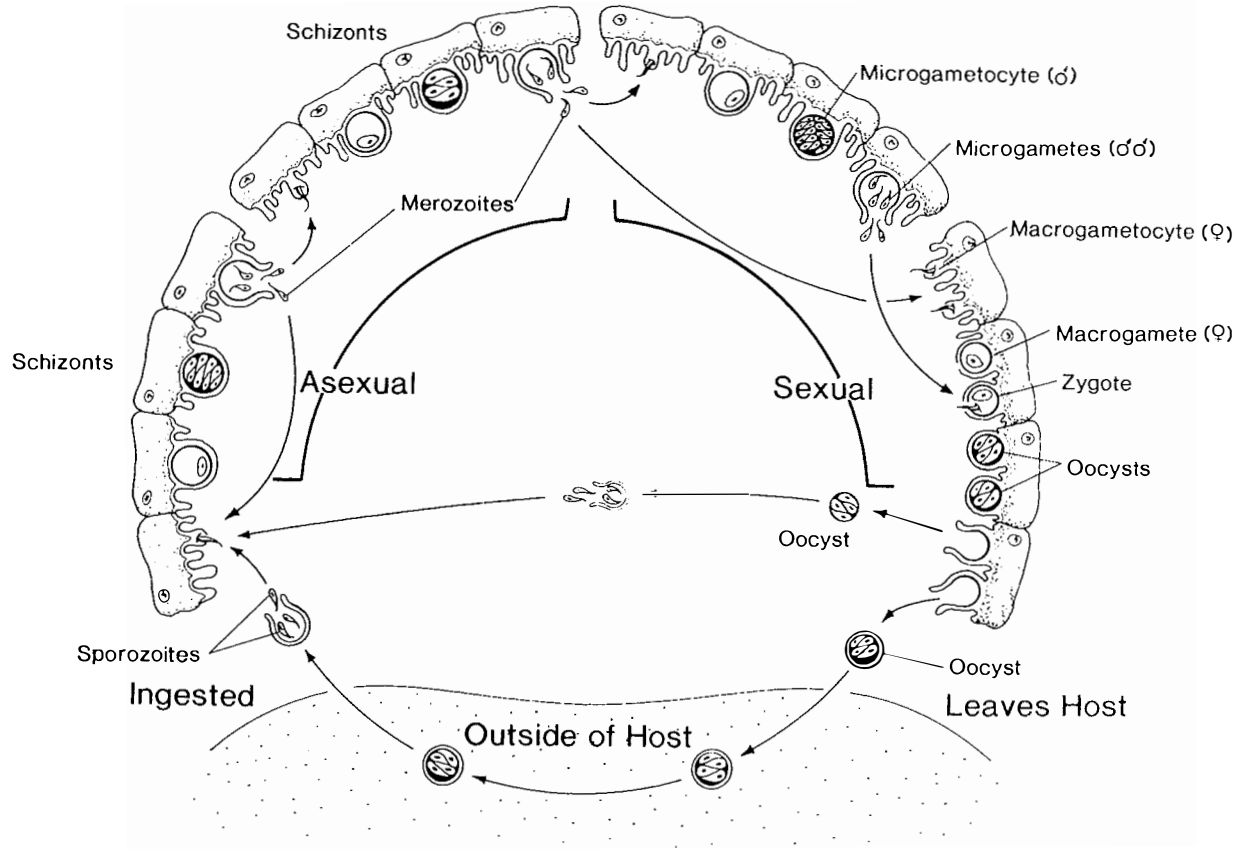


Fig. 80. Life cycle of *Cryptosporidium parvum*.

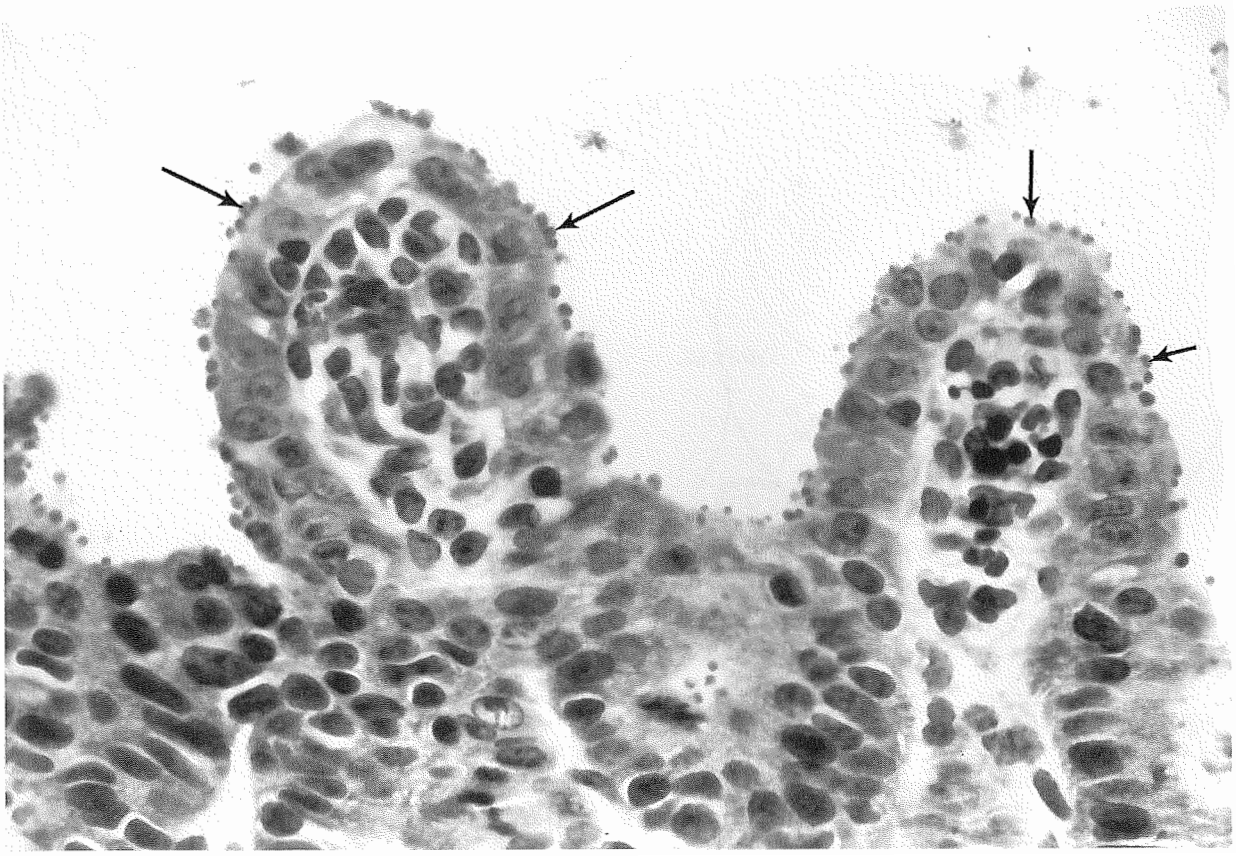


Fig. 81a. Histologic section of lamb small intestine with numerous *Cryptosporidum* oocysts (arrows) imbedded in the brush borders of the villi.

Neospora caninum

Common name: *Neospora caninum.*
Size of pseudocyst: Usually <100 µm .
Importance: This parasite can cause abortions. Liveborn calves may be underweight, weak, unable to stand, and may have neuromuscular signs. Transplacental transmission occurs.
Diagnosis: Clinical signs and histologically. Pseudocysts seen in neural tissue at necropsy.
Source of infection: Unknown.
Treatment: Treatment is experimental. Some coccidiostats and coccidiocides may be helpful.

Fig. 81b. *Neospora caninum* pseudocyst in the brain of an aborted calf.

Table 23. Efficacy of anthelmintics against major internal parasites of cattle

Drug	Dose (mg/kg PO)	Efficacy against Adult Nematodes (%)							
		Ostertagia	*Haemonchus*	*Trichostrongylus*	*Cooperia*	*Nematodirus*	*Bunostomum*	*Strongyloides*	*Oesophagostomum*
Albendazole	10.0	97–100	97–99	99–100	97–100	87–100	100	—	100
Clorsulon[a]	7.0	—	—	—	—	—	—	—	—
Coumaphos	2[b]	80–100	95–100	95–100	95–100	—	—	—	—
Doramectin	0.2 SC/IM	95–100	95–100	95–100	95–100	—	95–100	—	95–100
Eprinomectin	0.5 Pour on	95–100	95–100	95–100	95–100	95–100	95–100	95–100	95–100
Febantel	7.5	95–100	95–100	0–100	95–100	—	—	—	—
Fenbendazole	5/10	95–100	95–100	95–100	95–100	95–100	95–100	80–100	95–100
Ivermectin	0.2 SC	95–100	95–100	95–100	95–100	80–100	—	—	95–100
Levamisole	7–8	95–100	95–100	95–100	95–100	95–100	95–100	—	95–100
Morantel	10	80–100	95–100	95–100	95–100	95–100	95–100	—	95–100
Moxidectin	0.5 Pour on	95–100	95–100	95–100	95–97	95–100	95–100	—	95–100
Oxfendazole	2.5	95–100	95–100	95–100	95–100	95–100	95–100	95–100	95–100
Oxibendazole	10	95–100	80–100	95–100	95–100	80–100	95–100	95–100	95–100
Phenothiazine	220–400	80–100	95–100	95–100	0–100	0–100	0–100	—	95–100
Pyrantel	25	95–100	95–100	—	95–100	95–100	—	—	—

Dash indicates insufficient data or not effective.

[a]95–100% effective against *Fasciola hepatica*, both immature and mature.

[b]q 24 h × 7 d.

Note: Lactating dairy cattle can be treated with eprinomectrin at 0.5 mg/kg as a pour on, 0.5 mg/kg moxidectin as a pour on, coumaphos as a top dressing on feed at 2 mg/kg for 6 consecutive days, fenbendazole at 5–10 mg/kg PO, or with morantel at 10 mg/kg PO (see Courtney and Sundlof, 1991).

Table 24. Efficacy of anthelmintics against major internal parasites of sheep and goats

Drug	Dose(mg/kg PO)	Efficacy against Adult Parasites (%)								
		Haemonchus	*Ostertagia*	*Trichostrongylus*	*Cooperia*	*Nematodirus*	*Bunostomum*	*Strongyloides*	*Chabertia*	*Moniezia*
Albendazole	10	99–100	97–100	99–100	99–100	99–100	—	—	100	100
Doramectin	0.2	—	—	—	—	—	—	—	—	—
Febantel	5	95–100	95–100	95–100	—	95–100	95–100	95–100	—	—
Fenbendazole	10	95–100	95–100	95–100	95–100	95–100	95–100	—	80–100 85–95	
Ivermectin	0.2 SC	95–100	95–100	95–100	95–100	95–100	—	95–100	95–100	—
Levamisole	7.5 (5 SC & IM)	95–100	95–100	95–100	95–100	95–100	95–100	60–85	95–100	—
Morantel	10	95–100	95–100	95–100	95–100	95–100	—	—	95–100	—
Oxfendazole	5	95–100	95–100	95–100	95–100	95–100	—	—	95–100	95–100
Oxibendazole	10	95–100	95–100	0–100	95–100	95–100	95–100	95–100	95–100	95–100
Pyrantel	25	95–100	—	0–100	—	95–100	—	—	—	—

Dash indicates not effective or insufficient data (see Courtney and Sundlof, 1991).
Note: Doramectin and ivermectin are similar drugs.

Table 25. Major anticoccidial drugs used in cattle

Drug	Method	Use Level
Amprolium (prevention)	In feed/water	5 mg/kg × 21 d
Amprolium (treatment)	In feed/water	10 mg/kg × 5 d
Aureomycin-tetracycline (prevention)	In feed	35 g/d × 28 d
Decoquinate (prevention)	In feed	0.5 mg/kg × 28+ d
Lasalocid (prevention)	In feed	1 g/30 kg feed (1 mg/kg of body weight)
Monensin (prevention)	In feed	1 g/30 kg feed (1 mg/kg of body weight)
Sulfaquinoxaline	In water	13 mg/kg
Sulfamerazine	In feed	65–130 mg/kg

Table 26. Major anticoccidial drugs used in sheep and goats

Drug	Method	Use Level
Amprolium	Water	50 mg/kg of body weight q 24 h × 21 d or 0.2% in feed
Decoquinate	Feed	0.5 mg/kg of body weight in feed
Lasalocid	Feed	30 g/909 kg (ton) of feed
		454 g(15% active)/23 kg (50 lb)salt
Monensin	Feed	10–30 g/909 kg (ton) of feed
Sulfaguanidine	Feed	0.2% concentration in feed
Sulfamethazine	Feed	up to 0.5% concentration in feed

Table 27. Major drugs for control of external parasites in ruminants

Drug (Trade Name)	Parasites	Application
Organophosphates		
Chlorfenvinphos (Supona)	Ticks, lice, flies, keds, mites	Dip, spray
Chlorpyrifos (Dursban)	Ticks, lice	Dip, spray, pour on, dust, back rubber
Coumaphos (Co-Ral)	Fleas, flies, keds, lice, ticks, cattle grubs	Dip, spray, pour on, dust, back rubber, feed additive
Crotoxyphos (Cyodrin)	Ticks, mites, lice, flies	Dust, spray
Crufomate (Roulene)	Flies, lice, mites, ticks	Dip, spray, pour on
Diazinon	Flies, lice, keds, ticks	Dip, dust, spray
Dichlorvos (Vapona)	Flies	Resin granules, resin strips, spray
Dimethoate (Cygon)	Flies	Spray
Dioxathion (Delnav)	Flies, keds, lice, ticks	Dip, spray, back rubber
Famphur (Warbex)	Flies, lice, cattle grubs	Pour on, spray
Fenchlorphos (Korlan-ronnel)	Flies, lice, mites, ticks	Dust, oral, spray, back rubber, pour on
Fenthion (Tiguvon)	Cattle grubs, sheep nose bots, lice, keds, blowflies	Spray, pour on, spot on
Malathion (Cythion)	Fleas, flies, lice, keds, mites, ticks	Dip, dust, spray
Phosmet (Prolate)	Flies, lice, cattle grubs, ticks	Spray
Tetrachlorvinphos (Rabon-stirophos)	Fleas, flies, lice, ticks	Dust, ear tag, back rubber, spray
Trichlorfon (Neguvon)	Cattle grubs, flies, lice, mites	Pour on, oral, injectable, spray
Carbamates		
Carbaryl (Sevin)	Fleas, flies, lice, mites, ticks	Dip, dust, spray
Propoxur	Flies	Spray
Organochlorines		
Lindane	Flies, keds, lice, mites, ticks	Dust, spray, pour on, back rubber
Methoxychlor (Marlate)	Flies, keds, lice, mites, ticks	Dust, spray, back rubber
Toxaphene	Flies, keds, lice, mites, ticks	Dip, dust, spray, back rubber
Diamidines		
Amitraz (Mitaban, Triatox, Baam, Preventic collars)	Ticks, mites, lice +/-*	Dip, spray
Miscellaneous**		
Cypermethrin (P) (Curatick)	Ticks	Dip
Doramectin (Dectomax)	Sucking lice, grubs, *Psoroptes*, *Sarcoptes*	SC or IM (0.2 mg/kg)
Eprinomectin (Ivomec-Eprinex)	Lice, horn flies, *Sarcoptes*, *Chorioptes*, grubs	Pour on (0.5 mg/kg)
Fenvalerate(P) (Ectrin)	Flies, ticks	Spray, ear tags
Ivermectin (Ivomec)	Lice, mites, cattle grubs	Oral, injectable SC, IM (0.2 mg/kg)
Methoprene (IGR)	Flies	Feed additive
Moxidectin (Cydectin)	Lice, *Chorioptes*, *Psoroptes*	Pour on
Pyrethrum	Flies, fleas, keds, lice	Spray
Permethrin (P) (Ectiban)(Expar)	Flies, lice, mites, ticks	Dip, spray
Resmethrin (P)	Ticks	Spray
Bacillus thuringiensis (B)	Aquatic insect larvae	Dried powder

*+/- = variable efficacy.

**Includes pyrethroids (P), insect growth regulators (IGR), bacteria (B), and others.

Note: For lactating dairy cattle, the following drugs are used: coumaphos, crotoxyphos, dichlorvos, eprinomectrin, fenvalerate, malathion, methoprene, methoxychlor, permethrin, pyrethrins, and stirofos.

Read label directions carefully. The label is the most authoritative source of information.

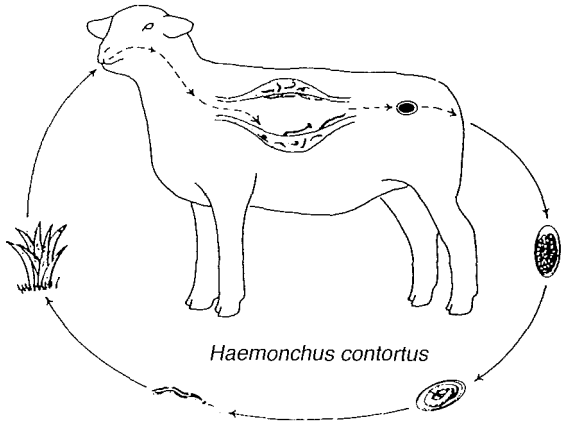


Fig. 82a. *Haemonchus contortus* (sheep) *Haemonchus placei* (cattle) prepatent period is 17–21 days.

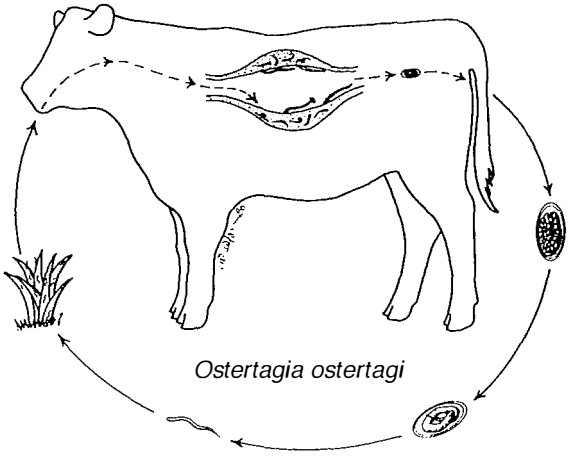


Fig. 83a. *Ostertagia ostertagi* (cattle) *Teladorsagia circumcincta* (sheep) prepatent period is 16–23 days.

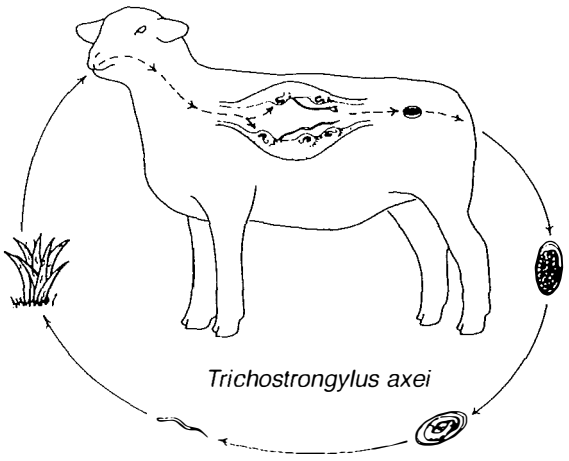


Fig. 84a. *Trichostrongylus axei* prepatent period is 3 weeks.

Internal Parasites

Haemonchus contortus

Common name: Barber's pole or wire worm (Trichostrongyloidea).
Adult size: 10–30 mm in abomasum.
Size of egg: 80 μm × 45 μm.
Importance: Acute anemia in lambs; bottle jaw, death, chronic weight loss in adults.
Diagnosis: Fecal flotation; eggs do not larvate after 4–5 days of refrigeration. At necropsy, adults are found in abomasum.
Treatment: Drug resistance often develops.
- Albendazole, 10 mg/kg PO
- Doramectin, 0.2 mg/kg IM or SC
- Eprinomectrin, 0.5 mg/kg pour on
- Ivermectin, 0.2 mg/kg SC
- Fenbendazole, 5 mg/kg PO
- Levamisole, 5–8 mg/kg PO (cattle)
- Morantel tartrate, 9.7 mg/kg PO
- Moxidectin, 0.5 my/kg pour on
- Tetramisole, 15 mg/kg PO (for sheep, do not exceed total 600-mg dosage)

Ostertagia ostertagi

Common name: Brown stomach worm (Trichostrongyloidea).
Adult size: 6–10 mm in abomasum.
Size of egg: 80 μm × 45 μm.
Importance: Larvae destroy gastric glands of cattle; may cause severe diarrhea and weight loss. Type I: Larvae mature and adults produce eggs. Pre-type II: Not clinically apparent. Fourth-stage larvae are inhibited in gastric glands. Type II: Maturation of inhibited larvae with weight loss, diarrhea, anorexia, anemia, no fever, often no eggs in feces.
Diagnosis: Fecal flotation; plasma pepsinogen levels may be increased. At necropsy, adults and nodular lesions are found in abomasum.
Treatment: Albendazole, 10 mg/kg PO kills Type II
- Doramectin, 0.2 mg/kg IM or SC
- Eprinomectrin, 0.5 mg/kg pour on
- Fenbendazole, 5 mg/kg PO kills Type II at 10 mg/kg
- Ivermectin, 0.2 mg/kg SC kills Type II
- Morantel tartrate, 9.7 mg/kg PO
- Moxidectin, 0.5 mg/kg pour on kills Type II

Trichostrongylus axei

Common name: Bankrupt worm or small stomach worm (Trichostrongyloidea).
Adult size: 4–8 mm in abomasum.
Size of egg: 80 μm × 40 μm.
Importance: In cattle, sheep, goats there is diarrhea, dehydration, bottle jaw, and emaciation in stressed animals.
Diagnosis: Eggs in fecal flotation. At necropsy, adults (4–6 mm) in abomasum.
Treatment: Albendazole, 10 mg/kg PO
- Doramectin, 0.2 mg/kg IM or SC
- Eprinomectrin, 0.5 mg/kg pour on
- Fenbendazole, Spring, 5 mg/kg PO
- Ivermectin, Fall, 0.2 mg/kg SC
- Morantel tartrate, 9.7 mg/kg PO
- Moxidectin, 0.5 mg/kg pour on

Fig. 82b. *Haemonchus contortus.*

Fig. 82c. *Haemonchus contortus .*

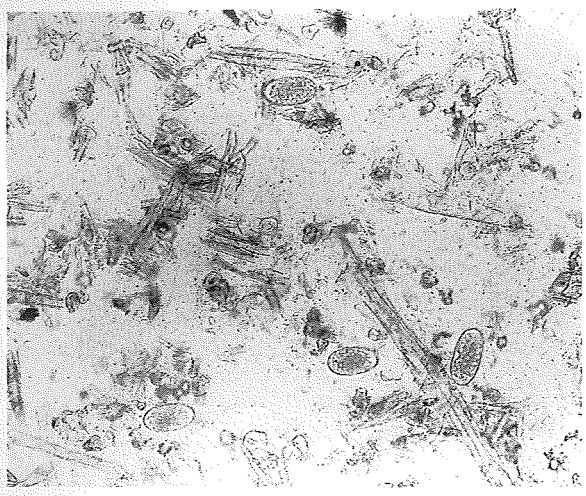


Fig. 83b. *Ostertagia ostertagi.*

Fig. 83c. *Ostertagia ostertagi.*

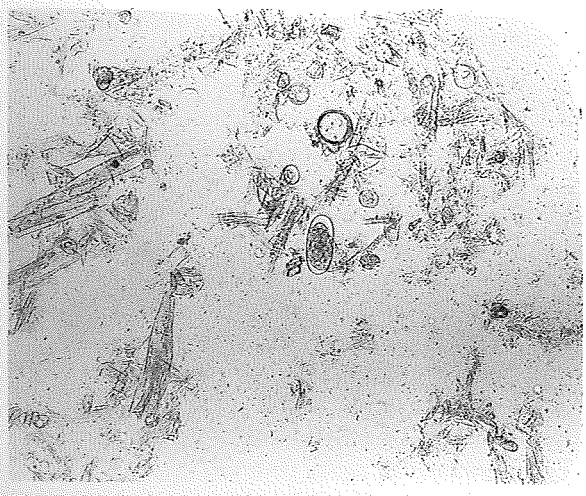


Fig. 84b. *Trichostrongylus axei.*

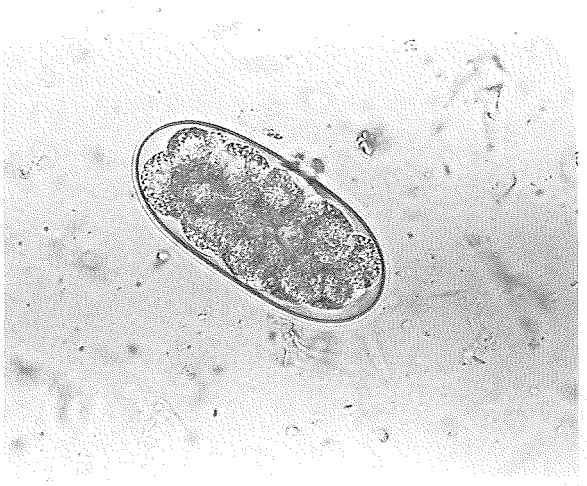


Fig. 84c. *Trichostrongylus axei.*

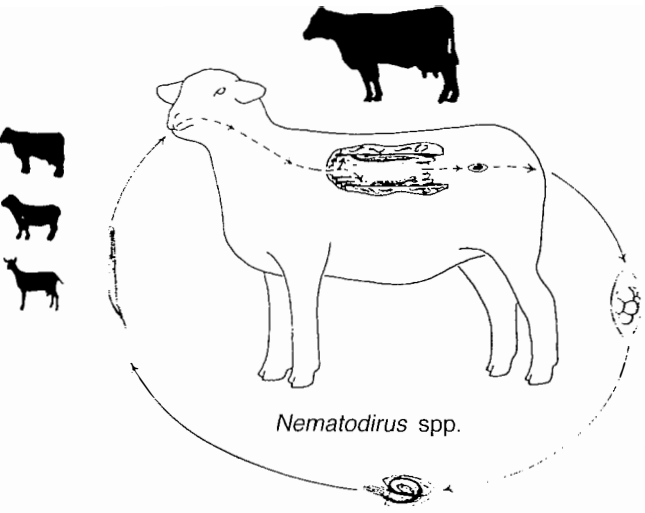


Fig. 85a. *Nematodirus* spp. prepatent period is 14–21 days.

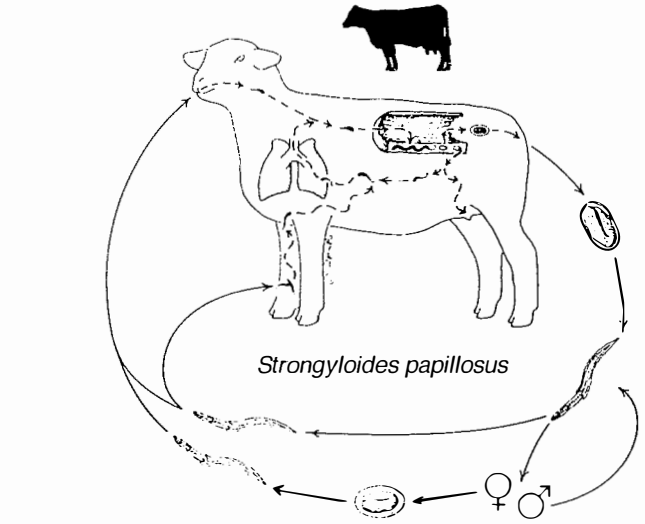


Fig. 86a. *Strongyloides* spp. prepatent period is 1–2 weeks.

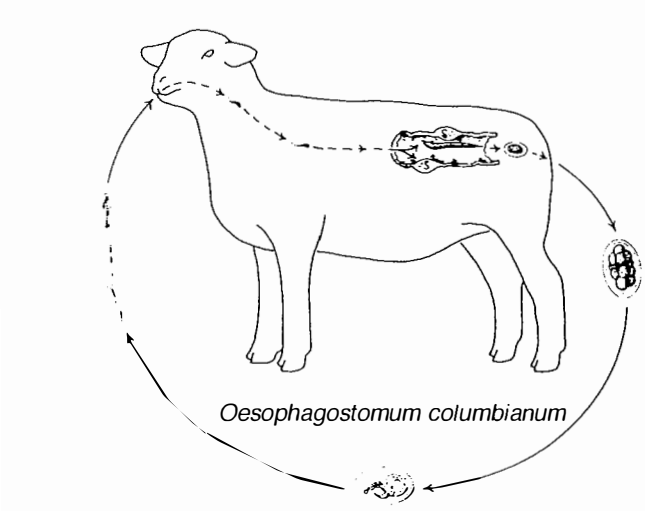


Fig. 87a. *Oesophagostomum columbianum* prepatent period is 40 days.

Nematodirus spp.

Common name: Thin-necked intestinal worm (Trichostrogyloidea).
Adult size: 10–25 mm in small intestine. Sheep: *N. filicollis*, *N. battus*, *N. spathiger*; cattle: *N. helvetianus*.
Size of egg: *N. filicollis* 200 µm × 90 µm; *N. battus* 175 µm × 75 µm.
Importance: Acute diarrhea in young animals; may be fatal, especially *N. battus*.
Diagnosis: Eggs in fecal flotation. At necropsy, adults are found in small intestine.
Treatment: Albendazole, 10 mg/kg PO
Eprinomectrin, 0.5 mg/kg pour on
Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg SC
Levamisole, 5–8 mg/kg PO
Morantel tartrate, 9.7 mg/kg PO
Moxidectin, 0.5 mg/kg pour on

Strongyloides papillosus

Common name: Threadworm (Rhabditoidea).
Adult size: 3–6 mm in small intestine.
Size of egg: 50 µm × 22 µm.
Importance: Cutaneous exposure in sheep may contribute to foot rot, diarrhea in young animals; transmammary transmission possible.
Diagnosis: Larvated eggs or larvae in fecal flotation.
Treatment: Eprinomectrin, 0.5 mg/kg pour on
Ivermectin, 0.2 mg/kg SC

Oesophagostomum columbianum

Common name: Nodular worm (Strongyloidea).
Adult size: 14–22 mm in large intestine. Sheep and goats: *O. columbianum*, *O. venulosum*; cattle: *O. radiatum*.
Size of egg: 80 µm × 40 µm.
Importance: Nodular worm of sheep and cattle. May cause diarrhea with subsequent fly strike in sheep.
Diagnosis: Eggs in fecal flotation. At necropsy, nodules are seen in walls of small and large intestines and adults are found in large intestine.
Treatment: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg IM or SC
Eprinomectrin, 0.5 mg/kg pour on
Levamisole, 5–8 mg/kg PO
Morantel tartrate, 9.7 mg/kg PO
Moxidectin, 0.5 mg/kg pour on

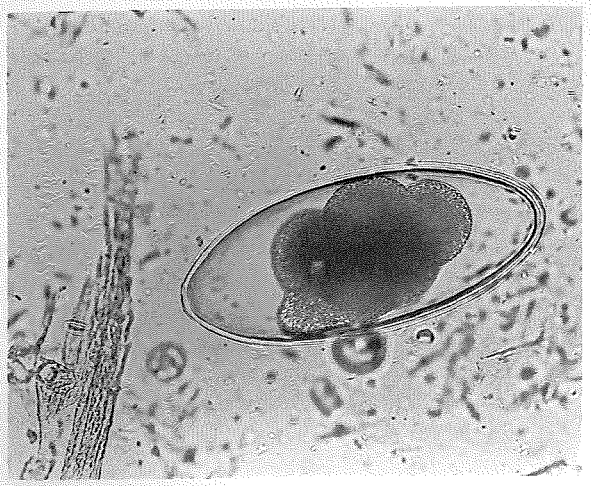


Fig. 85b. *Nematodirus filicollis.*

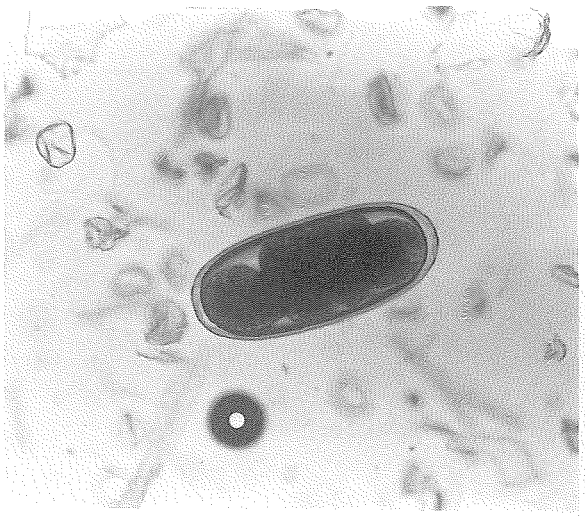


Fig. 85c. *Nematodirus battus.*

Fig. 86b. *Strongyloides* spp.

Fig. 86c. *Strongyloides* spp.

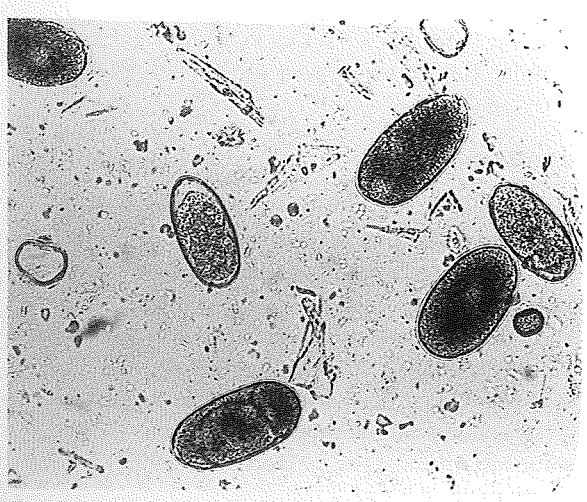


Fig. 87b. *Oesophagostomum columbianum.*

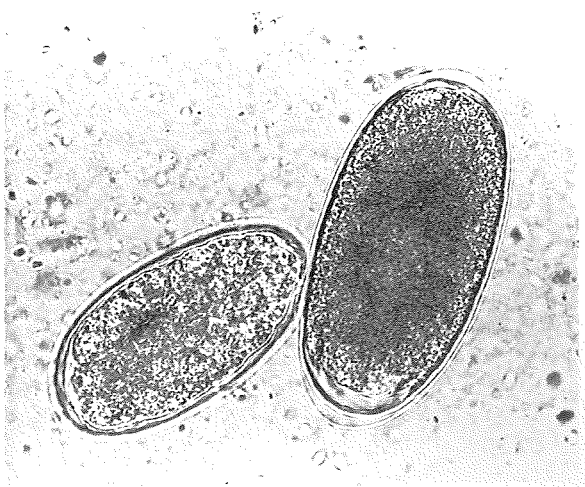


Fig. 87c. *Oesophagostomum columbianum.*

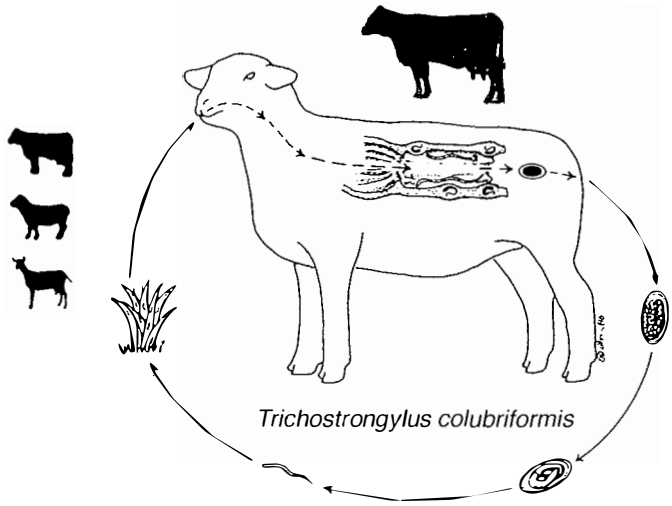


Fig. 88. *Trichostrongylus colubriformis* prepatent period is 3 weeks.

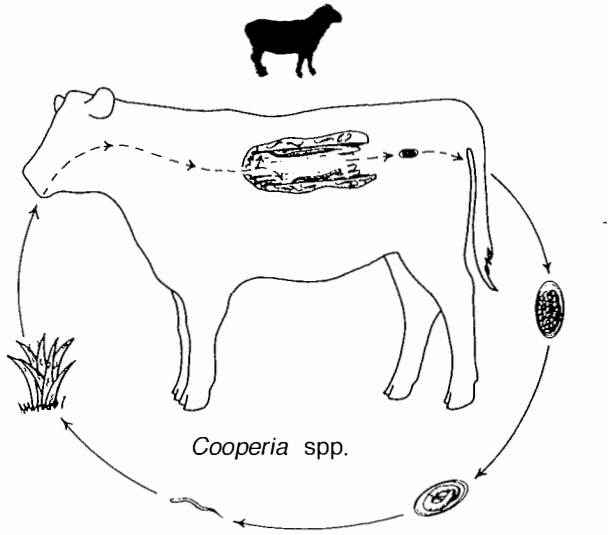


Fig. 89. *Cooperia* spp. prepatent period is 3 weeks.

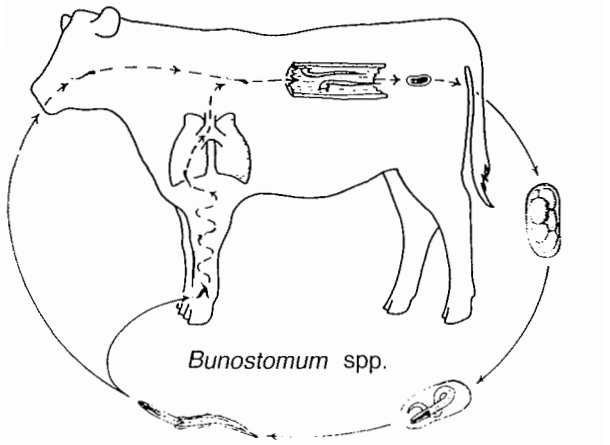


Fig. 90. *Bunostomum* spp. prepatent period is 2 months.

Trichostrongylus colubriformis

Common name: Hair worm, black scour worm (Trichostrongyioidea).
Adult size: 4–8 mm in small intestine.
Size of egg: 85 µm × 40 µm.
Importance: In sheep and goats, acute diarrhea in young; chronic diarrhea in older animals. May cause bottle jaw and severe reduction in growth.
Diagnosis: Eggs in fecal flotation. At necropsy, adults are found in small intestine.
Treatment: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg IM or SC
Eprinomectrin, 0.5 mg/kg pour on
Fenbendazole, 5 mg/kg PO
Levamisole, 7.5 mg/kg PO
Morantel tartrate, 9.7 mg/kg PO
Moxidectin, 0.5 mg/kg pour on

Cooperia spp.

Common name: Cattle bankrupt worm (Tricho-strongyloidea).
Adult size: 4–8 mm in small intestine. Cattle: *C. pectinata*, *C. punctata*, *C. spatulata*, *C. mcmasteri* (*surnabada*); sheep and goats: *C. punctata*, *C. pectinata*.
Size of egg: 77 µm × 34 µm.
Importance: In cattle, sheep, and goats, not highly pathogenic; diarrhea, anorexia, depressed growth. Synergistic with *Ostertagia ostertagia*.
Diagnosis: Eggs in fecal flotation. At necropsy, adults are found in small intestine.
Treatment: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg IM or SC
Eprinomectrin, 0.5 mg/kg pour on
Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg SC
Levamisole, 5–8 mg/kg PO
Morantel tartrate, 9.7 mg/kg PO
Moxidectin, 0.5 mg/kg pour on

Bunostomum spp.

Common name: Hookworm (Trichostrongyloidea).
Adult size: 10–28 mm in small intestine. Cattle: *B. phlebotomum*; Sheep: *B. trigonocephalum*.
Size of egg: 95 µm × 50 µm.
Importance: In cattle and sheep, anemia and diarrhea in young animals, loss of weight, death.
Diagnosis: Eggs in fecal flotation. At necropsy, adults are found in small intestine.
Treatment: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg IM or SC
Eprinomectrin, 0.5 mg/kg pour on
Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg SC
Moxidectin, 0.5 mg/kg pour on

Table 28. Miscellaneous Trichostrongyle parasites of ruminants that have similar "strongyle-type" eggs in feces, and other miscellaneous parasites

Cattle Strongyles		
Bunostomum phlebotomum	Cattle hookworm	Adult in small intestine
Cooperia mcmasteri (surnabada)	Cattle bankrupt worm	Adult in small intestine
Cooperia oncophora	Cattle bankrupt worm	Adult in small intestine
Cooperia punctata	Cattle bankrupt worm	Adult in small intestine
Cooperia pectinatia	Cattle bankrupt worm	Adult in small intestine
Haemonchus placei	Barber's pole worm	Adult in abomasum
Oesophagostomum radiatum	Nodular worm	Adult in large intestine
Oesophagestomum venulosum	Nodular worm	Adult in large intestine
Ostertagia ostertagia	Brown stomach worm	Adult in abomasum
Trichostrongylus axei	Bankrupt or hair worm	Adult in abomasum
Trichostrongylus colubriformis	Hair worm	Adult in small intestine
Sheep and Goat Strongyles		
Bunostomum trigonocephalum	Hookworm	Adult in small intestine
Chabertia ovina	Large-mouthed bowel worm	Adult in colon
Cooperia curticei	Cooperid	Adult in small intestine
Cooperia pectinata	Cooperid	Adult in small intestine
Cooperia punctata	Cooperid	Adult in small intestine
Cooperia oncophora	Cooperid	Adult in small intestine
Haemonchus contortus	Barber's pole worm	Adult in abomasum
Oesophagostomum columbianum	Nodular worm	Adult in large intestine
Oesophagostomum venulosum	Nodular worm	Adult in large intestine
Ostertagia lyrata	Brown stomach worm	Adult in abomasum
Teladorsagia circumcincta	Brown stomach worm	Adult in abomasum
Teladorsagia trifurcata	Brown stomach worm	Adult in abomasum
Trichostrongylus axei	Bankrupt or hair worm	Adult in abomasum
Trichostrongylus colubriformis	Hair worm	Adult in small intestine
Trichostrongylus vitrinus	Hair worm	Adult in small intestine
Trichostrongylus capricola	Hair worm	Adult in small intestine
Other Miscellaneous Nematodes Parasites		
Cattle		
Parafilaria bovicola	Filarial worm	Adult in subcutaneous tissue
Sheep and Goats		
Skrjabinema ovis	Pinworm	Adult in cecum

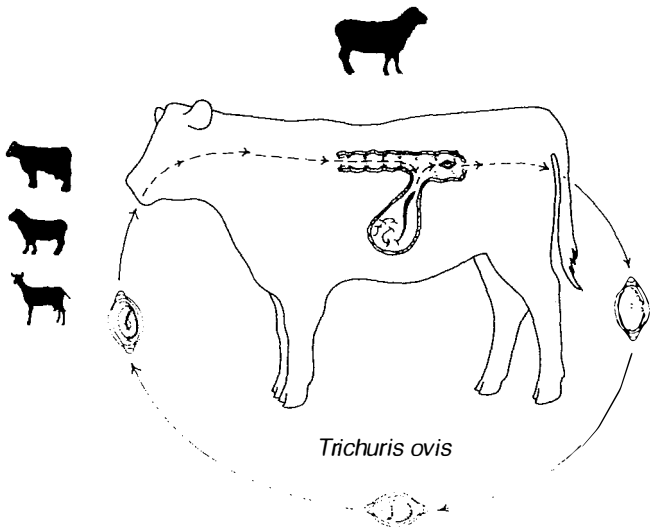


Fig. 91a. *Trichuris ovis* prepatent period is 2 months.

Trichuris ovis

Common name: Whipworm (Trichuroidea).
Adult size: 2–3 mm in cecum and large intestine.
Size of egg: 75 µm × 35 µm.
Importance: Rarely pathogenic; overwhelming infections may cause fatal hemorrhage into cecum.
Diagnosis: Eggs in fecal flotation. At necropsy, adults are found in cecum and large intestines.
Treatment: Doramectin, 0.2 mg/kg IM or SC
Eprinomectrin, 0.5 mg/kg pour on
Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg SC

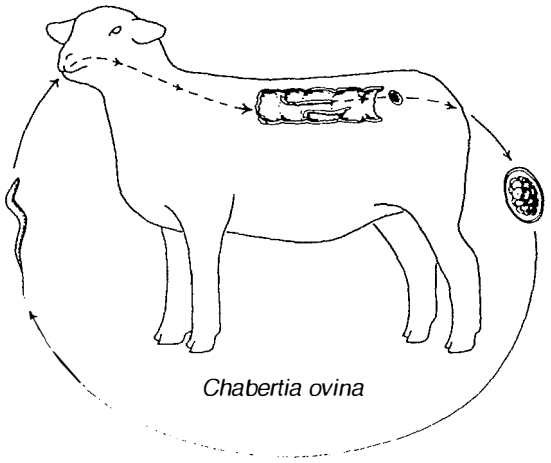


Fig. 92a. *Chabertia ovina* prepatent period is 2 months.

Chabertia ovina

Common name: Large-mouth bowel worm (Strongyloidea).
Adult size: 13–20 mm in large intestine.
Size of egg: 100–120 µm × 40–50 µm.
Importance: Occasionally causes severe anemia.
Diagnosis: Eggs in fecal flotation. At necropsy, adults are found in colon.
Treatment: Albendazole, 10 mg/kg PO
Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg SC

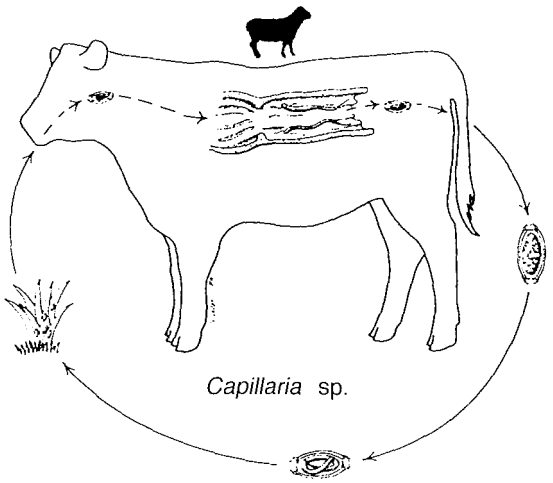


Fig. 93a. *Capillaria* sp. prepatent period is 6 weeks.

Capillaria sp.

Common name: Capillary worm (Trichuroidea).
Adult size: 5–8 mm in small intestine.
Size of egg: 50 µm × 30 µm.
Importance: Mostly nonpathogenic, but egg may be confused with *Trichuris* spp.
Diagnosis: Eggs in fecal flotation.
Treatment: None tested.
Doramectin, 0.2 mg/kg IM or SC
Eprinomectrin, 0.5 mg/kg pour on
Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg SC

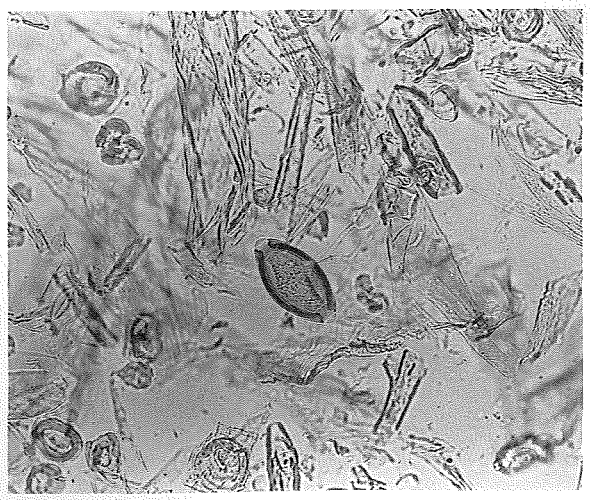


Fig. 91b. *Trichuris ovis.*

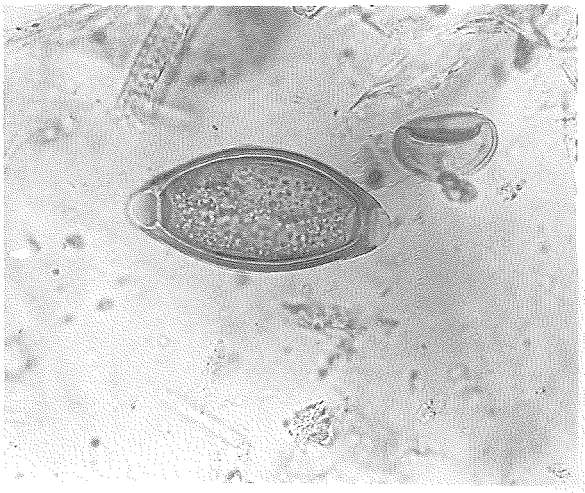


Fig. 91c. *Trichuris ovis.*

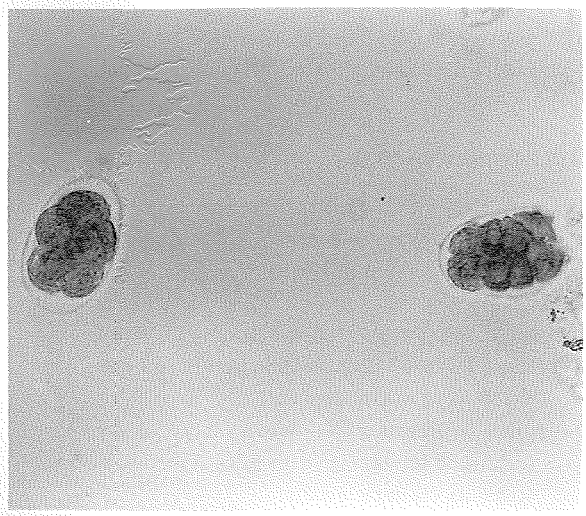


Fig. 92b. *Chabertia ovina.*

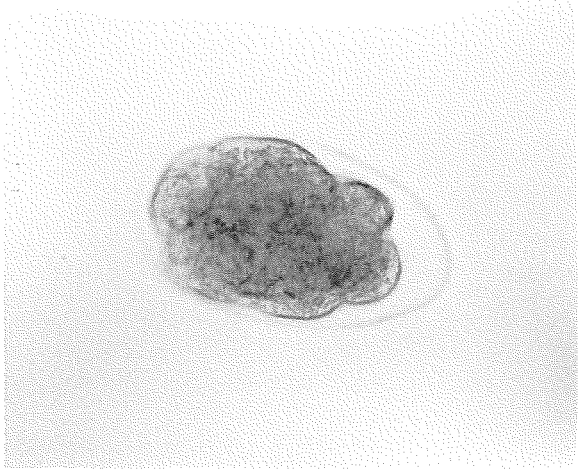


Fig. 92c. *Chabertia ovina.*

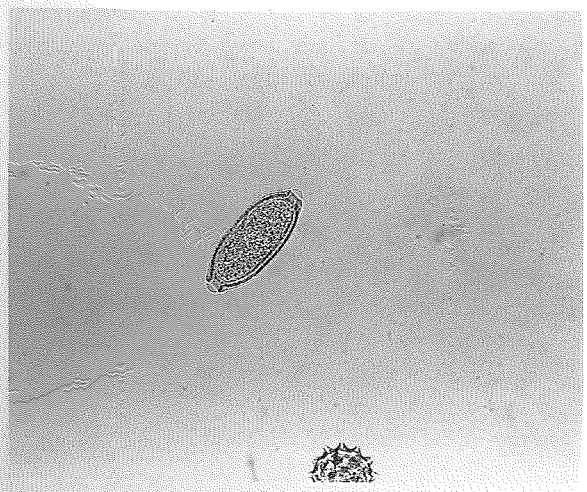


Fig. 93b. *Capillaria* sp.

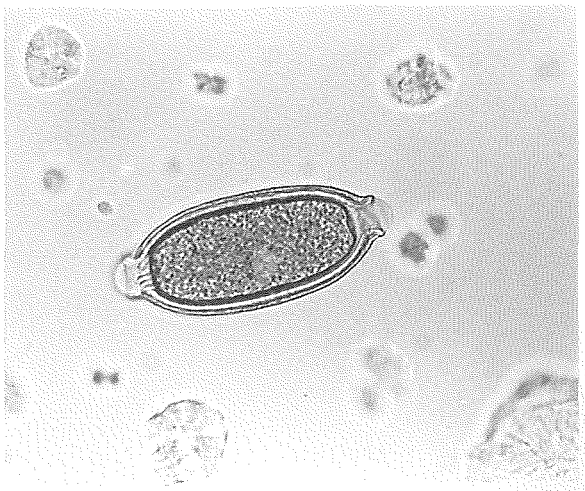


Fig. 93c. *Capillaria* sp.

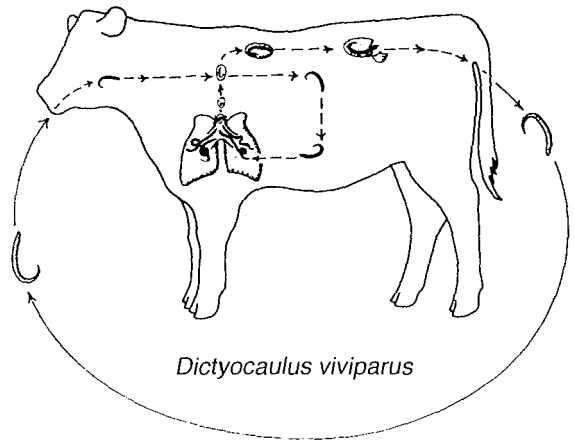


Fig. 94a. *Dictyocaulus viviparus* (cattle), *Dictyocaulus filaria* (sheep) prepatent period is 4 weeks (22–25 days).

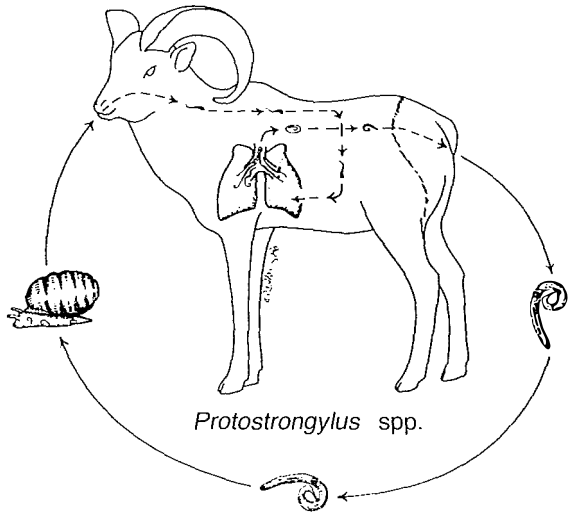


Fig. 95a. *Protostrongylus rufescens* (sheep), *P. rushi*, *P. stilesi* (bighorn sheep) prepatent period is 5 weeks.

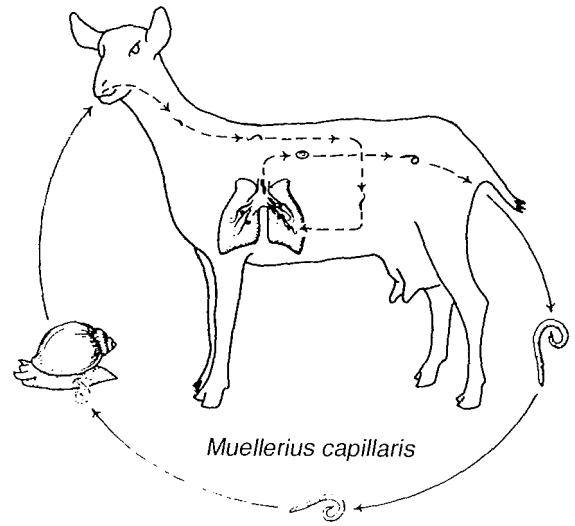


Fig. 96a. *Muellerius capillaris* prepatent period is 5 weeks.

Dictyocaulus viviparus

Common name: Lungworm (Trichostrongyloidea).
Adult size: 3–8 cm in lungs.
Size of larva: 390–450 µm × 20–25 µm.
Importance: Young animals (acute form): cough, cyanosis, dyspnea. Adults (chronic form): cough, dyspnea, lethargy.
Diagnosis: Baermann technique for larvae from feces: characteristic larvae (many interstitial cells, short tail). Fecal flotation: larvated ova or some free larvae in feces. At necropsy, adult (3–5 cm) in passages of lung. Cattle: *D. viviparus*; sheep: *D. filaria*.
Treatment: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg IM or SC
Eprinomectrin, 0.5 mg/kg pour on
Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg SC
Levamisole, 5–8 mg/kg PO in early spring
Moxidectin, 0.5 mg/kg pour on

Protostrongylus spp.

Common name: Bighorn sheep lungworm (Metastrongyloidea).
Adult size: 10–20 mm in lungs.
Size of larva: 340–400 µm × 20 µm.
Importance: Predisposes to pneumonia in bighorn sheep; transplacental transmission in bighorn sheep, respiratory signs.
Diagnosis: Uncommon in domestic sheep. Baermann technique for larvae from feces. Fiber optic endoscope to visualize adults.
Treatment: Albendazole, 10 mg/kg PO
Fenbendazole, 15 mg/kg PO
Ivermectin, 0.2 mg/kg SC

Muellerius capillaris

Common name: Goat lungworm (Metastrongyloidea).
Adult size: 4–12 mm in lungs.
Size of larva: 300 µm × 15 µm.
Importance: May predispose to pneumonia.
Diagnosis: Baermann technique for larvae from feces.
Treatment: Albendazole, 10 mg/kg PO
Fenbendazole, 15 mg/kg PO
Ivermectin, 0.2 mg/kg SC

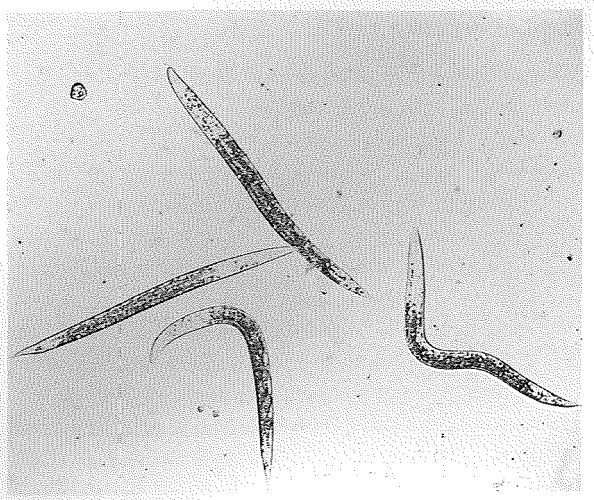


Fig. 94b. *Dictyocaulus viviparus.*

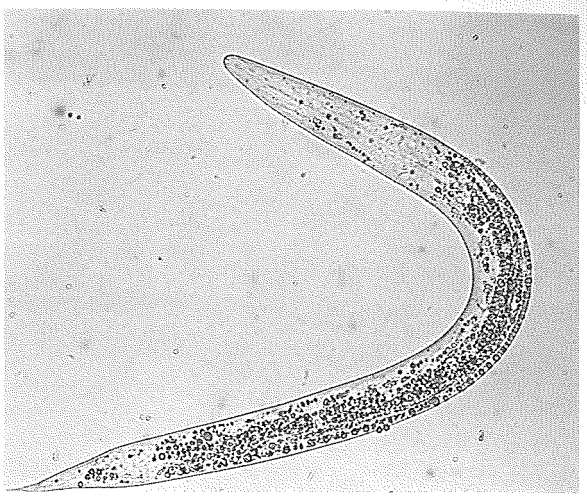


Fig. 94c. *Dictyocaulus viviparus.*

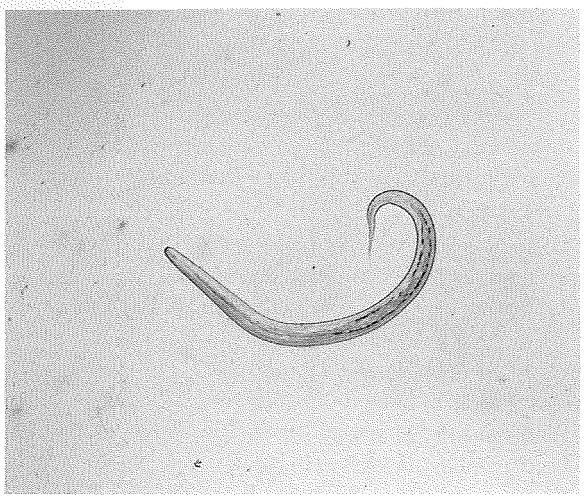


Fig. 95b. *Protostrongylus* sp.

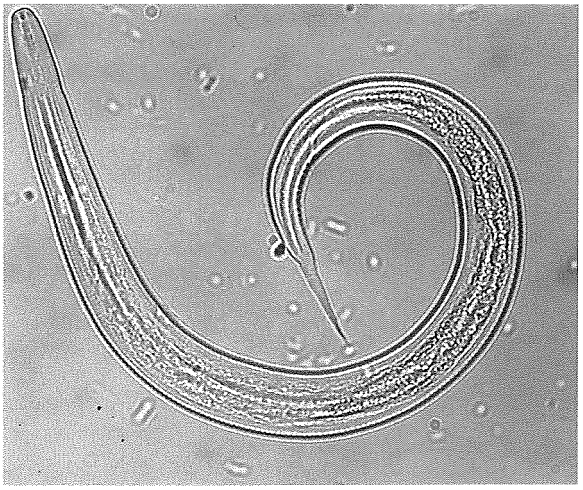


Fig. 95c. *Protostrongylus* sp. (Note long, straight tail.)

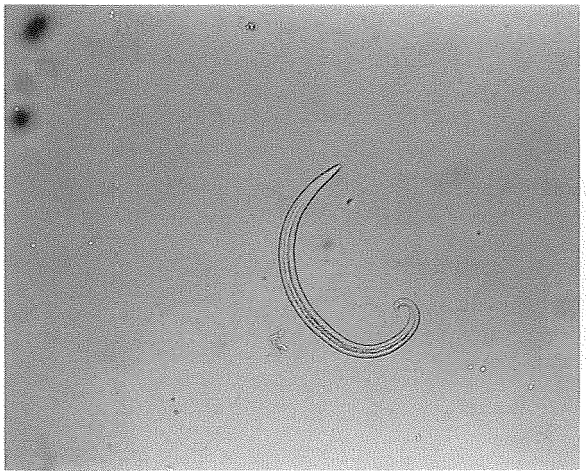


Fig. 96b. *Muellerius capillaris.*

Fig. 96c. *Muellerius capillaris.* (Note kinky tail.)

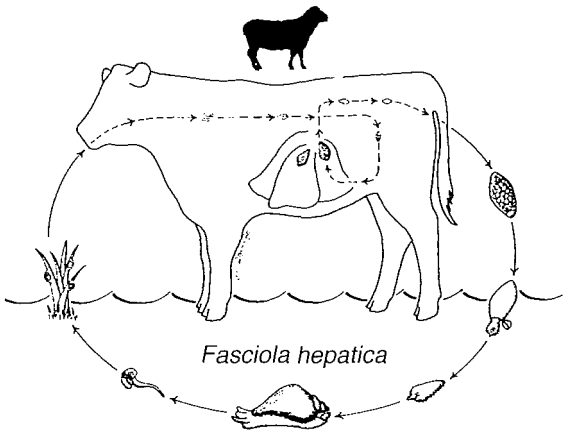


Fig. 97a. *Fasciola hepatica* prepatent period is 10–12 weeks.

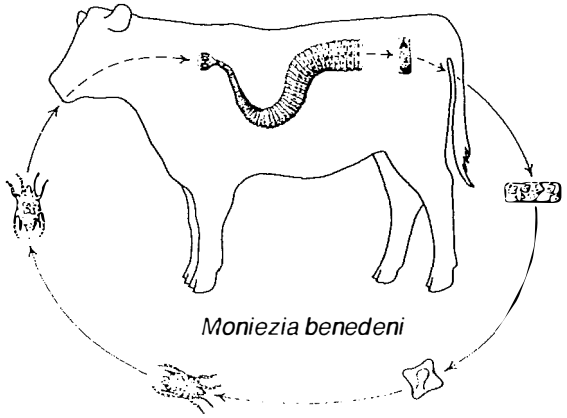


Fig. 98a. *Moniezia benedeni* (cattle), *Moniezia expansa* (sheep) prepatent period is 40 days.

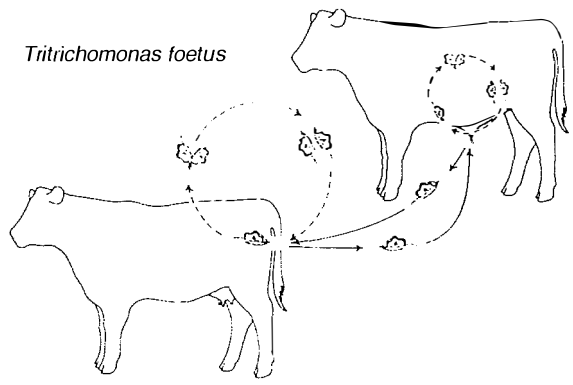


Fig. 99a. *Tritrichomonas foetus* reproduces quickly.

Fasciola hepatica

Common name: Common liver fluke (Fasciolidae).
Adult size: 3–4 cm in hepatic bile ducts.
Size of egg: 140 µm × 80 µm.
Importance: Acute syndrome: hepatic trauma due to migration may result in hepatitis and death. Chronic syndrome: anemia, weight loss, decreased production and weaning weights, liver condemnation; predisposes to clostridial diseases.
Diagnosis: Eggs in fecal sedimentation. At necropsy, trematodes (flukes) are found in bile ducts, tracts within liver parenchyma. Serology: ELISA test.
Treatment: Albendazole, PO 10 mg/kg (cattle); 15 mg/kg (sheep)
Clorsulon, 7 mg/kg PO
Nitroxynil, 10 mg/kg SC
Rafoxanide, 7.5 mg/kg PO
Prevention: Snail control; fence off snail-infested areas.

Moniezia benedeni

Common name: Tapeworm (Anoplocephalidae).
Adult size: Up to 100 cm in small intestine.
Size of egg: 60 µm.
Importance: Relatively nonpathogenic.
Diagnosis: Rectangular segments in feces, eggs in fecal flotation. At necropsy, adult tapeworms (100 cm) in small intestine.
Treatment: Albendazole, 10 mg/kg PO
Dichlorophen, 200–400 mg/kg PO
Fenbendazole, 10 mg/kg PO
Lead arsenate, 0.5–1.0 g/50 lb. PO
Niclosamide, 50 mg/lb. PO

Tritrichomonas foetus

Common name: Trich (Mastigophora), a flagellated protozoan parasite.
Size of trophozoite: 10–25 µm in genital tract.
Importance: Venereal disease of cattle, early abortion storms (15 to 18 days after conception) and pyometra.
Diagnosis: Preputial washings and culture.
Treatment: Ipronidazole, 30 g/bull on day 1, then 15 g/bull q 24 h on days 2 and 3.
Metronidazole, 75 mg/kg IV q 12 h × 3 d
Self-limiting in cows not bred for 90 days after abortion.
Note: Trichomonas vaginalis in humans is treated with metronidazole, 500 mg q 12 h × 7 d, or 2 g in a single dose, or 2 g q 24 h × 3–5 d.

Fig. 97b. *Fasciola hepatica.*

Fig. 97c. *Fasciola hepatica.* The operculum has opened.

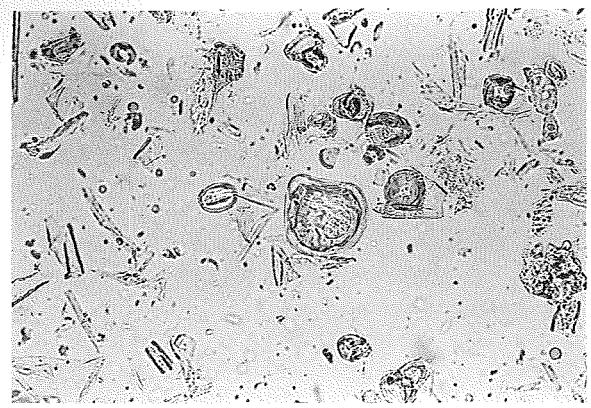


Fig. 98b. *Moniezia benedeni.*

Fig. 98c. *Moniezia benedeni.* Note hooks in egg.

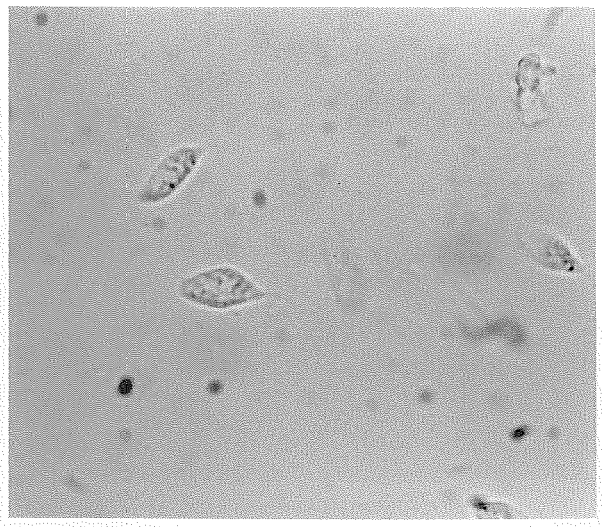


Fig. 99b. *Tritrichomonas foetus.* Fresh smear.

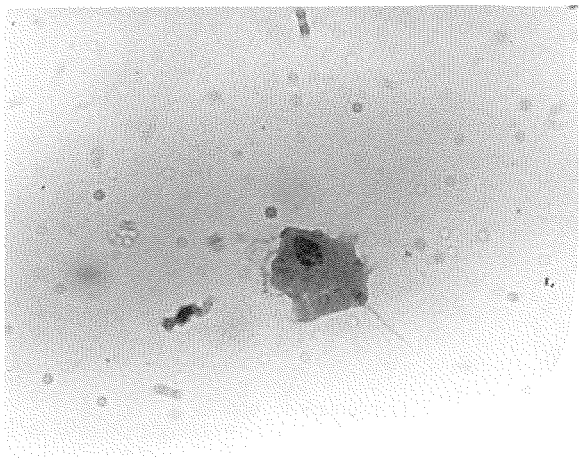


Fig. 99c. *Tritrichomonas foetus.* Stained specimen.

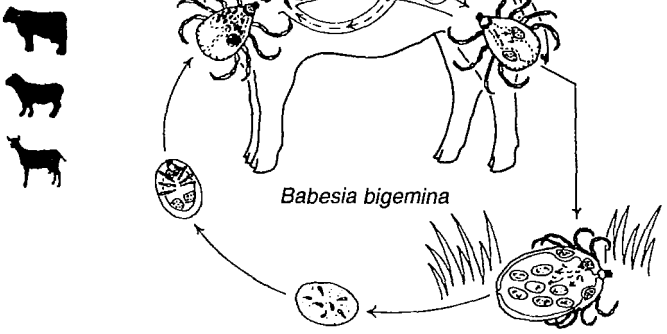


Fig. 100a. *Babesia bigemina*. Incubation period is variable (14–70 days).

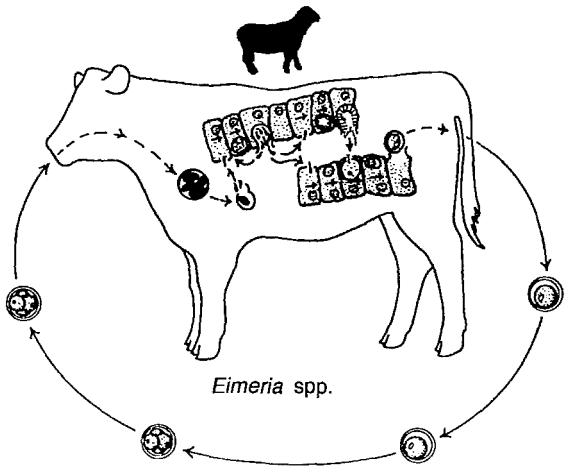


Fig. 101a. *Eimeria* spp. Prepatent period is 12–18 days.

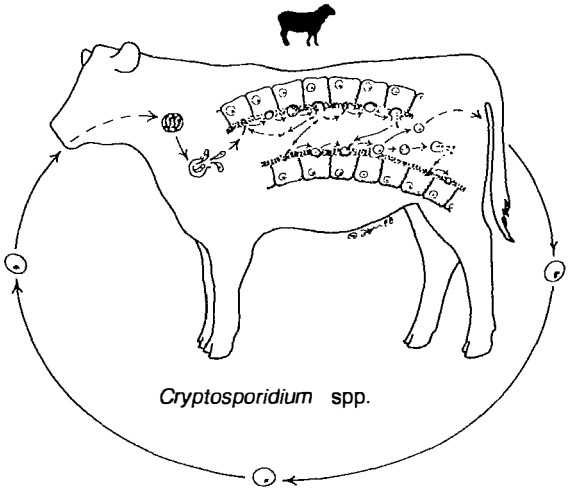


Fig. 102a. *Cryptosporidium* sp. Prepatent period is 3–5 days.

Babesia bigemina

Common name: *Babesia* or pyroplasma (Apicomplexa).
Size of trophozoites: 2–3 µm × 4–5 µm in red blood cells.
Importance: Causes Texas cattle fever (babesiosis, pyroplasmosis), anemia, high fever, splenomegaly. This is an exotic and reportable disease in the USA. It is transmitted by *Boophilus* ticks, which are also reportable.
Diagnosis: Stained blood smear.
Treatment: Dip for ticks.
Acriflavine, 200–400 ml IV or 1:200 to 1:1,000 solution
Berenil, 3.5–5.0 mg/kg IM
Phenamide, 9.0–13.5 mg/kg IM

Eimeria spp.

Common name: Coccidia (Apicomplexa).
Size of oocyst: 16–47 µm × 13–32 µm in small intestine; several species. (See Tables 19 and 21.)
Importance: Some pathogenic species cause clinical coccidiosis. Young animals: bloody diarrhea, death. Adults: decreased production, diarrhea.
Diagnosis: Oocysts in fecal flotation. Hyperemic, hemorrhagic intestines, whitish raised lesions in intestines found at necropsy.
Treatment: Amprolium, 10 mg/kg PO q 24 h × 5–21 d
Sulfamethazine, 0.5% in feed, or 130 mg/kg PO, then 65 mg/kg q 12 h × 4 d
Prevention: Decoquinate, 0.5 mg/kg PO q 24 h × 28+ d
Lasalocid, 1 mg/kg PO q 24 h × 30+ d
Monensin, 0.25 mg/kg PO in feed q 24 h × 31 d
Sulfaguanidine, 0.2% of feed

Cryptosporidium spp.

Common name: Crypto (Apicomplexa).
Size of oocyst: 6 µm × 6 µm in small intestine.
Importance: Diarrhea in calves 1–2 weeks old; varying pathogenicity; transmissible to humans.
Diagnosis: Oocysts in fecal flotation. Oocysts float high against coverslip – focus high.
Treatment: Supportive care.

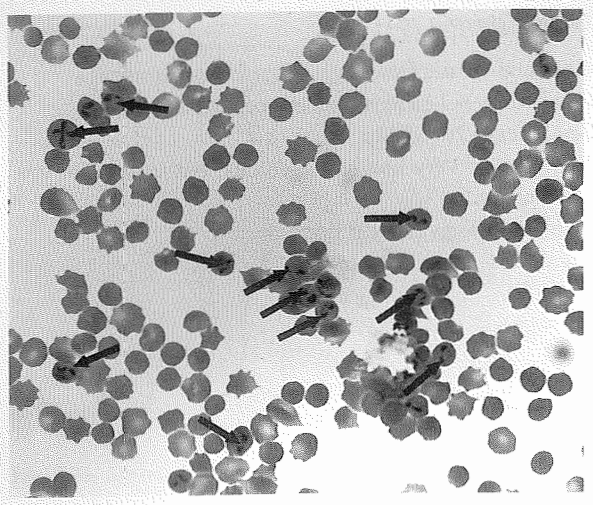


Fig. 100b. *Babesia bigemina* (arrows). In the red blood cells.

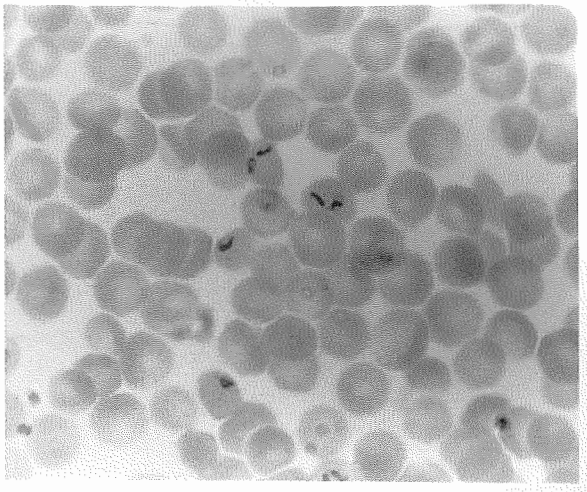


Fig. 100c. *Babesia bigemina*. In the red blood cells.

Fig. 101b. *Eimeria* sp. (arrow).

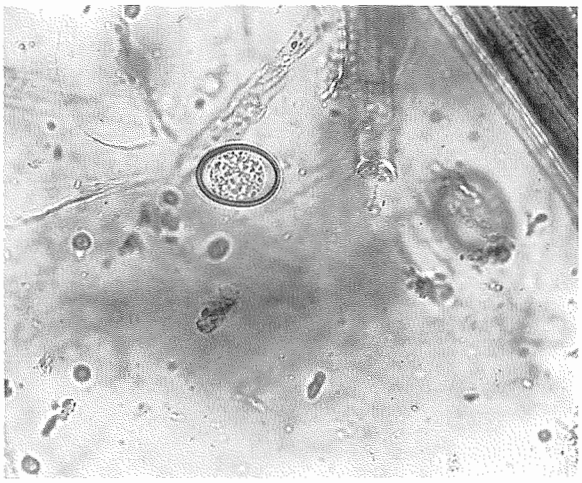


Fig. 101c. *Eimeria* sp.

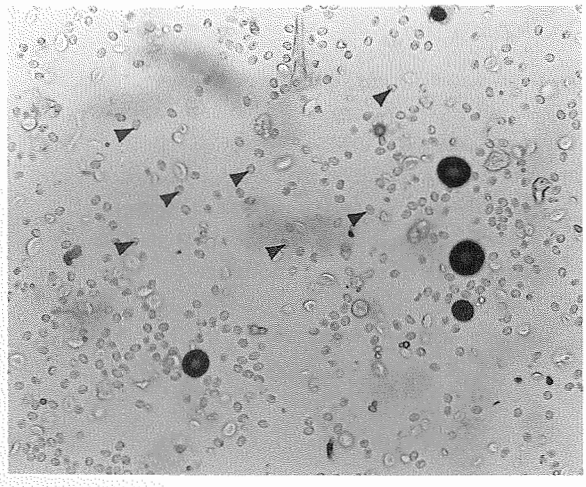


Fig. 102b. *Cryptosporidium* sp. (arrowheads).

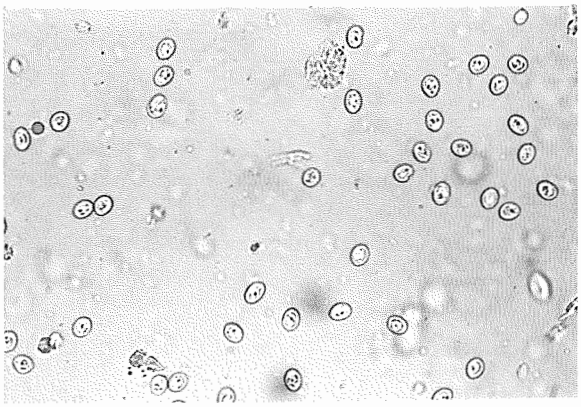


Fig. 102c. *Cryptosporidium* sp.

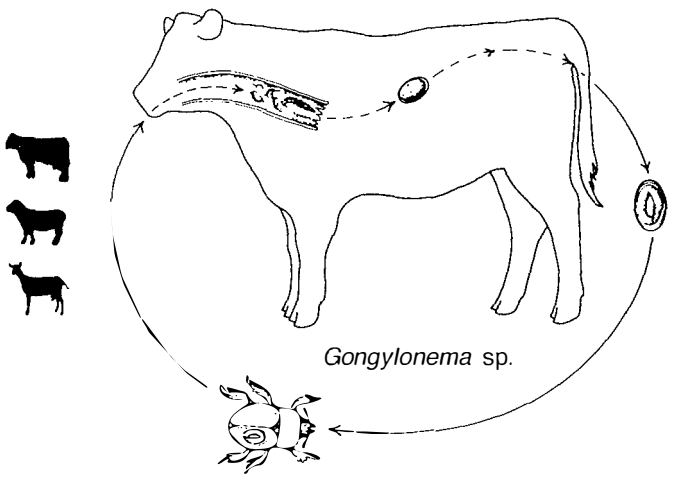


Fig. 103. *Gongylonema pulchrum* prepatent period is unknown.

Gongylonema sp.

Common name: Esophageal worm (Spiruroidea).
Adult size: 3–12 cm in mucosa of esophagus.
Size of egg: 70–35 µm.
Importance: Very low pathogenicity, but may cause irritation.
Diagnosis: Eggs in fecal flotation.
Treatment: None known.

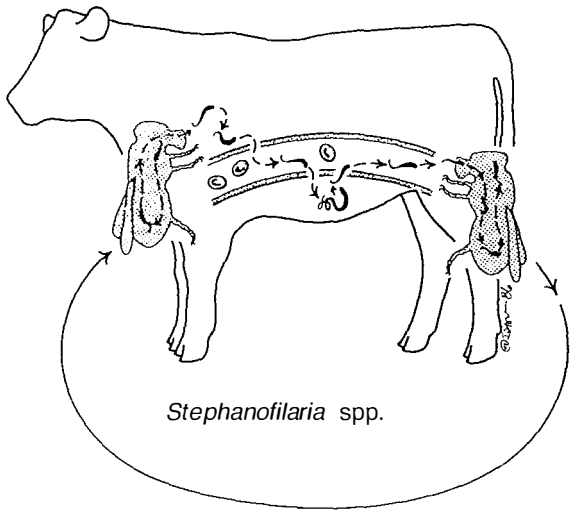


Fig. 104. *Stephanofilaria stilesi* prepatent period is 6–8 weeks.

Stephanofilaria spp.

Common name: Brisket worm (Filarioidea).
Adult size: 3–8 cm in subcutaneous tissue.
Size of microfilaria: 500–600 µm.
Importance: Causes dermatic lesions on the ventral abdomen.
Diagnosis: Deep skin scrapings; look for adults or microfilariae in tissue near lesion.
Treatment: None.
Prevention: Control of horn flies, the vector.

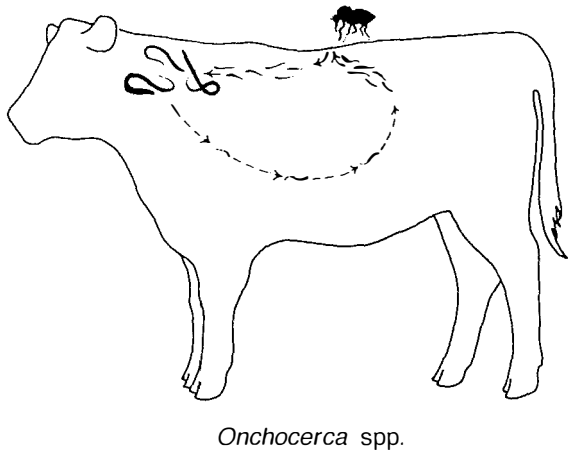


Fig. 105. *Onchocerca* spp. prepatent period is 6–12 months.

Onchocerca spp.

Common name: Skin nodular worm (Filarioidea). Adult (up to 80 cm) coiled in subcutaneous tissue.
Size of microfilariae: 200 – 260 µm.
Importance: Microfilariae may cause keratitis or iritis. Infected carcass may not be suitable for sale.
Diagnosis: Identification of microfilariae from an excised piece of skin near nodules.
Treatment: None.
Prevention: Arthropod control.

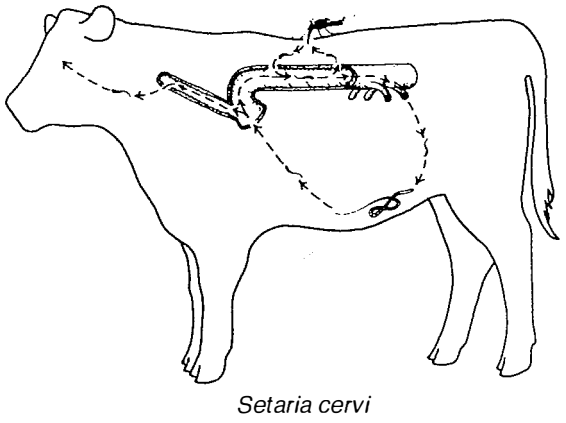


Fig. 106. *Setaria* (*Artionema*) sp. prepatent period is variable.

Setaria cervi

Common name: Abdominal worm (Filarioidea).
Adult size: 8–13 cm; free in abdominal cavity in cattle, sheep, and goats.
Size of microfilariae: 140–230 µm.
Importance: May cause cerebral nematodiasis. Usually nonpathogenic.
Diagnosis: Identification of microfilariae in blood.
Treatment: None.

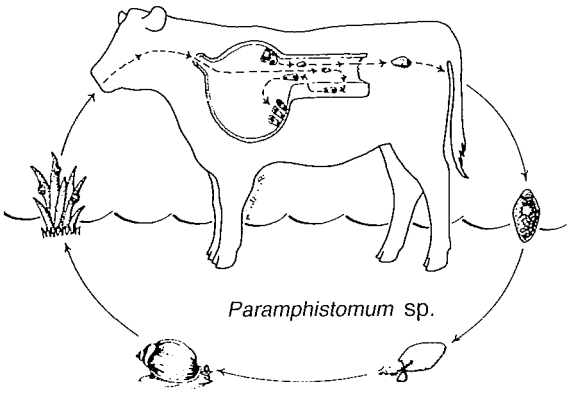


Fig. 107. *Paramphistomum* sp. prepatent period is 48–95 days.

Paramphistomum sp.

Common name: Rumen fluke (Paramphistomatidae).
Adult size: 5–15 mm in rumen.
Size of egg: 150 µm × 75 µm.
Importance: Adults are nonpathogenic. Immature flukes may cause enteritis and diarrhea.
Diagnosis: Fecal sedimentation technique, detect eggs.
Treatment: Niclosamide, 90 mg/kg PO
Oxyclozanide, 25 mg/kg PO

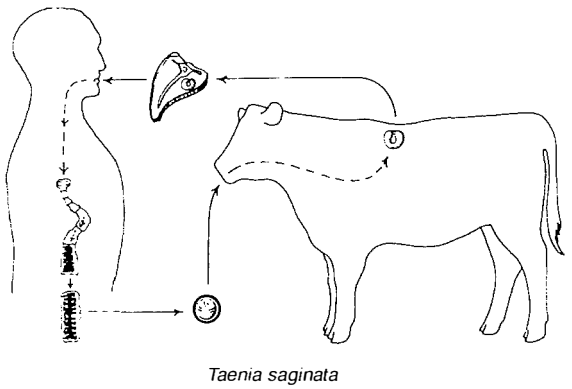


Fig. 108. *Taenia saginata* prepatent period is 8–10 weeks.

Taenia saginata

Common name: Beef cysticercosis, measles (Taeniidae). Cysticercus in meat.
Size of cysticercus: 3–10 mm.
Importance: Responsible for carcass condemnation, retention, or trimming. Transmission is from eggs in human feces to cattle by ingestion.
Diagnosis: Observation at necropsy; serological tests.
Treatment: None that are economically justified.
Prevention: Prevent contamination of human feces in cattle feed.
In humans, *T. saginata* is treated with niclosamide (Yomesan) 2 g chewed as a single dose q 24 h × 5 d or with praziquantel 5–20 mg/kg PO once.

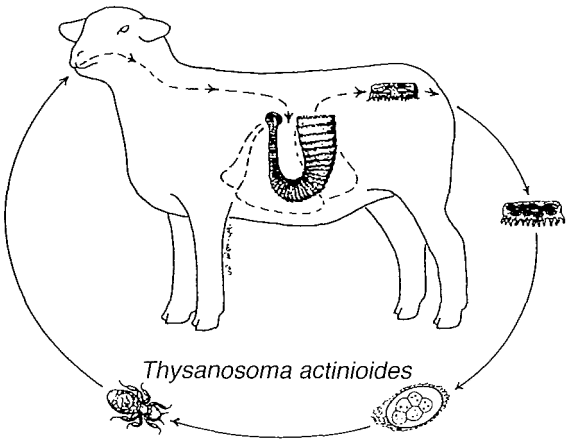


Fig. 109. *Thysanosoma actinioides* prepatent period is 1 month.

Thysanosoma actinioides

Common name: Fringed tapeworm (Anoplocephalidae).
Adult size: Up to 30 mm in common bile duct and small intestine.
Size of egg packet: 100 µm × 90 µm.
Importance: Relatively nonpathogenic; decreased weight gains. Responsible for liver condemnation.
Diagnosis: Segments in feces; observe at necropsy.
Treatment: Albendazole, 10 mg/kg PO
Fenbendazole, 5–10 mg/kg PO

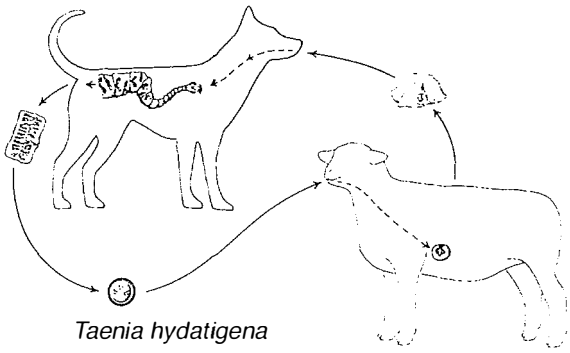


Fig. 110. *Taenia hydatigena.* Prepatent period in dog is 51 days.

Taenia hydatigena

Common name: *Cysticercus tenuicollis* (Taeniidae).
Size of cysticercus: Up to 3 cm.
Importance: Cysticercus has one scolex; relatively nonpathogenic;, may be confused with a hydatid cyst (many scolices).
Diagnosis: Cysticercus found free in peritoneal cavity or attached to or in omentum or liver at necropsy.
Treatment: None.
Prevention: Do not feed sheep offal to dogs. Deworm dogs for tapeworms. Do not allow access of sheep to dog feces.

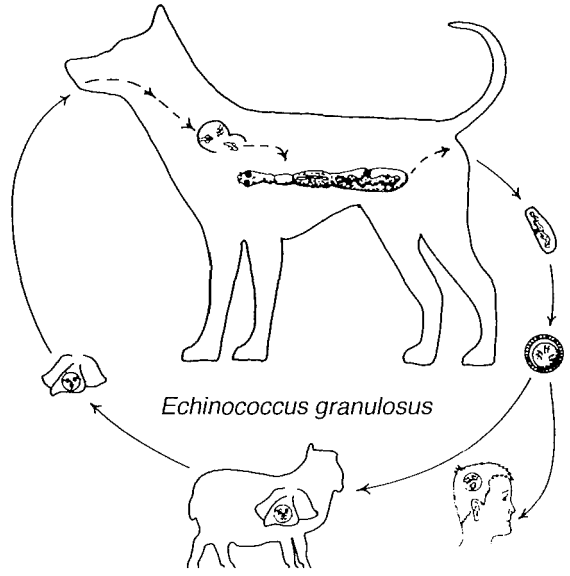


Fig. 111. *Echinococcus granulosus.* Prepatent period in dog is 7–9 weeks.

Echinococcus granulosus

Common name: Hydatid cyst (Taeniidae).
Size of hydatid cyst: Up to 10 cm.
Importance: Sheep are intermediate hosts for *E. granulosis* and sources of infection for carnivores.
Diagnosis: Cyst is usually found in lung or liver at necropsy.
Treatment: None.
Prevention: Do not feed sheep offal to dogs or wild canids, treat all dogs for tapeworms.

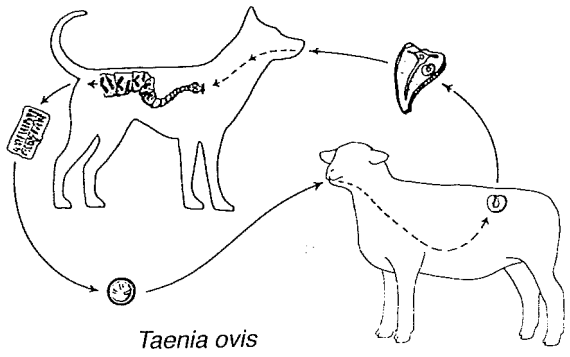


Fig. 112. *Taenia ovis.* Prepatent period in dogs is 60 days.

Taenia ovis

Common name: Sheep cysticercosis (Taeniidae).
Size of cysticercus: Up to 5 mm.
Importance: Responsible for condemnation or trimming.
Diagnosis: Cysticercus is found in muscles at necropsy.
Treatment: None.
Prevention: Do not feed raw meat to dogs or wild canids. Deworm all dogs for tapeworms.

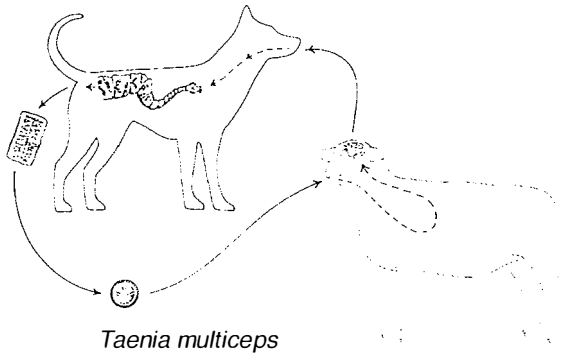


Fig. 113. *Taenia multiceps.* Prepatent period in dogs is 2–3 months.

Taenia multiceps

Common name: Gid (Taeniidae).
Size of coenurus: Up to 4 cm.
Importance: Rare in the United States. Causes CNS disorders.
Diagnosis: Coenurus usually in brain at necropsy.
Treatment: None.
Prevention: Do not feed raw offal to dogs or wild canids. Deworm all dogs for tapeworms.

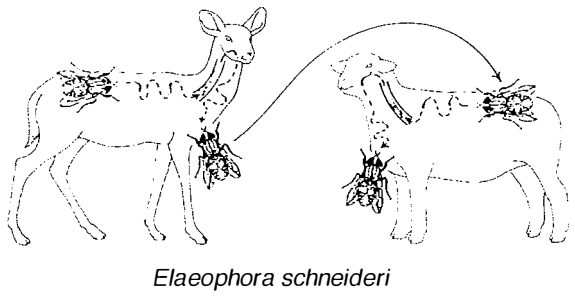


Fig. 114. *Elaeophora schneideri* prepatent period is 4–5 months.

Elaeophora schneideri

Common name: Sorehead, filarial dermatitis (Filarioidea).
Adult size: 6–12 mm in arteries anterior to heart, microfilariae in skin of head.
Size of microfilaria: 300 μm × 6 μm.
Importance: A common parasite of mule deer in the Western United States. Causes filarial dermatitis "sorehead" in sheep, usually older sheep.
Diagnosis: Microfilariae can be seen in skin, such as a skin punch from the ear placed in saline in a Petri dish.
Treatment: None.

External Parasites

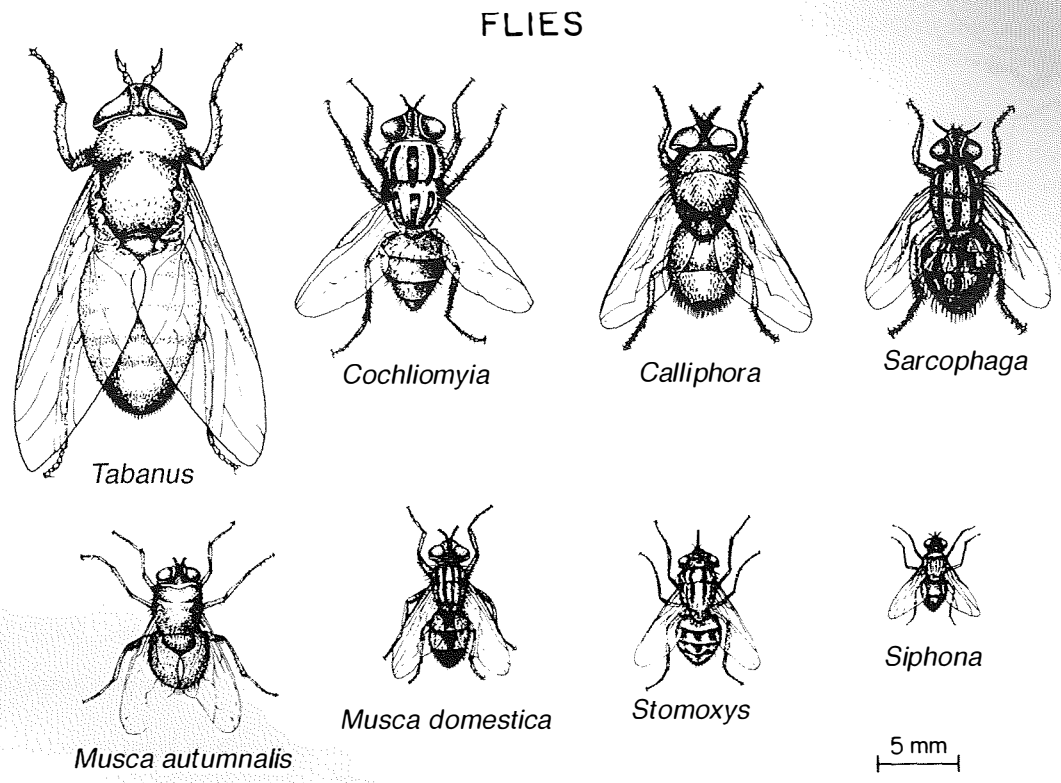


Fig. 115. Common flies found on ruminants.

Table 29. List of common flies found on ruminants

Genus and Species	Common Name
Biting Flies	
Simulium spp.	Black flies, buffalo gnats
Culicoides spp.	Biting gnats, punkies, no see-ums
Tabanus/Chrysops spp.	Horse and deer flies
Stomoxys calcitrans	Stable fly
Siphona (Haematobia) irritans	Horn fly
Melophagus ovinus	Sheep ked
Aedes, Culex, Anopheles, etc.	Mosquitoes
Nonbiting Flies	
Musca autumnalis	Face fly
Musca domestica	House fly
Fannia spp.	Latrine fly, little house fly
Erystalis tenax	Drone fly, rat-tailed maggot
Myiasis-producing Flies	
Hypoderma spp.	Cattle bot fly
Cochliomyia hominovorax	Screwworm fly
Oestrus ovis	Sheep bot fly
Odemagena tarandi	Caribou warble fly
Cephenemyia spp.	Deer nasal bot fly
Phaenicia(Lucilia), Phormia, Calliphora	Blowflies or fleece worms

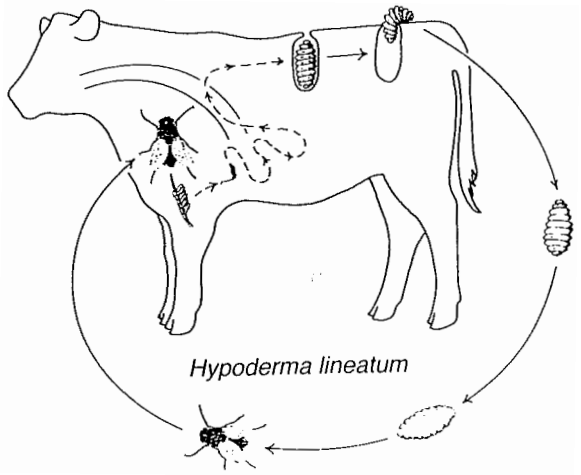


Fig. 116. *Hypoderma lineatum* (*H. bovis* is similar). Life cycle is 10–12 months.

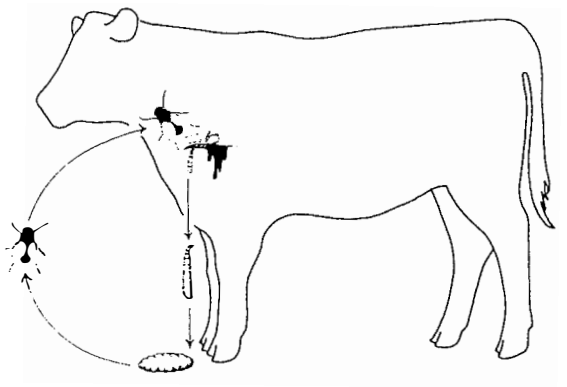


Fig. 117. *Cochliomyia hominivorax*. Life cycle is 3 weeks.

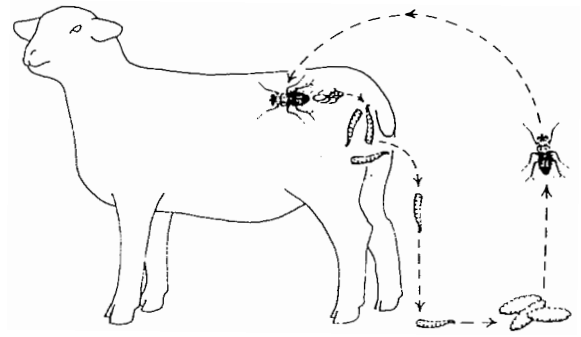


Fig. 118. Sheep blowflies (bottle flies). Life cycle is 10 days.

Hypoderma lineatum

Common name: Common cattle bot fly (*H. lineatum*) and northern cattle bot fly (*H. bovis*) (Insecta-Diptera).

Size: Larvae (grubs) are up to 30 mm.

Importance: Larvae migrate through flesh and cause a reduction in weight gain and value of hides. Migrate to esophagus (*H. lineatum*) or spinal column (*H. bovis*) before forming warbles on the back. Adult flies do not sting or bite, but terrify cattle and predispose to physical injury and significant production losses.

Diagnosis: Third-stage larvae form warbles on the back of cattle. Also occasionally in bison, horses, sheep, and goats.

Treatment: Pour-on organophosphates: coumaphos, famphur, fenthion, trichlorfon; ivermectin, doramectin, eprinomectin, moxidectin. Do not treat with organophosphates in late fall when grubs are in the submucosa of the esophagus (*H. lineatum*) because an inflammatory edematous reaction may occur, or in the epidural fat of the spinal canal (*H. bovis*) because inflammation and paraplegia may occur.

Cochliomyia hominivorax

Common name: Screwworm (Insecta-Diptera).

Larvae size: Larvae are up to 15 mm.

Importance: A reportable disease in the United States. Highly pathogenic to all livestock, causing mortality. Maggots penetrate into tissue where there is broken skin. Usually found in southern Texas only.

Diagnosis: Send larvae from wounds to state diagnostic laboratory.

Treatment: Ivermectin, organophosphates.

Prevention: Release of sterile male flies.

Blowflies

Common name: Sheep blowflies or bottle flies (*Lucilia*, *Phormia*, *Calliphora*, etc.); (Insecta-Diptera).

Larvae size: Larvae (grubs) are up to 15 mm.

Importance: Responsible for myiasis "strike" in sheep.

Diagnosis: Find larvae in rotting wool on sheep.

Treatment: Clean the wound and treat with organophosphates.

Prevention: Sanitation and management to prevent wet, dirty wool – crutching, docking, shearing, etc.; treatment of parasites and other organisms that predispose to diarrhea; fly control.

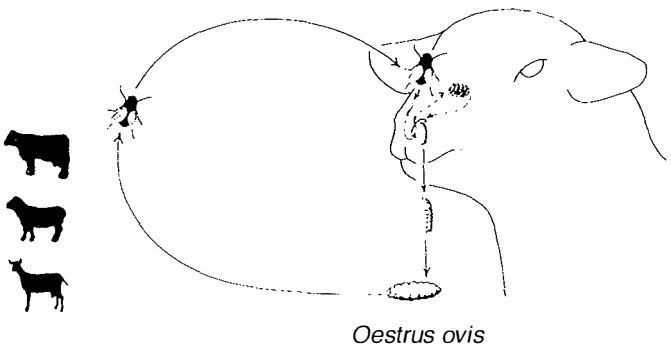


Fig. 119. *Oestrus ovis* is in host for 1 month or through the winter.

Oestrus ovis

Common name: Sheep nasal bot fly (Insecta-Diptera).
Larvae size: Larvae up to 15 mm.
Importance: Causes nasal discharge and difficulty in breathing. Adult flies frighten sheep and predispose to reduced production.
Diagnosis: Clinical signs; observe larvae at necropsy.
Treatment: Ivermectin, 0.2 mg/kg SC
Bacillus thuringiensis as an aerosol

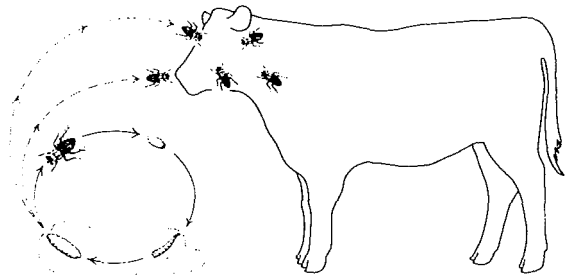


Fig. 120. *Musca autumnalis*. Life cycle is variable, 10–14 days.

Musca autumnalis

Common name: Face fly (Insecta-Diptera).
Adult size: 6–9 mm.
Importance: Irritate the eyes and nostrils, may predispose to bacterial keratoconjunctivitis "pink eye", transmit eyeworms (*Thelazia* spp.), and infectious bovine rhinotracheitis.
Diagnosis: Identification of flies.
Treatment: See Table 27.
Prevention: Sanitation; feed larvacidal drugs such as methoprene or tetrachlorvinphos; insecticide-impregnated ear tags; biological control methods.

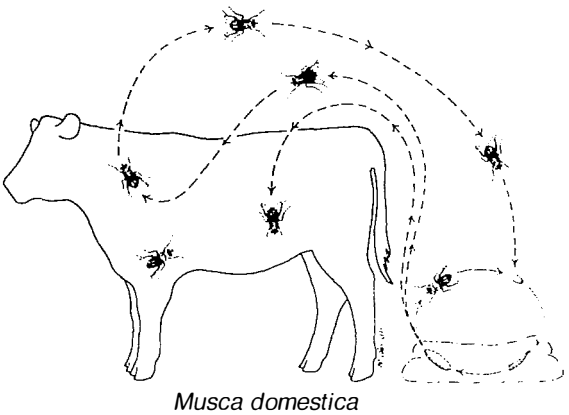


Fig. 121. *Musca domestica*. Life cycle is variable, 10–14 days.

Musca domestica

Common name: House fly (Insecta-Diptera).
Adult size: 5–12 mm.
Importance: Irritate cattle, cause reduced weight gains and loss of production.
Diagnosis: Identification of flies.
Treatment: See Table 27.
Prevention: Sanitation; feed larvacidal drugs such as methoprene, tetrachlorvinphos, or chlorfenvinphos; insecticide-impregnated ear tags; biological control methods.

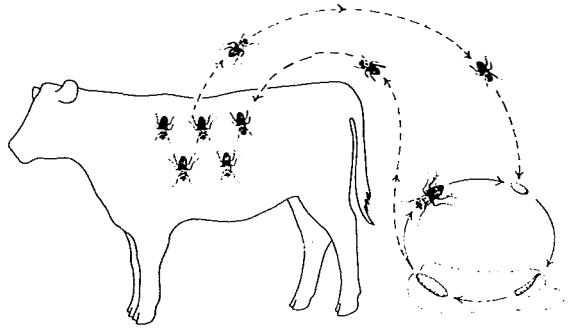


Fig. 122. *Siphona (Haematobia) irritans*. Life cycle is 3 weeks or more.

Siphona (Haematobia) irritans

Common name: Horn fly (Insecta-Diptera).
Adult size: 4–5 mm.
Importance: Irritate cattle; occur in large numbers and cause weight and blood loss, and reduce production.
Diagnosis: Identification of adult fly. Size is smaller than a house fly. Usually feed with head down.
Treatment: See Table 27.
Prevention: Ivermectin kills larvae in manure; methoprene as a feed additive; insecticide-impregnated (fenvalente, permethrin) ear tags; biological control.
Eprinomectin at 0.5 mg/kg as a pour on is effective.
Moxidectin, 0.5 mg/kg as a pour on is effective.

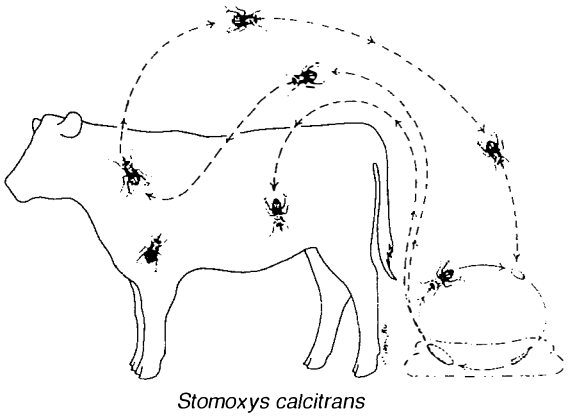


Fig. 123. *Stomoxys calcitrans*. Life cycle is 4 weeks or more.

Stomoxys calcitrans

Common name: Stable fly (Insecta-Diptera).
Adult size: 7–8 mm.
Importance: These are persistent blood-sucking flies that bite and irritate cattle; cause reduced weight gains and reduced feed efficiency.
Diagnosis: Identification of adult fly. Size of a house fly, but proboscis projects straight forward.
Treatment: See Table 27.
Prevention: Flies breed in rotting vegetation; therefore, sanitation is helpful. Methoprene fed to animals or use *Bacillus thuringiensis*.

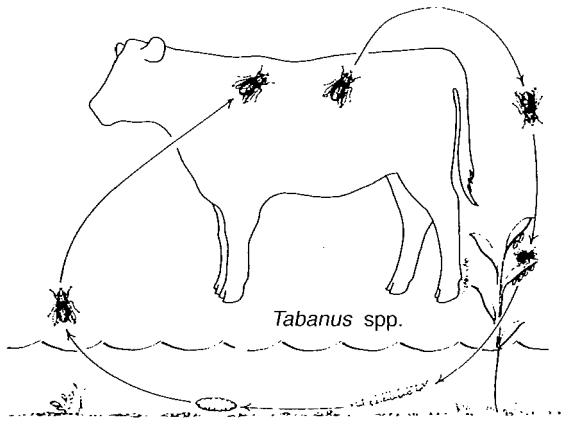


Fig. 124. *Tabanus* spp. One generation per year.

Tabanus spp.

Common name: Horse fly (Insecta-Diptera).
Adult size: Up to 30 mm.
Importance: Vicious biters, causing stampeding and reduction of weight gain. Transmit anaplasmosis, etc.
Diagnosis: Identification of adult fly.
Treatment: See Table 31.

BOVINE LICE

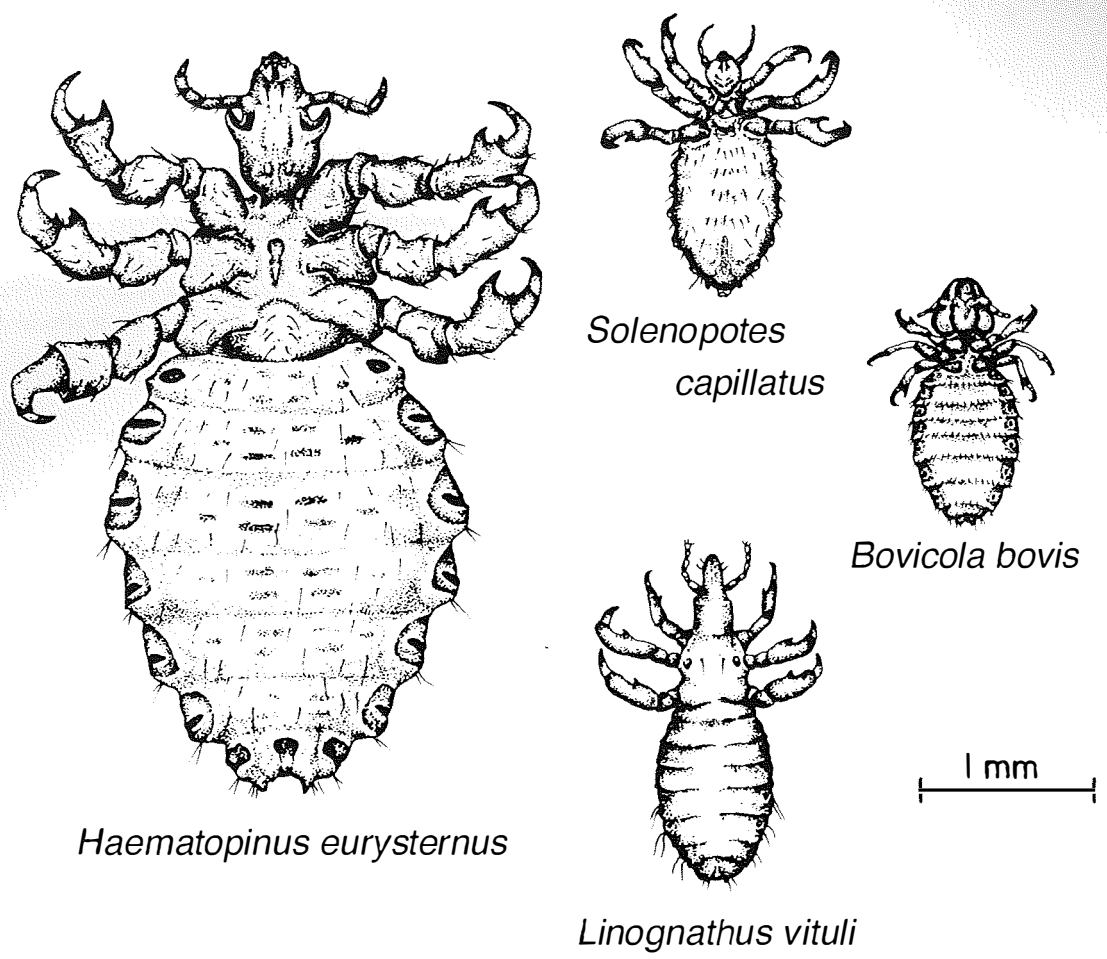


Fig. 125. Common lice found on ruminants.

Table 30. List of common lice found on ruminants

Genus and Species	Common Name
Mallophaga (biting lice)	
Bovicola (*Damalinia*) spp.	Biting or chewing louse
Anoplura (sucking lice)	
Haematopinus eurysternus	Short-nosed cattle louse
Linognathus africanus	African blue louse
Linognathus vituli	Long-nosed cattle louse
Linognathus stenopsis	Goat sucking louse
Linognathus pedalis	Sheep foot louse
Linognathus ovillus	Sheep face and body louse
Solenopotes capillatus	Little blue cattle louse

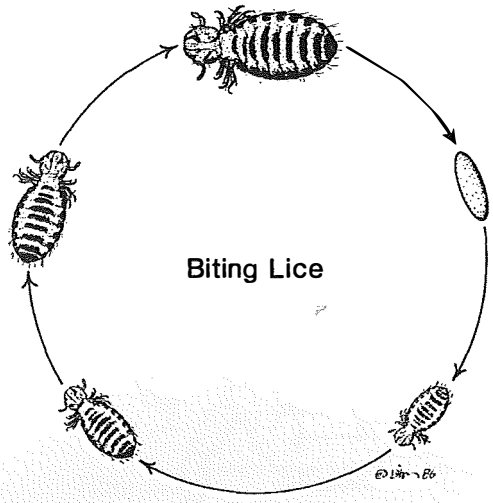


Fig. 126a. Life cycle of a biting louse (about 4 weeks).

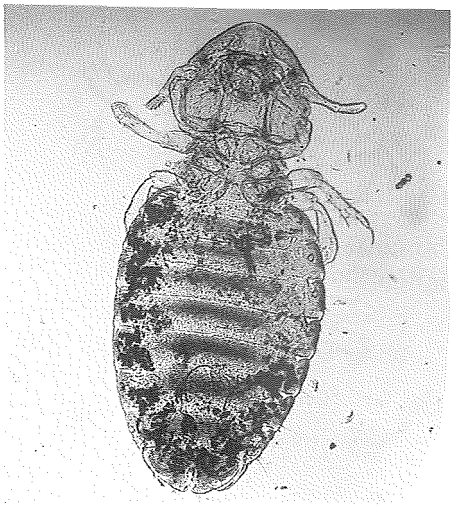


Fig. 126b. *Bovicola (Damalinia) bovis.*

Bovicola (Damalinia) bovis

Common name: Biting louse (Insecta-Mallophaga) of cattle, sheep, and goats.
Size of adult: 2–3 mm.
Importance: Cause irritation and weight loss; constant scratching, licking, and biting affected areas. Most common in fall and winter. In cattle are usually on neck, brisket, head, and between legs.
Diagnosis: Examination of skin and hair for eggs, nymphs, and adult lice.
Treatment: See Table 27. Usually dipping or high pressure sprays Coumaphos, 25% wettable powder at 0.06%
Diazinon, 50% wettable powder at 0.03%
Cypermethrin, 2.5% as a pour on
Ivermectin, 0.2 mg/kg SC
Eprinomectin, 0.5 mg/kg as a pour on
Moxidectin, 0.5 mg/kg pour on
All animals must be treated simultaneously.

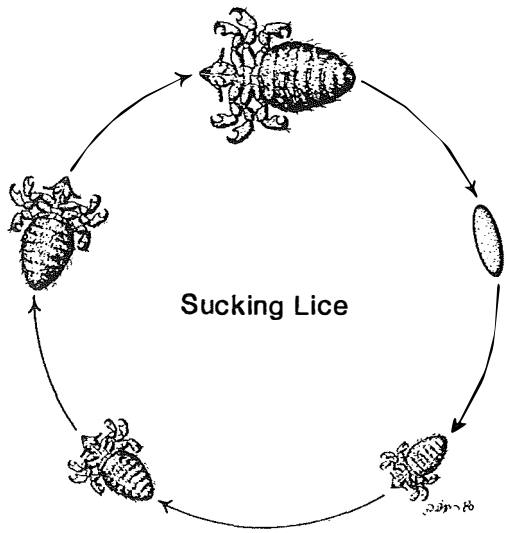


Fig. 127a. Life cycle of a sucking louse (about 4 weeks).

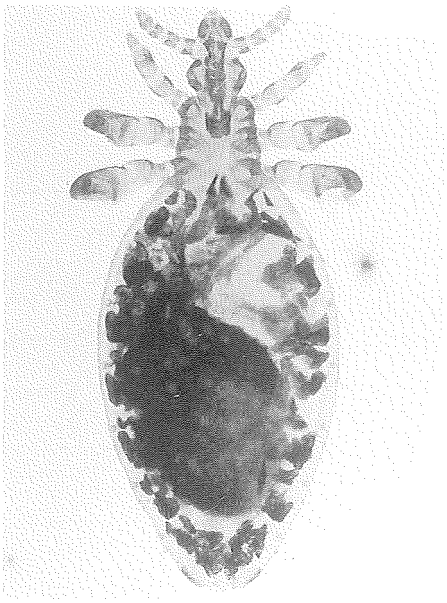


Fig. 127b. *Linognathus* sp.

Linognathus sp.

Common name: Sucking lice (Insecta-Anoplura) of cattle, sheep, and goats. Includes *L. vituli* (long-nosed or blue cattle louse); *Haematopinus eurysternus* (short-nosed cattle louse). In sheep, *Linognathus* spp. are primarily on the legs. Affected animals lick, scratch, and bite-affected areas.
Size of adult: 2.5–5.0 mm.
Importance: Cause irritation and weight loss; may cause anemia.
Diagnosis: Examine skin and hair for eggs, nymphs, and adults.
Treatment: See Table 27. All animals must be treated simultaneously.

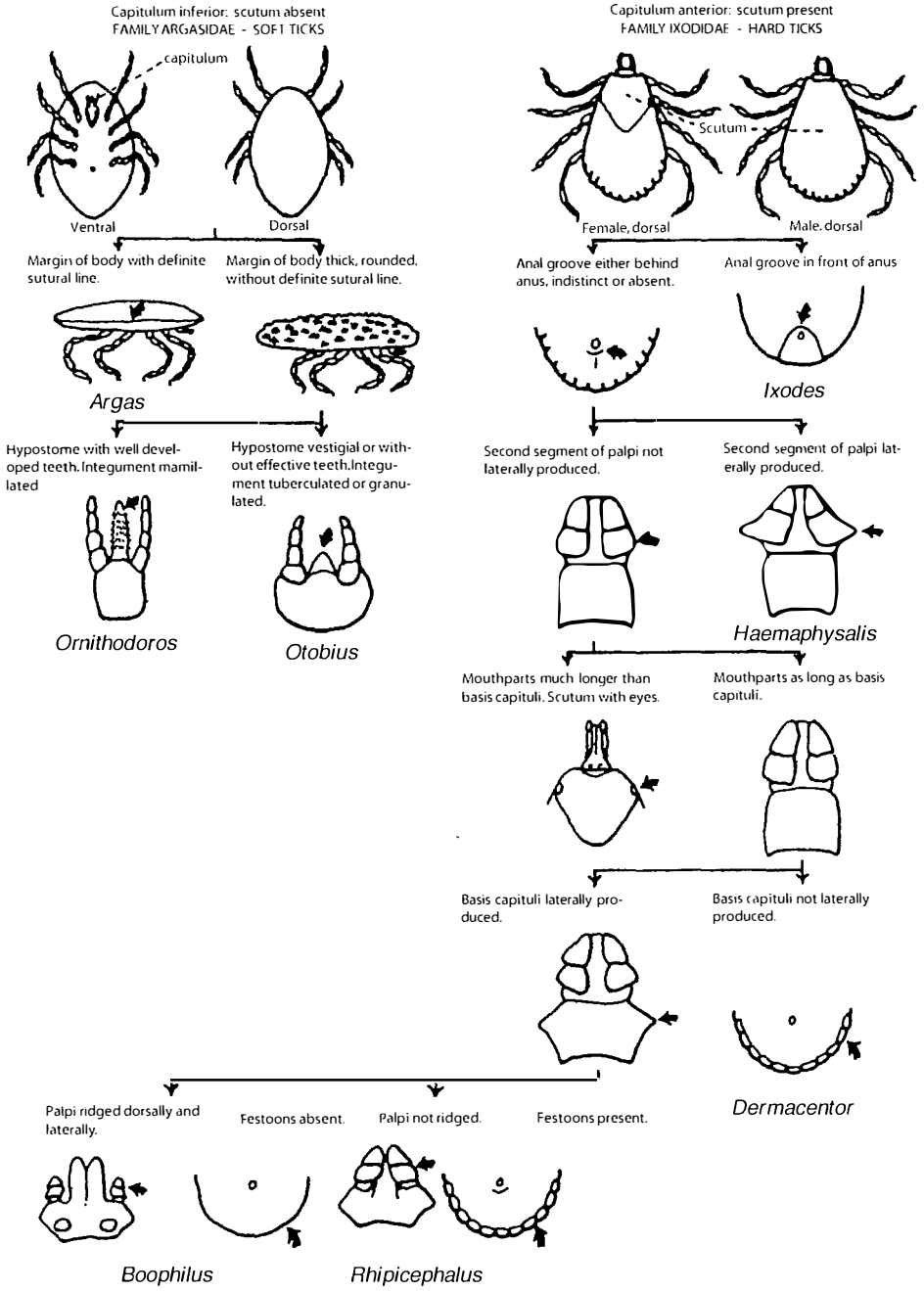


Fig. 128. Simplified key to common ticks of animals and birds.

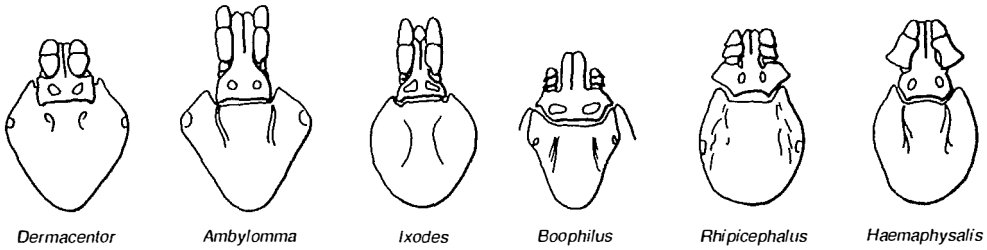


Fig. 129. Morphology of basis capitulum and scutum of the major genera of ticks.

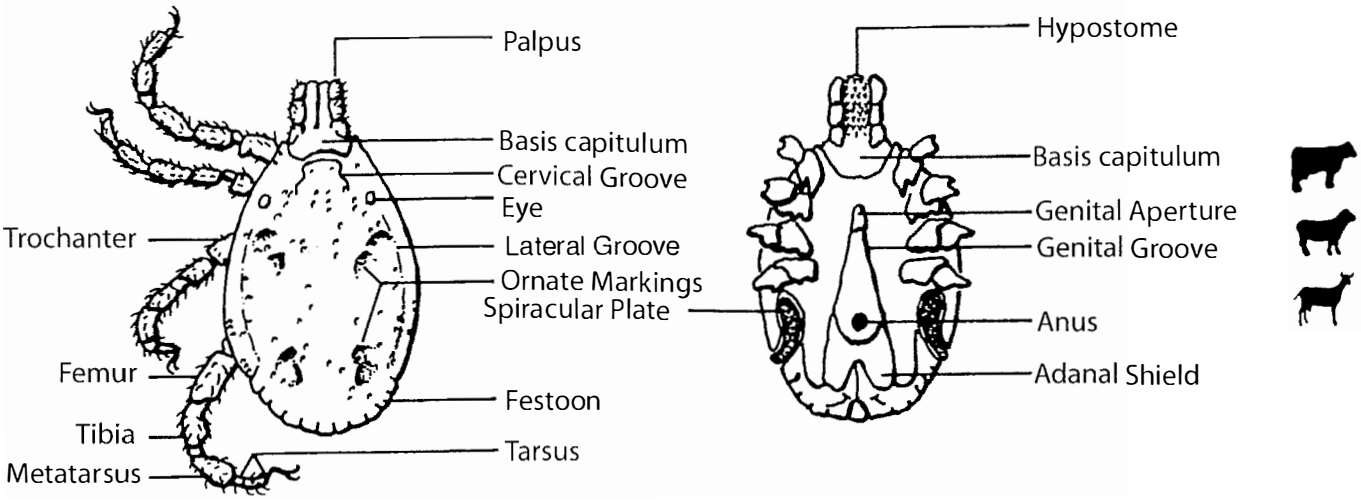


Fig. 130. Simplified morphology of a tick.

Table 31. Common ticks and mites of cattle

Genus and Species	Common Name
Ticks	
Dermacentor variabalis	American dog tick
Dermacentor andersoni	Rocky Mountain wood tick
Dermacentor albipictus	Winter tick
Dermacentor occidentalis	Pacific coast tick
Ixodes scapularis	Black-legged tick
Amblyomma americanum	Lone star tick
Amblyomma maculatum	Gulf coast tick
Boophilus annulatus	Cattle tick
Boophilus microplus	Southern cattle tick
Otobius megnini	Spinose ear tick
Ornithodorus cariaceus	Pajoroello tick
Mites	
Psoroptes ovis	Mange mite, scab mite
Sarcoptes scabei	Mange mite
Chorioptes bovis	Mange mite
Demodex bovis	Mange mite
Psorergates bos	Itch mite

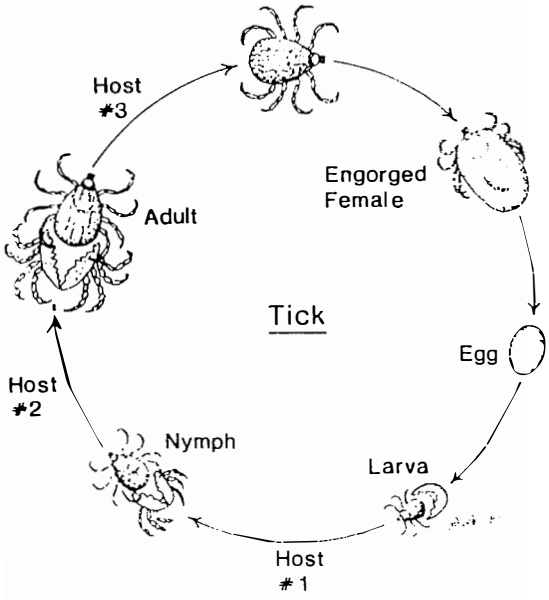


Fig. 131. Life cycle of a three-host tick.

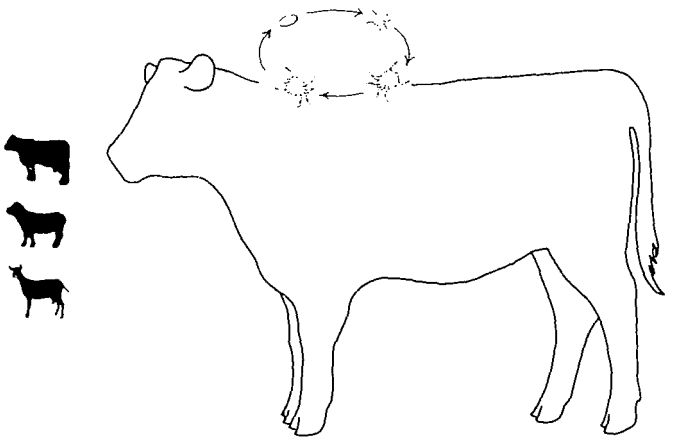


Fig. 132a. *Psoroptes* sp. Life cycle is about 3 weeks.

Psoroptes sp.

Common name: Mange mite or scab mite of cattle, sheep, and goats (Arachnida-Psoroptidae).
Adult size: 500 µm (male); 700 µm (female).
Importance: This is a reportable disease in cattle and sheep in some states. It is very contagious and highly pathogenic, causing dramatic weight loss. Mites puncture skin and cause inflammation and hair loss. Affected animals bite and scratch. Affects cattle and sheep.
Diagnosis: Skin scraping at the periphery of the crusty lesion. Mites have long, jointed pedicels.
Treatment: Ivermectin 0.2 mg/kg SC; treat twice at 3-week interval
Doramectin, 0.2 mg/kg SC or IM
Moxidectin, 0.5 mg/kg pour on

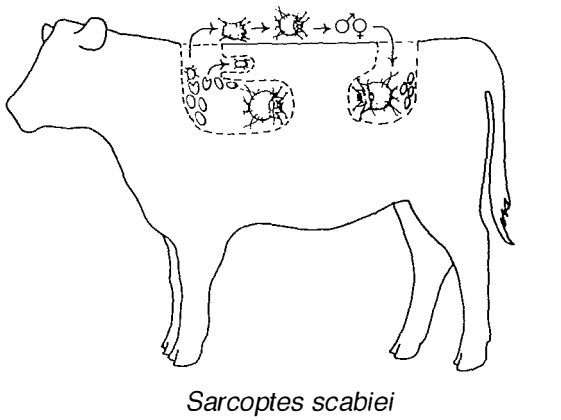


Fig. 133a. *Sarcoptes scabiei*. Life cycle is about 3 weeks.

Sarcoptes scabiei

Common name: Mange mite of cattle and sheep (Arachnida-Sarcoptidae).
Adult size: 250 µm (male); 600 µm (female).
Importance: This is a reportable disease in cattle in some states. Causes intensive itching.
Diagnosis: Skin scraping. Mites have long, nonjointed pedicels.
Treatment: Ivermectin 0.2 mg/kg SC; treat twice at 3-week interval
Eprinomectin, 0.5 mg/kg pour on
Doramectin, 0.2 mg/kg SC or IM

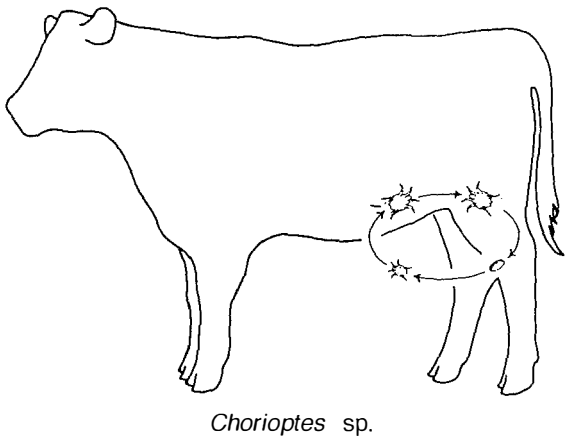


Fig. 134a. *Chorioptes* sp. Life cycle is about 3 weeks.

Chorioptes sp.

Common name: Mange mite of cattle, sheep, and goats (Arachnida-Psoroptidae).
Adult size: 250 µm (male); 600 µm (female).
Importance: This is a reportable disease in cattle in some states. It is not as pathogenic as *Psoroptes* or *Sarcoptes*. Causes tail or foot mange.
Diagnosis: Skin scraping. Mites have very short, unjointed pedicels.
Treatment: Ivermectin, 0.2 mg/kg SC; treat twice at 3-week interval
Doramectin, 0.2 mg/kg SC or IM
Eprinomectin, 0.5 mg/kg pour on
Moxidectin, 0.5 mg/kg pour on

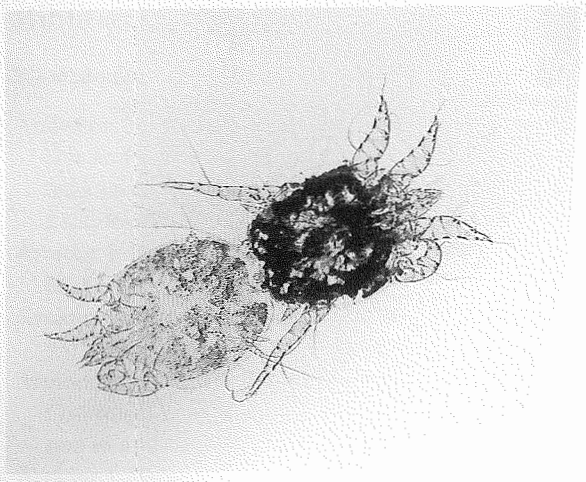


Fig. 132b. *Psoroptes* sp.; a mating pair of *Psoroptes*.

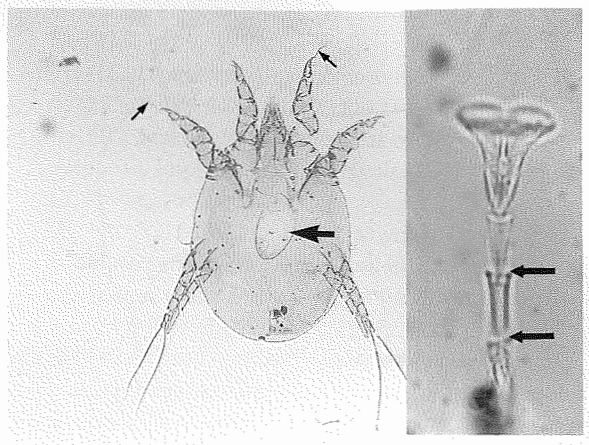


Fig. 132c. *Psoroptes* sp. adult female with egg (large arrow). Inset shows jointed pedicels at ends of legs (smaller arrows).

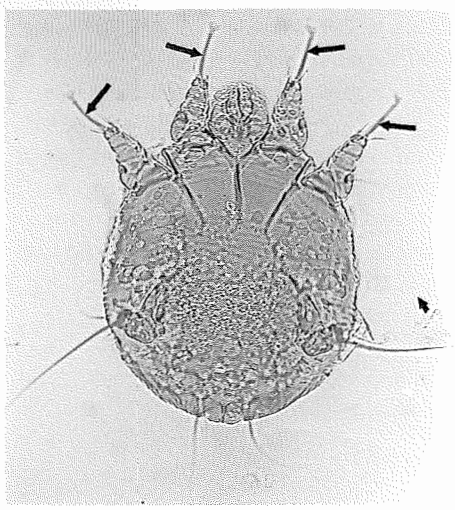


Fig. 133b. *Sarcoptes scabiei*. Arrows indicate nonjointed pedicels.

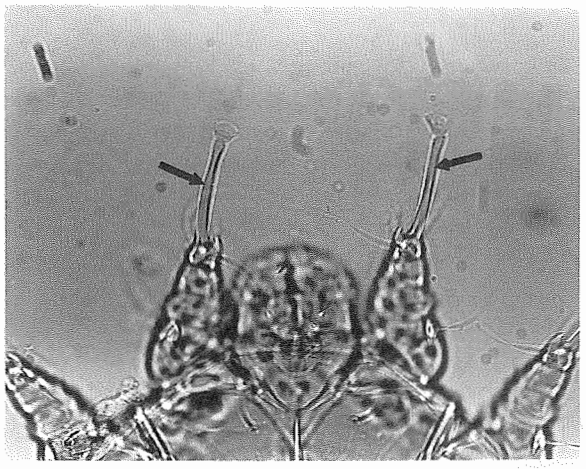


Fig. 133c. *Sarcoptes scabiei* enlarged anterior view (arrows: nonjointed pedicels).

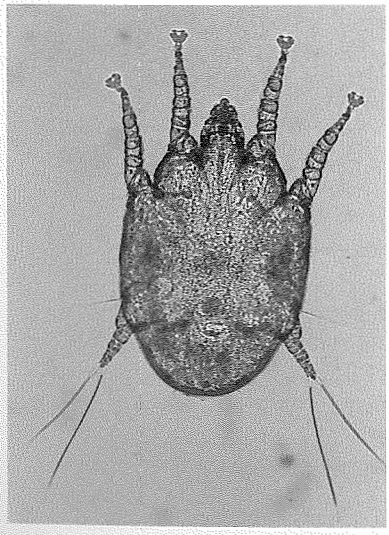


Fig. 134b. *Chorioptes* sp.

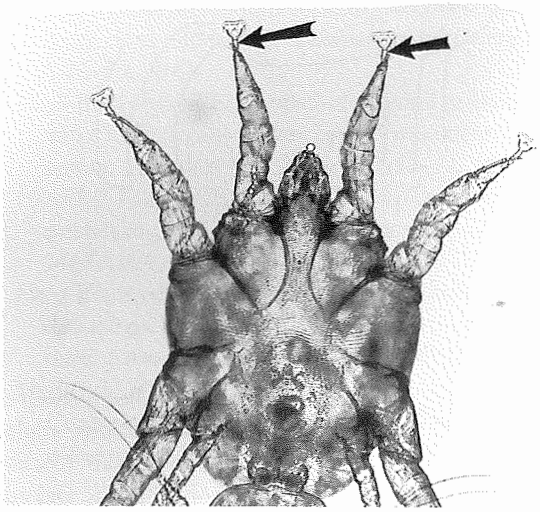
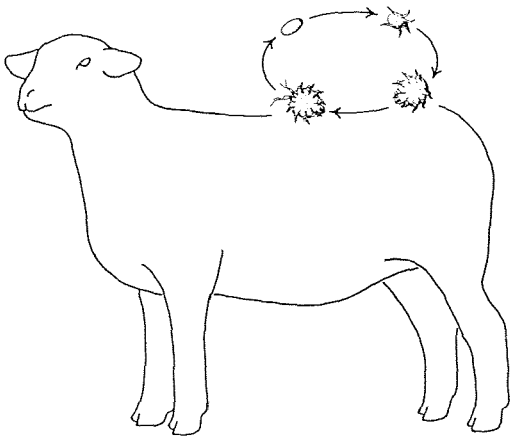


Fig. 134c. *Chorioptes* sp. (arrows: very short pedicels).



Psorergates sp.

Fig. 135a. Life cycle of *Psorergates* sp.

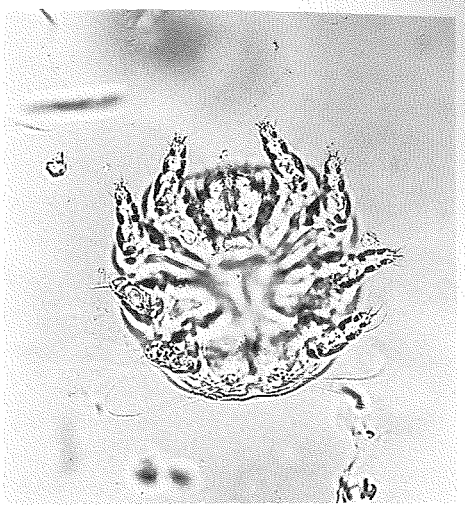
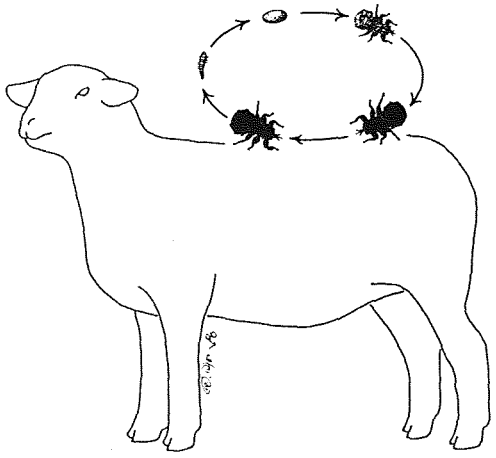


Fig. 135b. *Psorergates* sp.

Psorergates sp.

Common name: Itch mite (Arachnida-Psoroptidae).
Adult size: 165 µm (male); 190 µm (female). Body is almost spherical.
Importance: May be confused with reportable mites, but is much smaller. Infection spreads very slowly over several years. Mild, chronic irritation. Affects cattle and sheep, but is rare.
Diagnosis: Skin scrapings.
Treatment: Ivermectin, 0.2 mg/kg SC
Organophosphate sprays after shearing



Melophagus ovinus

Fig. 136a. Life cycle of *Melophagus ovinus.*

Fig. 136b. *Melophagus ovinus.*

Melophagus ovinus

Common name: Sheep ked, erroneously called a sheep tick (Insecta-Diptera).
Adult size: 5–8 mm. Life cycle is about 3 months, adults live about 3 months.
Importance: Causes irritation, lesions to the skin (cockle), anemia, wool loss, and reduction in weight gain.
Diagnosis: Visual observation of wool for pupae and adults.
Treatment: Spray applications of trichlorphon, coumaphos, crotoxyphos, fenchlorphos, tetrachlorvinphos, phosmet. Ivermectin, 0.2 mg/kg SC. Treat after shearing because shearing removes a majority of the keds.

Bibliography

Nematodes

Anderson N: The efficiency of levamisole, thiabendazole and fenbendazole against naturally acquired infections of *Ostertagia ostertagi* in cattle. *Res Vet Sci* 23:298–302, 1977.

Armour J: Bovine ostertagiasis: A review. *Vet Rec* 86:184–190, 1970.

Armour J: Parasitic gastroenteritis in cattle. *Vet Rec* 95:391–395, 1974.

Armour J, Bruce RG: Inhibited development of *Ostertagia ostertagi* infections: A diapause phenomenon in a nematode. *Parasitology* 60:161–174, 1974.

Armour J, Bairden K, Preston JM: Anthelmintic efficiency of ivermectin against naturally occurring gastrointestinal nematodes of sheep. *Vet Rec* 111:809–81, 1982.

Baker NF, Fisk RA, Bushnell RB, et al.: Seasonal occurrence of infective nematode larvae on irrigated pasture grazed by cattle in California. *Am J Vet Res* 42:1188–1191, 1981.

Barger IA, Gibbs HC: Milk production of cows infected experimentally with trichostrongylid parasites. *Vet Parasitol* 9:69–73, 1981.

Becklund WW: Revised check list of internal and external parasites of domestic animals in the United States and possessions and in Canada. *Am J Vet Res* 25:1380–1416, 1964.

Bliss HD, Todd AC: Milk production by Vermont dairy cattle after deworming. *Vet Med Small Anim Clin* 81:1251–1254, 1976.

Brunsdon RV: The seasonal variations in the nematode egg counts of sheep comparison of the spring rise phenomenon in breeding and unmated ewes. *NZ Vet J* 12:75–80, 1966.

Connan RM: The post parturient rise in fecal nematode egg counts of ewes: Its aetiology and epidemiological significance. *World Rev Anim Prod* 4:53–58, 1968.

Courtney CH, Sundlof SF: *Veterinary Antiparasitic Drugs, A Compreshensive Compendium of FDA-Approved Antiparasitic Drugs*, American Association of Veterinary Parasitologists Publication SP96, University of Florida, Gainesville, 224 pages, 1991.

Craig TM: Seasonal transmission of bovine gastrointestinal nematodes in the Texas Gulf Coast. *J Am Vet Med Assoc* 174:844–847, 1970.

Donald AD, Morley FHW, Waller PH, et al.: Effects of reproduction, genotype and anthelmintic treatment of ewes on *Ostertagia* spp. populations. *Int Parasitol* 12:403–411, 1982.

Foreyt WJ, Wescott RB, Johnson R, et al.: Treatment for lungworms (*Prostostrongylus* spp.) in Rocky Mountain bighorn sheep. *Vet Med Small Anim Clin* 78:1435–1439, 1983.

Gibbs HC: Gastrointestinal nematodiasis in dairy cattle. *J Dairy Sci* 65: 2182–2188, 1981.

Gibbs HC: Mechanisms of survival of nematode parasites with emphasis on hypobiosis. *Vet Parasitol* 11:25–48, 1982.

Gibbs HC: Relative importance of winter survival of larval nematodes in pasture and infected carrier calves in a study of parasitic gastroenteritis in calves. *Am J Vet Res* 40:227–231, 1979.

Gibbs HC, Kitsos A: Effectiveness of a slow release, morantel tartrate anthelmintic bolus for controlling parasitic gastroenteritis in replacement dairy heifers. *Am J Vet Res* 46:2241–2244, 1985.

Goudie C, Evans NA, Gration KA, et al.: Doramectin: a potent novel endectocide. *Vet Parasitol* 49:5–15, 1993.

Gregory E, Foreyt WJ, Breeze R: Efficacy of ivermectin and fenbendazole against lungworms. *Vet Med* 80:114–117, 1985.

Grisi L, Todd AC: Prevalence of gastrointestinal parasites among milking cows in Wisconsin, Pennsylvania, and North Carolina. *Am J Vet Res* 39:51–54, 1978.

Guichon PT, Jim GK, Booker CW, et al.: Relative cost-effectiveness of treatment of feedlot calves with ivermectin versus treatment with a combination of fenbendazole, permethrin, and fenthion. *J Am Vet Med Assoc* 216:1965–1969, 2000.

Gupta RP, Gibbs HC: Epidemiological investigations on *Dictyocaulus viviparus* (Block, 1782) infection in cattle. *Can Vet J* 11:149–156, 1970.

Hammerberg B, Lamm WD: Changes in periparturient fecal egg counts in beef cows calving in the spring. *Am J Vet Res* 41:1686–1689, 1980.

Herd RP: A practical approach to parasite control in dairy cows and heifers. *Compend Continuing Ed* 5:73–80, 1983.

Herd RP, Heider LE: Control of internal parasites in dairy replacement heifers by two treatments in the spring. *J Am Vet Med Assoc* 177:51–54, 1980.

Herd RP, Parker CF, McClure KE: Epidemiologic approach to the control of sheep nematodes. *J Am Vet Med Assoc* 184:680–687, 1984.

Herd RP, Riedel RM, Heider LE: Identification and epidemiologic significance of nematodes in a dairy barn. *J Am Vet Med Assoc* 176:1370–1373, 1980.

Herlich H: The effects of the intestinal worms, *Cooperia pectinata* and *Cooperia oncophora* on experimentally infected calves. *Am J Vet Res* 26:1032–1035, 1965.

Herlich H: The importance of helminth infections in ruminants. *World Anim Rev* 26:22–26, 1978.

Kennedy TJ, Todd AC: Efficacy of fenbendazole against gastrointestinal parasites of sheep. *Am J Vet Res* 36:1465–1467, 1975.

Lyons ET, Drudge JH: Two eye worms *Thelazia gulosa* and *Thelazia skrjabini* in cattle in Kentucky. *J Parasitol* 61:1119–1122, 1975.

Malczewski A, Westcott RB, Spratling BM, et al.: Internal parasites of Washington cattle. *Am J Vet Res* 36:1671–1675, 1975.

Randall RW, Gibbs HC: Effects of clinical and subclinical gastrointestinal helminthiasis on digestion and energy metabolism in calves. *Am J Vet Res* 42:1730–1734, 1981.

Robers JL, Swan RA: Quantitative studies of ovine haemonchosis I. Relationship between fecal egg counts and total worm counts. *Vet Parasitol* 8:165–171, 1981.

Ross JG, Dow C: The course and development of the abomasal lesion in calves experimentally infected with the nematode parasite *Ostertagia ostertagi*. *Br Vet J* 121:228–233, 1965.

Smith HJ, Archibald R McG: The overwinter survival of ovine gastrointestinal parasites in the maritime provinces. *Can Vet J* 6:257–267, 1965.

Theodorides VJ, Nawalinski T, Chang J: Efficacy of albendazole against *Haemonchus*, *Nematodirus*, *Dictyocaulus*, and *Moniezia* of sheep. *Am J Vet Res* 37:1515–1516, 1976.

Thomas RJ, Ali DA: The effect of *Haemonchus contortus* infection of the pregnant and lactating ewe. *Int J Parasitol* 11:393–398, 1983.

Todd KS, Mansfield ME, DiPetro JA: Anthelmintic efficacy of avermectin B_{1a} and dihydroavermectin B_{1a} against ovine gastrointestinal nematodes in 1977. *Am J Vet Res* 45:976–977, 1984.

Tunnicliffe EA: The occurrence of *Cooperia oncophora* and *Nematodirus helvetianus* in calves. *J Am Vet Med Assoc* 33:250–241, 1932.

Wescott RB, LeaMaster BR: Efficacy of ivermectin against naturally acquired and experimentally induced nematode infections in sheep. *Am J Vet Res* 43:531–533, 1982.

Williams JC, Know JW, Baumann BA, et al.: Seasonal changes of gastrointestinal nematode populations in yearling beef cattle in Louisiana with emphasis on prevalence of inhibition of *Ostertagia ostertagi*. *Int J Parasitol* 13:133–143, 1983.

Williams JC, Lovacano AF, DeRosa A, et al.: A comparison of persistent anthelmintic efficacy of topical formulations of doramectin, ivermectin, eprinomectin and moxidectin against naturally acquired nematode infections of beef calves. *Vet Parasitol* 85:277–288, 1999.

Williams JC, Nault C, Ramsey RT, et al.: Efficacy of Cydectin moxiclectin 1% injectable against experimental infestations of *Dicyocaulus viviparous* and *Bunostomum phlebotomum* superimposed on natural gastrointestinal infections in calves. *Vet Parasitol* 43:293–299, 1992.

Williams JC, Sheehan DS, Fuselier RH, et al.: Experimental and natural infection of calves with *Bunostomum phlebotomum*. *Vet Parasitol* 13:225–237, 1983.

Yazwinski T, Tucker C, Copeland S, Yazwinski T, Guerino F: Dose confirmation of moxidectin pour-on against natural nematode infections of lactating dairy cows. *Vet Parasitol* 86:223–228, 1999.

Trematodes

Armour J: The epidemiology and control of bovine fascioliasis. *Vet Rec* 96:198–201, 1975.

Boray JC, Crowfoot PD, Strong MB, et al.: Treatment of immature and mature *Fasciola hepatica* infections in sheep with triclabendazole. *Vet Rec* 113:315–317, 1983.

Craig TM, Bell RR: Seasonal transmission of liver flukes to cattle in the Texas gulf coast. *J Am Vet Med Assoc* 173:104–107, 1978.

Craig TM, Huey RL: Efficacy of triclabendazole against *Fasciola hepatica* and *Fascioloides magna* in naturally infected calves. *Am J Vet Res* 45:1644–1645, 1984.

Dargie JD, Berry CI, Parkins JJ: The pathophysiology of ovine fascioliasis: Studies on the feed intake and digestibility, body weight and nitrogen balance of sheep given rations of hay or hay plus a pelleted supplement. *Res Vet Sci* 26:289–295, 1979.

Doyle JJ: Acquired immunity to experimental infection with *Fasciola hepatica* in cattle. *Res Vet Sci* 12:527–534, 1971.

Farrell CJ, Shen DT, Wescott RB, et al.: An enzyme-linked immunosorbent assay for diagnosis of *Fasciola hepatica* infection in cattle. *Am J Vet Res* 42:237–240, 1981.

Foreyt WJ: Experimental infection of lymnaeid snails in Wisconsin with miracidia of *Fascioloides magna* and *Fasciola hepatica*. *J Parasitol* 64:1132–1134, 1978.

Foreyt WJ, Foreyt KM: Albendazole treatment of experimentally induced *Fascioloides magna* infection in goats. *Vet Med Small Anim Clinic* 75:1441–1444, 1980.

Foreyt WJ, Hunter RL: Clinical *Fascioloides magna* infection in sheep in Oregon on pasture shared by Columbian white-tailed deer. *Am J Vet Res* 41:1531–1532, 1980.

Foreyt WJ, Todd AC: Development of the large American liver fluke *Fascioloides magna* in white-

tailed deer, cattle, and sheep. *J Parasitol* 62:26–32, 1976.

Foreyt WJ, Todd AC: Liver flukes in cattle: Prevalence, distribution and experimental treatment. *Vet Med Small Anim Clin* 71:816–822, 1976.

Hjerpe CA, Tennant BC, Crenshaw GL, et al.: Ovine fascioliasis in California. *J Am Vet Med Assoc* 159:1266–1271, 1971.

Hoover RC, Lincoln JD, Hall RF, et al.: Seasonal transmission of *Fasciola hepatica* to cattle in northwestern United States. *J Am Vet Med Assoc* 184:69.

Krull WH, Mapes CR: Studies on the biology of *Dicrocoelium dendriticum* (Rudolphi, 1819) Looss, 1899 (Trematoda: Dicrocoeliidae), including its relation to the intermediate host, *Cionella lubrica* (Muller). IX Notes on the cyst, metacercariae, and infection in the ant, *Formica fusca*. *Cornell Vet* 44:389–410, 1954.

Leathers CW, Foreyt WJ, Fetcher A, et al.: Clinical fascioliasis in domestic goats in Montana. *J Am Vet Med Assoc* 180:1451–1454, 1982.

Malone JB, Loyacano A, Armstrong DA, et al.: Bovine fascioliasis: Economic impact and control in Gulf coast cattle based on seasonal transmission. *Bovine Pract* 17:126–133, 1982.

Malone JB, Ramsey RT, Loyacano AF: Efficacy of clorsulon against 8 week-old experimentally induced and mature naturally acquired *Fasciola hepatica* in cattle. *Am J Vet Res* 45:851–854, 1984.

Malone JB, Smith PH, Loyacano A, et al.: Efficacy of albendazole for treatment of naturally acquired *Fasciola hepatica* in calves. *Am J Vet Res* 43:879–881, 1982.

Olsen OW: Longevity of metacercariae of *Fasciola hepatica* on pastures in the upper coastal region of Texas and its relationship to liver fluke control. *J Parasitol* 33:36–42, 1947.

Price EW: The fluke situation in American ruminants. *J Parasitol* 39:119–134, 1953.

Symons LEA, Boray JC: The anemia of acute and chronic ovine fascioliasis. *Z Tropenmed Parasit* 19:451–472, 1968.

Vermunt JJ, West DM, Pomroy WE: Multiple resistance to ivermectin and oxfendazole in *Cooperia* species of cattle in New Zealand. *Vet Rec* 137:43–45, 1995.

Wescott RB, Farrell CJ, Shen DT: Diagnosis of naturally occurring *Fasciola hepatica* infections in cattle with an ELISA test. *Am J Vet Res* 45:178–179, 1984.

Protozoa

Abbit B, Meyerholz GW: *Trichomonas foetus* infection of range bulls in south Florida. *Vet Med Small Animal Clin* 74:1339–1342, 1979.

Baker NF, Walters GT, Fish RA: Amprolium for control of coccidiosis in feedlot lambs. *Am J Vet Res* 33:83–86, 1972.

Barr BC, Rowe JD, Sverlow KW, et al.: Experimental reproduction of bovine fetal *Neospora* infection and death with a bovine *Neospora* isolate. *J Vet Diagn Invest* 6:207, 1994.

Bergstrom RC, Maki LR: Coccidiostatic action of monensin fed to lambs: Body weight gains and feed conversion efficacy. *Am J Vet Res* 37:79–81, 1976.

Bergstrom RC, Maki LR: Effect of monensin in young crossbred lambs with naturally occurring coccidiosis. *J Am Vet Med Assoc* 165: 288–289, 1974.

Beverly JKA, Watson WA: Prevention of experimental and naturally occurring ovine abortion due to toxoplasmosis. *Vet Rec* 88:39–41, 1971.

Blewett DA, Watson WA: The epidemiology of ovine toxoplasmosis. II. Possible sources of infection in outbreaks of clinical disease. *Br Vet J* 139:546–555, 1983.

Clark BL, Parsonson IM, White ME, et al.: Control of trichomoniasis in large herd of beef cattle. *Aust Vet J* 50:424–425, 1974.

Davison H, Otter A, Trees AJ: Estimation of vertical and horizontal transmission parameters of *Neospora caninum* infections in dairy cattle. *Int J Parasitol* 29:1683, 1999.

Dubey JP: A review of *Sarcocystis* of domestic animals and of other coccidia of cats and dogs. *J Am Vet Med Assoc* 169:1061–1078, 1976.

Dubey JP: Epizootic toxoplasmosis associated with abortion in dairy goats in Montana. *J Am Vet Med Assoc* 178:661–670, 1981.

Dubey JP: *Toxoplasma*, *Hammondia*, *Sarcocystis*, *Besnoitia* and other tissue cyst-forming coccidia of man and animals. In Kreier, JP, (ed): *Parasitic Protozoa*. New York, Academic Press, 1977, pp 101–237.

Dubey JP: *Toxoplasma*-induced abortion in dairy goats. *J Am Vet Med Assoc* 178:671–674, 1981.

Dubey JP: Neosporosis in cattle: biology and economic impact. *J Am Vet Med Assoc* 214:1160, 1999.

Dubey JP: Recent advances in *Neospora* and neosporosis. *Vet Parasitol* 84:349, 1999.

Dubey JP, Kirkbride CA: Epizootics of ovine abortion due to *Toxoplasma gondii* in north central United States. *J Am Vet Med Assoc* 184:657–660, 1984.

Dubey JP, Lindsay DS, Anderson ML, et al.: Induced transplacental transmission of *Neospora caninum* in cattle. *J Am Vet Med Assoc* 201:709, 1992.

Dubey JP, Speer CA, Epling GP: Sarcocystosis in newborn calves fed *Sarcocystis cruzi* sporocysts from coyotes. *Am J Vet Res* 43:2147–2164, 1982.

Dubey JP, Weisbrode SE, Speer CA, et al.: Sarcocystosis in goats: Clinic signs and pathologic and hematologic findings. *J Am Vet Med Assoc* 178:683–699, 1981.

Fayer R, Reid WM: Control of coccidiosis. In Long PF (ed): *The Biology of the Coccidia*. Baltimore, Maryland, University Park Press, 1982.

Fitzgerald PR, Mansfield ME: Ovine coccidiosis: Effect of the antibiotic monensin against *Eimeria ninakohlyakimovae* and other naturally occurring coccidia of sheep. *Am J Vet Res* 37:7–10, 1978.

Fitzgerald PR, Johnson AE, Hammond DM: Treatment of genital trichomoniasis in bulls. *Am J Vet Res* 143:259–262, 1963.

Foreyt WJ, Gates NL, Rich JE: Evaluation of lasalocid in salt against ovine coccidia. *Am J Vet Res* 42:54–56, 1981.

Foreyt WJ, Gates NL, Wescott RB: Effects of lasalocid and monensin against experimentally induced coccidiosis in confinement-reared lambs from weaning to market weight. *Am J Vet Res* 40:97–100, 1979.

Foreyt WJ, Parish SM, Foreyt KM: Lasalocid for improved weight gains and control of coccidia in lambs. *Am J Vet Res* 42:57–60, 1981.

Gasparini G, Vaghi M, Tardani T: Treatment of bovine trichomoniasis with metronidazole. *Vet Rec* 75:940–943, 1963.

Hammond DM, Kuta JE, Miner ML: Amprolium for control of experimental coccidiosis in lambs. *Cornell Vet* 57:611–623, 1967.

Horton GMJ, Stockdale PHG: Effects of amprolium and monensin on oocyst discharge, feed utilization and rumen metabolism of lambs with coccidiosis. *Am J Vet Res* 40:966–970, 1979.

Kirkpartrick CE, Farrell JP: Cryptosporidiosis. *Compend Continuing Ed* 6:154–165, 1984.

Leek RG, Fayer R, Johnson AT: Sheep experimentally infected with *Sarcocystis* from dogs: I. Disease in young lambs. *J Parasitol* 63:642–650, 1977.

Leek RG, Fayer R, McLoughlin DK: Effect of monensin on experimentally infections of *Eimeria ninakohlyakimovae* in lambs. *Am J Vet Res* 37:339–341, 1976.

Levine ND, Ivens V: *The Coccidian Parasites (Protozoan: Sporozoa) of Ruminants*. Illinois Biology Monograph No. 44, Urban, Illinois, University of Illinois Press, 1970.

Levine ND, Ivens V, Fritz TE: *Eimeria christenseni* sp. n. and other coccidia (Protozoa: Eimeriidae) of the goat. *J Parasitol* 48:255–269, 1962.

Lima JD: *Eimeria caprina* sp. n. from the domestic goat, *Capra hircus*, from the USA. *J Parasitol* 65:902–903, 1979.

Lima JD: Life cycle of *Eimeria christenseni* Levine, Ivens & Fritz, 1962 from the domestic goat, *Capra hircus*. L. *J Protozool* 27:59–64, 1981.

Long MT, Baszler TV: Fetal loss in BALB/C mice infected with *Neospora caninum*. *J Parasitol* 82:608, 1996.

McDougal LR: Attempted cross-transmission of coccidia between sheep and goats and description of *Eimeria ovinoidalis* sp. n. *J Protozool* 26:109–113, 1979.

McLoughlin DK: Dimetridazole, a systemic treatment for bovine venereal trichomoniasis I: Oral administration. *J Parasitol* 51:835–836, 1965.

Morgan BB: *Bovine trichomoniasis*. Minneapolis, Minnesota, Burgess Publishing Co., 1944.

O'Handley RM, Olson ME, McAllister TA: Efficacy of fenbendazole for treatment of giardiasis in calves. *Am J Vet Res* 58:384–388, 1997.

Olson ME, Guselle NH, O'Handley RM, et al.: *Giardia* and *Cryptosporidium* in dairy calves in British Columia. *Can Vet J* 38:703–706, 1997.

Parsonson IM, Clark BL, Dufty J: The pathogenesis of *Tritrichomonas foetus* infection in the bull. *Aust Vet J* 50:421–523, 1984.

Pellerdy LP: *Coccidia and Coccidiosis*. Berlin, Parey, 1974.

Pout DD: Coccidiosis of sheep: A review. *Vet Rec* 98:340–341, 1976.

Radostits OM: Stockdale PHG: A brief review of bovine coccidiosis in western Canada. *Can Vet J* 21:227–230, 1980.

Samizadeh-Yazd A, Rhodes CN, Todd AC: Ovine coccidiosis; Comparison of the effects of monensin and aureomycin on lambs infected with coccidia. *Am J Vet Res* 40:1107–1109, 1979.

Soulsby EJL: Helminths, *Arthropods and Protozoa of Domesticated Animals*. Edition 7. London, Bailliere Tindall, 1982.

Thurmond MC, Hietala SK: Effect of congenitally acquired *Neospora caninum* infection on risk of abortion and subsequent abortions in dairy cattle. *Am J Vet Res* 58:1381, 1997.

Wilson SK, Kocan AA, Gaudy ET, et al.: The prevalence of trichomoniasis in Oklahoma beef bulls. *Bovine Pract* 14:109–110, 1979.

Wouda W, Moen AR, Schukken YH: Abortion risk in progeny of cows after a *Neospora caninum* epidemic. *Theriogenology* 49:1311, 1998.

Xiao L, Saeed K, Herd RP: Efficacy of albendazole and fenbendazole against *Giardia* infection in cattle. *Vet Parasitol* 61:165–170, 1996.

External Parasites

Bequaert J: A monograph of the *Melophaginae*, or ked

flies, of sheep, goats, deer and antelope (*Diptera, Hippoboscidae*). *Enottomo Am* 22:1–220, 1942.
Desch CE Jr., Hoogstraal H, Nutting WB: Biology of ticks (Metastigmata: Ixodida). In Nutting WB (ed): *Mammalian Diseases and Arachnids*, vol 1. Boca Raton, Florida, CRC Press, Inc., 1984, pp 111–140.
Drummond RO, George JE, Kunz SE: *Control of Arthropod Pests of Livestock: A Review of Technology*. CRC Press, Inc., Boca Raton, FL, 1988, 245 pages.
Drummond RO, Lambert G, Smalley HE Jr., et al.: Estimated losses of livestock to pests. In: *CRC Handbook of Pest Management in Agriculture*. Volume 1. Boca Raton, Florida, CRC Press, 1981.
Foil LD, Hogsette JA: Biology and control of tabanids, stable flies and horn flies. *Rev Sci Tech* 13:1125–1138, 1994.
Guglielmone AA, Mangold AJ, Munoz C, et al.: Moxidectin pour-on for control of natural populations of the cattle tick *Boophilus microplus* (*Acarina: Ixodiae*). *Vet Parasitol* 87:237–241, 2000.
Harwood RF, James MT: *Entomology in Human and Animal Health*. MacMillan, New York, 1979.
Hourrigan JL: Spread and detection of psoroptic scabies of cattle in the United States. *J Am Vet Med Assoc* 175:1278–1280, 1979.
Keirans JE, Clifford CM: The genus *Ixodes* in the United States: A scanning electron microscope study and key to the adults. *J Met Entomol* (Suppl) 2:1–14, 1978.
McLaughlin RF, Addison EM: Tick (*Dermacentor albipictus*)-induced winter hair loss in captive moose (*Alces alces*). *J Wildl Dis* 22:502–510, 1986.
Steelman CD: Effects of external and internal arthropod parasites on domestic livestock production. *An Rev Entomol* 21:166–178, 1976.
Strickland RK, Gerrish RR, Hourrigan JL, et al.: *Ticks of Veterinary Importance*, no. 485. Washington, D.C., Animal and Plant Health Inspection Service, U.S. Department of Agriculture, 1976, p. 122.
Williams RE, Hall RD, Broce AB, et al. (eds): *Livestock Entomology*. John Wiley and Sons, New York, 1985.
Wright FC, Guilliot FS, Meleney WP: Transmission of psoroptic mites from bighorn sheep (*Ovis canadensis mexicana*) to domestic sheep, cattle and rabbits. *J Wildl Dis* 17:381–386, 1981.

Section 6

PARASITES OF LLAMAS

Fecal Eggs and Oocysts

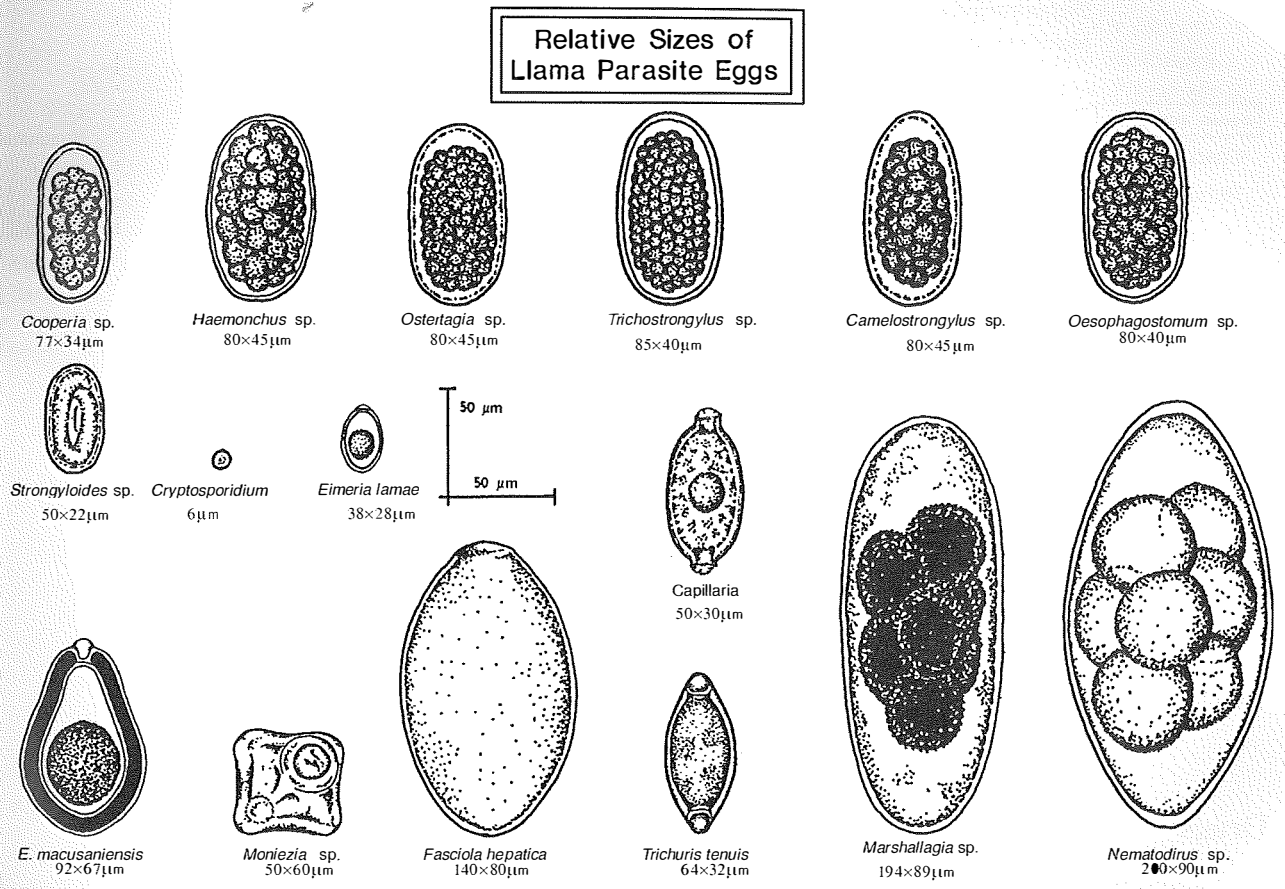


Fig. 137. Common parasite eggs and oocysts found in llama feces.

Coccidia in Llamas

Table 32. Species of coccidia (*Eimeria*) in llamas*

Species	Size (µm)	Prepatent Period
Eimeria alpacae	26 × 21	16–18 days
Eimeria lamae	38 × 28	15–16 days
Eimeria macusaniensis	92 × 67	33–34 days
Eimeria punoensis	21 × 18	10 days

*All have micropylar caps.

Location of Major Parasites

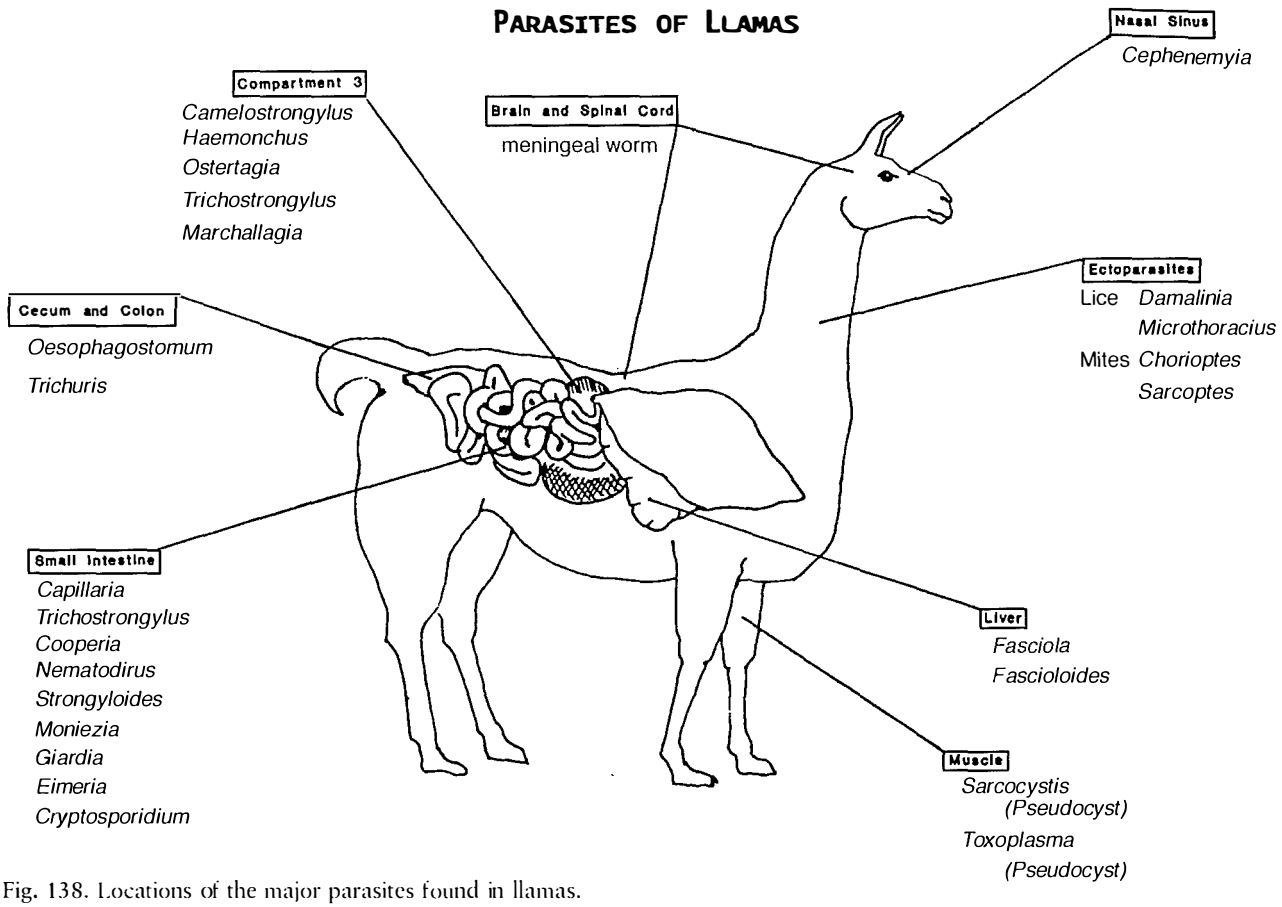


Fig. 138. Locations of the major parasites found in llamas.

Drugs

Table 33. Anthelmintics used commonly in llamas

Drug	Dosage	Parasites Affected
Albendazole	10 mg/kg	Liver flukes, gastrointestinal nematodes, lungworms
Clorsulon	7 mg/kg	Liver flukes
Doramectin	0.2 mg/kg	Gastrointestinal nematodes, lungworms, external parasites
Fenbendazole	5–10 mg/kg q 24 h × 3 d	Cestodes, gastrointestinal nematodes, lungworms
Ivermectin	0.2 mg/kg	Gastrointestinal nematodes, lungworms, sarcoptic mange, sucking lice
Levamisole	5–8 mg/kg	Gastrointestinal nematodes, lungworms
Mebendazole	22 mg/kg q 24 h × 3 d	Gastrointestinal nematodes
Pyrantel pamoate	18 mg/kg q 24 h × 1–3 d	Gastrointestinal nematodes

Fig. 139. Typical strongyle eggs. Prepatent period is 17–36 days.

Internal Parasites

Species of *Camelostrongylus, Cooperia, Haemonchus, Oesophagostomum, Ostertagia, and Trichostrongylus*

Common name: Strongyles.
Size of eggs: 77 µm × 45 µm.
Importance: These are the most prevalent parasites in llamas. Clinical signs of infection are stunted growth, emaciation, and diarrhea. Prevalence is highest in young.
Diagnosis: Eggs in fecal flotation.
Treatment: Albendazole, 10 mg/kg PO
Fenbendazole, 10 mg/kg q 24 × 3 d PO
Ivermectin or doramectin, 0.2 mg/kg SC or IM
Levamisole, 5–8 mg/kg SC, PO
Mebendazole, 22 mg/kg q 24 h × 3 d PO
Pyrantel pamoate, 18 mg/kg q 24 × 1–3 d PO

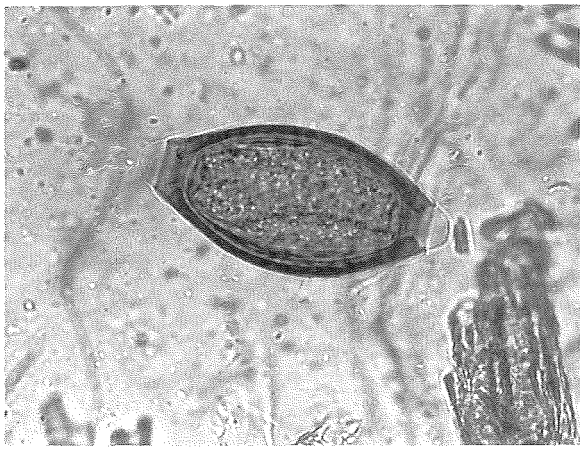


Fig. 140. *Trichuris tenuis*. Prepatent period is unknown.

Trichuris tenuis

Common name: Whipworm.
Size of egg: 64 µm × 32 µm.
Importance: Poor growth, diarrhea.
Diagnosis: Eggs in fecal flotation.
Treatment: Efficacy is unknown. Recommendations are treatment with: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg SC or IM
Fenbendazole, 10–15 mg/kg q 24 h × 3 d PO
Ivermectin, 0.2 mg/kg SC

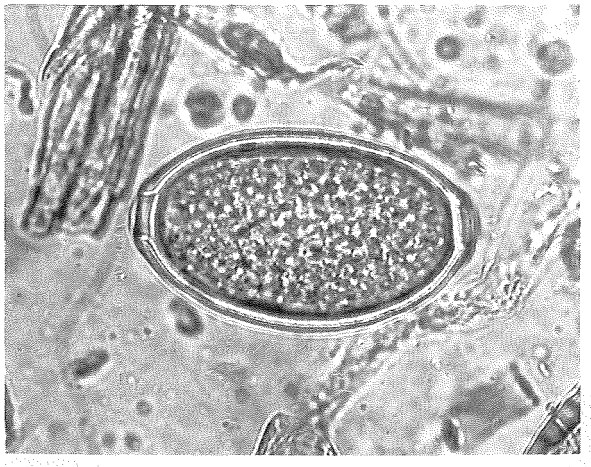


Fig. 141. *Capillaria* sp. Prepatent period is unknown.

Capillaria spp.

Common name: Capillary worm (at least two species).
Size of egg: 50 µm × 30 µm, 75 µm × 40 µm.
Importance: Unknown. Low prevalence on fecal analysis, high prevalence upon necropsy.
Diagnosis: Eggs in fecal flotation.
Treatment: Efficacy is unknown. Recommendations include treatment with: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg SC or IM
Fenbendazole, 10–15 mg/kg q 24 h × 3 d PO
Ivermectin, 0.2 mg/kg SC

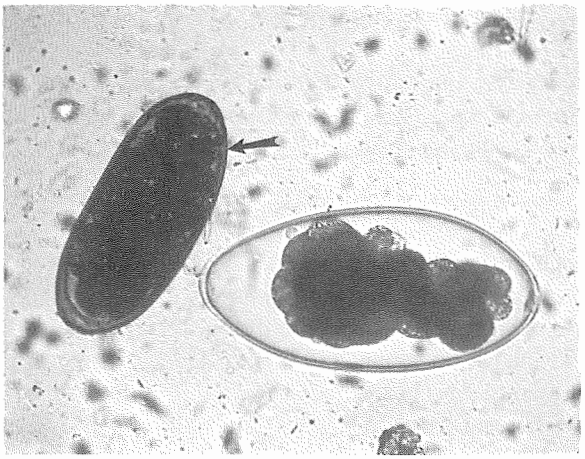


Fig. 142. *Nematodirus battus* (arrow)/*N. helvetianus*. Prepatent period is 2–3 weeks_

Nematodirus battus, N. helvetianus

Common name: Thin-necked intestinal worm.
Size of egg: 200 µm × 90 µm.
Importance: Common in llamas, especially young; causes poor growth, diarrhea.
Diagnosis: Eggs in fecal flotation.
Treatment: Albendazole, 10 mg/kg PO
Doramectin, 0.2 mg/kg SC or IM
Fenbendazole, 10 mg/kg q 24 h × 3 d PO
Ivermectin, 0.2 mg/kg SC
Levamisole, 5–8 mg/kg SC, PO
Mebendazole, 22 mg/kg q 24 h × 3 d PO
Pyrantel pamoate, 18 mg/kg q 24 h × 1–3 d PO

Fig. 143. *Eimeria lamae*. Prepatent period is 15–16 days.

Eimeria lamae

Common name: Coccidia.
Size of oocysts: 38 µm × 28 µm.
Importance: Very common in llamas, especially young. Causes diarrhea and poor growth, especially in llamas less than 4 months old.
Diagnosis: Oocysts in fecal flotation (see Table 32).
Treatment: Amprolium, 10 mg/kg PO q 24 h × 5–21 d
Sulfamethazine, 0.5% in feed; or 130 mg/kg PO, then 65 mg/kg q 12 h × 4 d
Prevention: Decoquinate, 0.5 mg/kg PO q 24 × 28+ d
Lasalocid, 1 mg/kg PO q 24 × 30+ d
Monensin, 0.25 mg/kg PO in feed q 24 × 31
Sulfaguanidine, 0.2% of feed

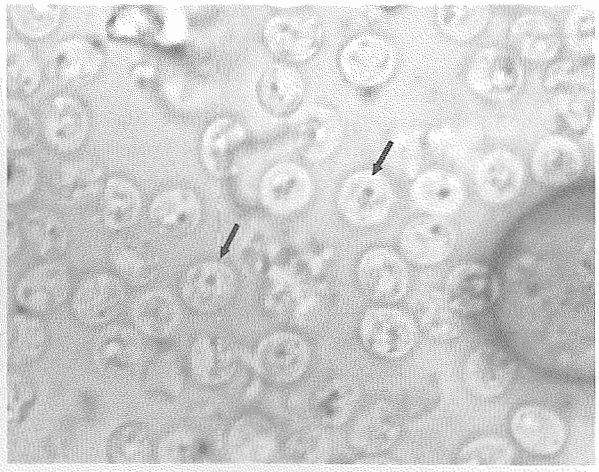


Fig. 144. *Cryptosporidium* sp. (arrows). Prepatent period is 3–7 days.

Cryptosporidium sp.

Common name: Crypto.
Size of oocyst: 5 µm × 6 µm.
Importance: Uncommon in llamas, but our laboratory has seen *Cryptosporidium* associated diarrhea in neonatal llamas and weaned llamas. Diarrhea in young less than 30 days of age is most common. Note: *Cryptosporidium* can infect humans.
Diagnosis: Oocysts in fecal flotation.
Treatment: None. Prevention through sanitation is helpful.

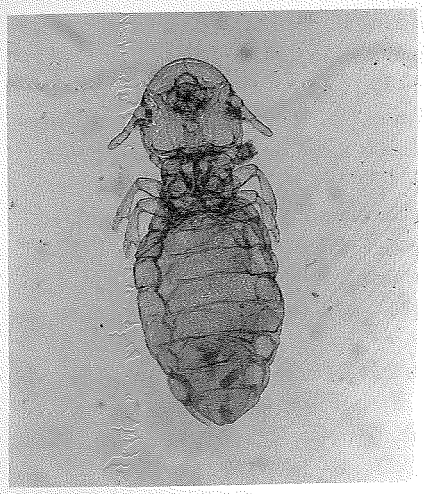


Fig. 145. *Damalinia* sp. (biting lice). Life cycle is approximately 3 weeks.

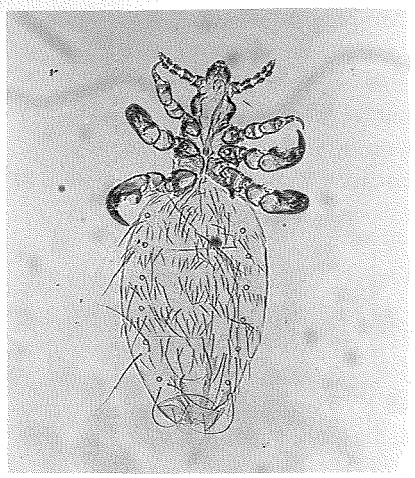


Fig. 146. *Microthoracius* sp. (sucking lice). Life cycle is approximately 3 weeks.

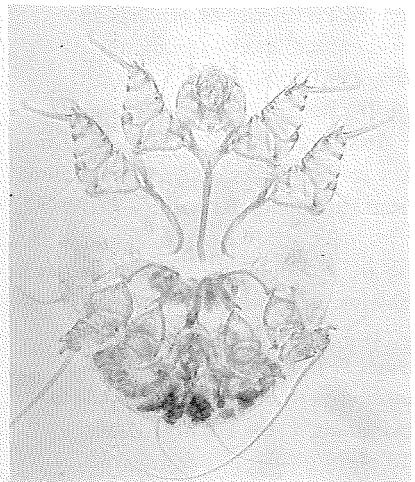


Fig. 147. *Sarcoptes scabiei* (mange mites). Life cycle is approximately 3 weeks.

External Parasites

Damalinia (Bovicola) sp.

Common name: Biting lice.
Size of adult: 2–4 mm.
Importance: Common in llamas, especially in winter. Causes itching, restlessness, hair loss, and poor growth.
Diagnosis: Direct observation of hair, especially along dorsal midline and rump. Examining with a flashlight is helpful.
Treatment: Treat all animals simultaneously.
Coumaphos, dust, spray
Fenvalerate, spray
Invermectin-type products
(See Table 27 for complete list.)

Microthoracius sp.

Common name: Sucking lice.
Size of adult: 2–5 mm.
Importance: Common in llamas, especially in winter. Causes itching, restlessness, hair loss, and poor growth.
Diagnosis: Direct observation of hair, especially along dorsal midline and rump. Examining with a flashlight is helpful.
Treatment: Treat all animals simultaneously.
Coumaphos, dust, spray
Fenvalerate, spray
Invermectin-type products
(See Table 27 for complete list.)

Sarcoptes scabiei

Common name: Sarcoptic mange mite.
Size of adult: 250–600 μm.
Importance: Was very common, but prevalence is decreasing, probably due to use of ivermectin. Causes alopecia on face, neck, and other areas; pruritus.
Diagnosis: Deep skin scraping at edge of lesion. Observe mites microscopically.
Treatment: Treat all animals simultaneously.
Ivermectin or doramectin, 0.2 mg/kg SC; repeat in 10–14 d.

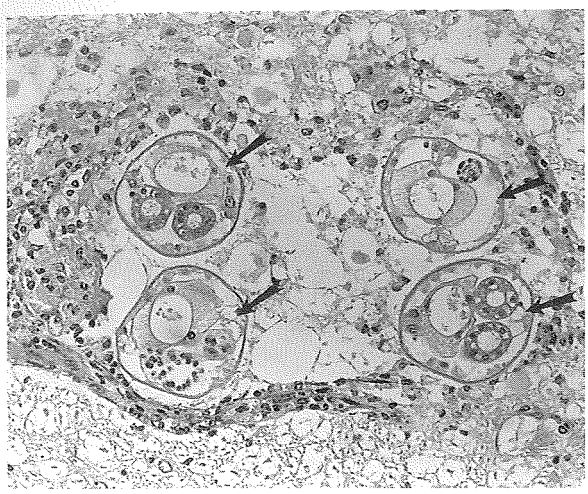


Fig. 148. Meningeal worm larvae in spinal cord. Prepatent period is 90 ± 9 days in deer. Larvae are approximately 50 µm in diameter.

Parelaphostrongylus tenuis

Common name: Meningeal worm or brain worm.
Size of larvae: Less than 100 µm in diameter in CNS.
Importance: This parasite is found normally in white-tailed deer in the Eastern USA and Canada. When larvae in snails are ingested by llamas, the parasite migrates into the spinal cord and brain and usually kills the llama. Paralysis and incoordination are seen before death. Larvae cause severe inflammation to the CNS. Death usually occurs 30–60 days after infection. (See references.)
Diagnosis: Evaluation of CNS fluid; eosinophilia is present. At necropsy larvae are seen histologically in spinal cord and brain.
Treatment: Ivermectin 0.2 mg/kg SC at 14-day intervals may prevent most larvae from causing significant damage. Ivermectin treatment should be initiated before transmission of larvae occurs. Once lesions develop, damage is irreversible.

Bibliography

Baumgartner W, Zajac A, Hull BL, et al.: Parelaphostrongylosis in llamas. *J Am Vet Med Assoc* 187:1243–1245, 1985.

Bishop JK, Rickard LG: Fecal survey of llamas (*Lama glama*) in Oregon: Incidental recovery of *Nematodirus battus*. *J Am Vet Med Assoc* 191:1579–1581, 1987.

Brown TT, Jr, Jordan HE, Demorest CN: Cerebrospinal parelaphostrongylosis in llamas. *J Wildl Dis* 14:441–444, 1978.

Conboy GA, O'Brien TD, Stevens DL: A natural infection of *Fascioloides magna* in a llama (*Lama glama*). *J Parasitol* 74:345–346, 1988.

Cornick JJ: Gastric squamous cell carcinoma and fascioliasis in a llama. *Cornell Vet* 78:235–241, 1988.

Foreyt WJ, Lagerquist J: Experimental infections of *Eimeria alpacae* and *Eimeria punoensis* in llamas (*Llama glama*). *J Parasitol* 78:906–909, 1992.

Foreyt WJ, Rickard LG, Dowling S, Parish S, Pipas M: Experimental infections of two llamas with the meningeal worm (*Parelaphostrongylus tenuis*). *J Zoo and Wildl Med* 22:339–344, 1991.

Fowler ME: *Medicine and surgery of South American camelids: Llama, alpaca, vicuna, guanaco*. Iowa State University Press, Ames, Iowa, 1989.

Fowler ME, Paul-Murphy J: *Cephenemyia* sp. infestation in the llama. *Calif Vet* 39:10–12, 1985.

Hodgin C, Schillhorn van Veen TW, Fayer R, et al: Leptospirosis and coccidial infection in a guanaco. *J Am Vet Med Assoc* 185:1442–1444, 1984.

Kiorpes AL, Kirkpatrick CE, Bowman DD: Isolation of *Giardia* from a llama and from sheep. *Can J Vet Res* 51:277–280, 1987.

Krogdahl DW, Thilsted JP, Olsen SK. Ataxia and hypermetria caused by *Paralaphostrongylus tenuis* infection in llamas. *J Am Vet Med Assoc* 190:191–193, 1987.

Lunn DP, Hinchcliff KW: Cerebrospinal fluid eosinophilia and ataxia in five llamas. *Vet Rec* 124:302–305, 1989.

O'Brien T, O'Leary TP, Leininger JR, et al.: Cerebrospinal parelaphostrongylosis in Minnesota. *Minn Vet* 26:18–22, 1986.

Rickard LG, Bishop JK: Prevalence of *Eimeria* spp. (Apicomplexa: Eimeriidae) in Oregon llamas. *J Protozool* 35:335–336, 1988.

Rickard LG, Bishop JK: Redescription of *Trichuris tenuis* Chandler, 1930 from llamas in Oregon (*Lama glama*) with a key to the species of *Trichuris* present in North American ruminants. *J Parasitol* 77:70–77, 1991.

Rickard LG, Bishop JK: Helminth parasites of llamas in the Pacific Northwest. *J Helminthol Soc Wash* 58:110–115, 1991.

Riemann HP, Behymer D E, Fowler ME, et al.: Prevalence of antibodies to *Toxoplasma gondii* in captive exotic mammals. *J Am Vet Med Assoc* 165:798–800, 1974.

Section 7

PARASITES OF HORSES

Fecal Eggs and Oocysts

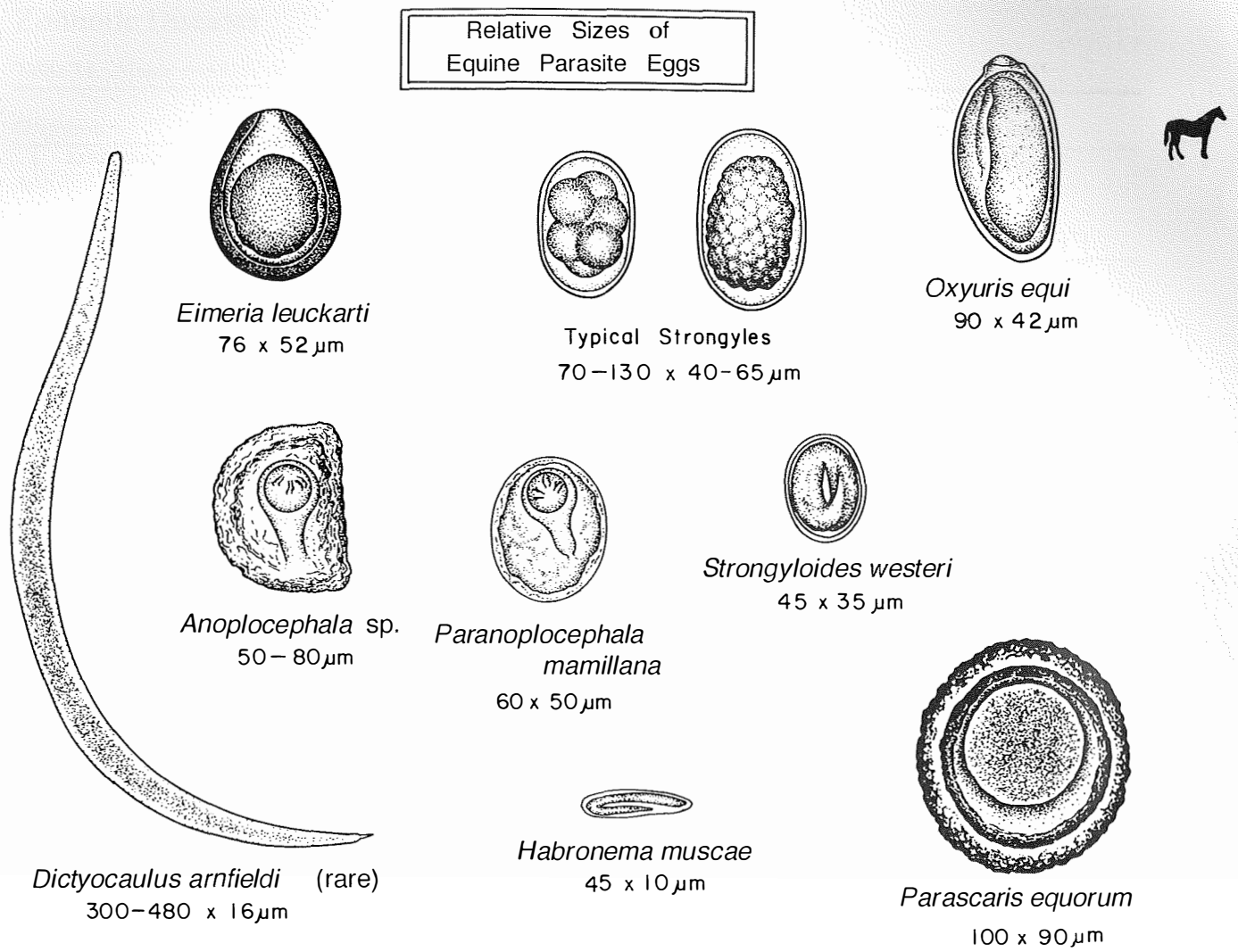


Fig. 149. Common parasite eggs and oocysts found in horse feces.

Location of Major Parasites

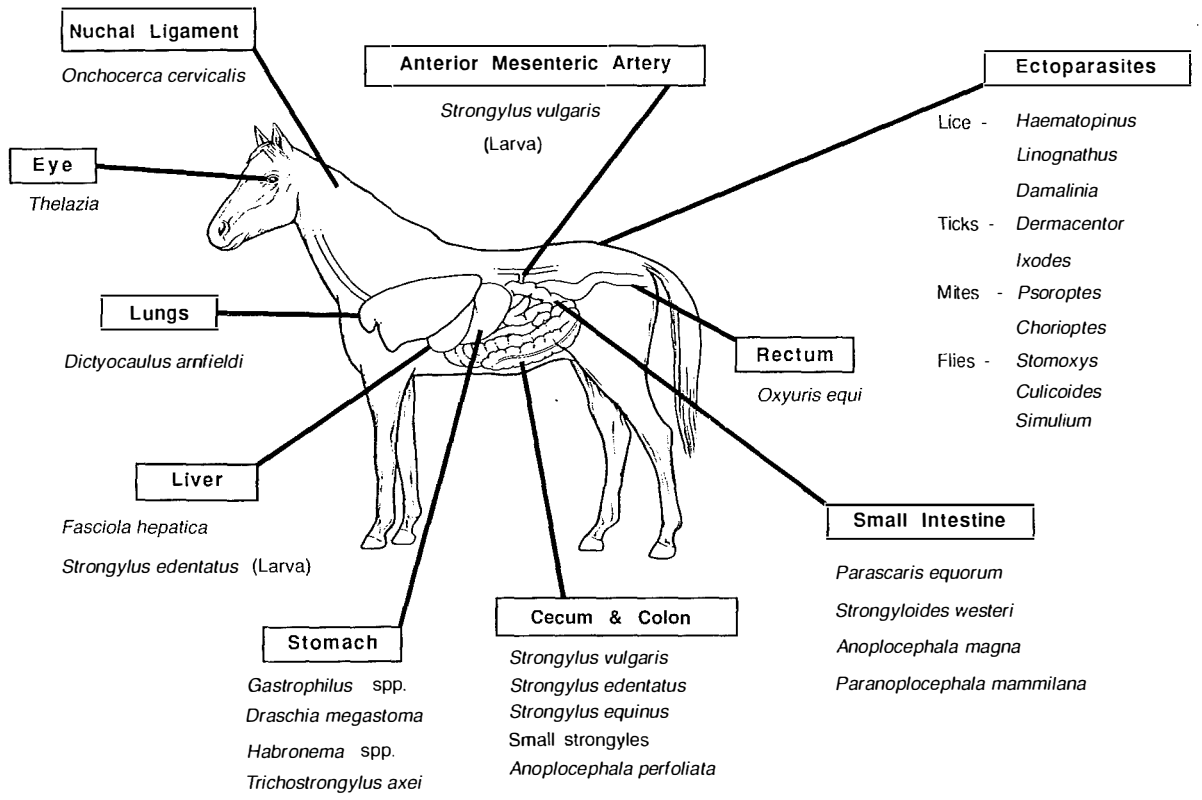


Fig. 150. Locations of the major parasites found in horses.
Note: *Micronema* (*Halicephalobus*) *deletrix* larvae are in tissues. Adults are saprophytes.

Zoonotic Diseases

Table 34. Major zoonotic diseases associated with horses–uncommon

Organism	Disease	Method of Infection
Arthropods		
Gastrophilus spp.	Myiasis	Contact with adult fly
Lice	Transient pediculosis	Contact with infected horses

Drugs

Table 35. Common names and sources of drugs used for deworming horses

Generic and Class Name	Trade Name	Source	Method
Avermectins			
Ivermectin	Eqvalan	Merial	Paste
Milbemycin			
Moxidectin	Quest	Ft. Dodge	Oral gel
Benzimidazoles			
Fenbendazole	Panacur	Hoechst	Feed, paste, stomach tube
Mebendazole	Telmin	Pitman-Moore	Feed, paste, stomach tube
Mebendazole + trichlorfon	Telmin-B	Pitman-Moore	Feed, paste, stomach tube
Oxfendazole	Benzelmin	Diamond	Feed, stomach tube
Oxibendazole	Anthelcide-EQ	Norden	Feed, paste, stomach tube
Oxibendazole	Equipar	Cooper	Feed, paste, stomach tube
Phenylguanidines			
Febantel	Rintal	Haver	Feed, paste, stomach tube
Fenbendazole + trichlorfon	Combotel	Haver	Paste
Imidothiazole			
Levamisole + piperazine	Ripercol-Piperazine	Beecham	Stomach tube
Isoquinolenes			
Praziquantel + ivermectin	Equimax	Ft. Dodge	Paste
Organophosphates			
Dichlorvos	Equigard	Squibb	Feed
Dichlorvos	Equigel	Squibb	Paste
Trichlorfon	Combot	Haver	Paste, stomach tube
Piperazines			
Piperazine	Various	Various	Stomach tube
Piperazine-carbon disulfide + phenothiazine	Parvex Plus	Upjohn	Stomach tube
Piperazine + Phenothiazine + trichlorfon	Dyrex, T.F.	Ft. Dodge	Stomach tube
Pyrimidines			
Pyrantel	Strongid-T or P	Pfizer	Feed, paste, stomach tube
Pyrantel	Imathal-Equine	Beecham	Feed, stomach tube
Other			
Phenothiazine	Various	Various	Feed, stomach tube
Carbon disulfide	Various	Various	Stomach tube

Table 36. Antiparasitic compounds for major internal parasites of horses

Drug	Dose (mg/kg PO)	Average Removal Expectancy (%)						Toxicosis Factor*
		Bots	Ascarids	Strongyles			Oxyuris	
				S. vulgaris	*S. edentatis*	Small		
Avermectin								
Ivermectin	0.2	95–100	90–100	95–100	95–100	95–100	72–100	6–10×
Milbemycin								
Moxidectin	0.4	95–100	90–100	95–100	95–100	95–100		5×
Benzimidazoles								
Fenbendazole	5–10	0	90–100	95–100	95–100	90–100	95–100	100×
Mebendazole	8.8	0	95–100	95–100	65–95	80–95	95–100	40×
Oxfendazole	10	0	90–100	95–100	95–100	95–100	95–100	10×
Oxibendazole	10	0	90–100	95–100	95–100	95–100	90–100	60×
Phenylguanidines (Pro-BZ)								
Febantel	6	0	95–100	95–100	95–100	95–100	95–100	40×
Pyrimidines								
Pyrantel	6.6	0	90–100	95–100	67–75	90–100	60–70	20×
Piperazines								
Piperazine	88	0	95–100	40–60	0–10	90–100	40–60	3×
Organophosphates								
Dichlorvos	10–35	80–100	90–100	0–100	70–80	85–95	90–100	2–3×
Trichlorfon	40	95–100	95–100	0	0	0	95–100	1×
Imidothiazole								
Levamisole + piperazine	8+88	0	95–100	95–100	60–70	90–100	30–40	3×
Phenothiazine								
Phenothiazine	4.4–55	0	0	50–100	20–100	85–100	0	1×
Combinations								
Mebendazole + trichlorfon	8.8 + 40	95–100	95–100	95–100	65–95	80–95	95–100	1×
Febantel + trichlorfon	6 + 35	95–100	95–100	95–100	95–100	95–100	95–100	1×
Piperazine+carbon disulfide + phenothiazine	58 + 52 + 18	65–75	95–100	90–100	70–90	90–100	50–70	4×
Piperazine + phenothiazine + trichlorfon	88 + 28 + 40	95–100	95–100	95–100	30–50	90–100	90–100	1×
Carbon disulfide	53	90–100	50–100	0	0	0	0	1×

*Toxicosis factor is the level above the recommended dosage that has been shown to produce toxic effects. (See Courtney and Sundlof, 1991.)

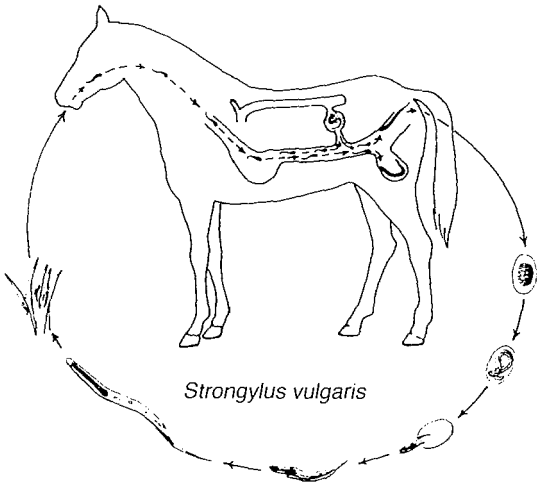


Fig. 151a. *Strongylus* spp. (*S. vulgaris*, *S. edentatus*, *S. equinus*). Prepatent period is 200–332 days.

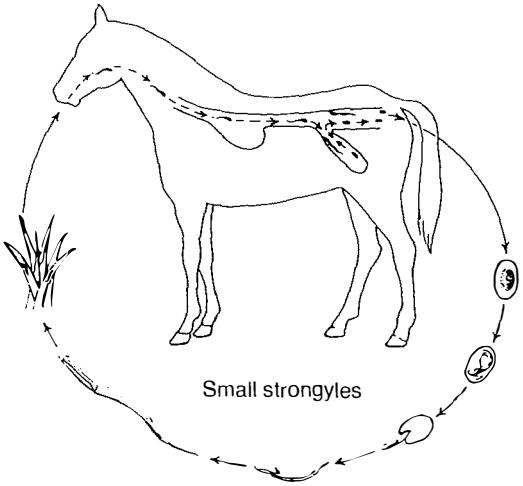


Fig. 152a. Small strongyles (cyathostomes). Prepatent period is 40 days.

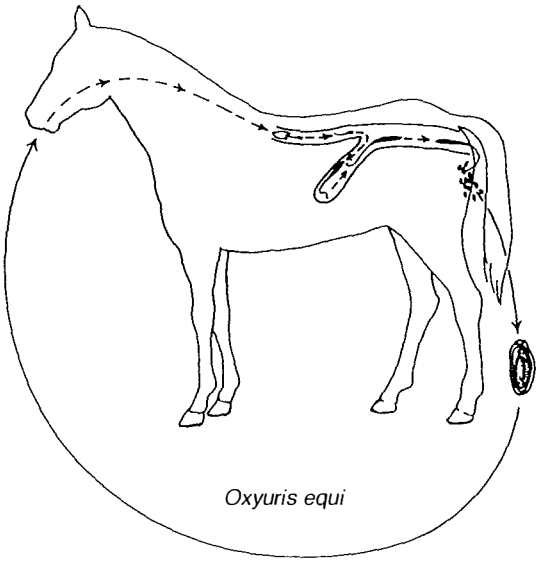


Fig. 153a. *Oxyuris equi*. Prepatent period is 5 months.

Internal Parasites

Strongylus vulgaris

Common name: Large strongyle (Strongyloidea).
Size of adult: 14–24 mm in large intestine and cecum.
Size of egg: 90 µm × 50 µm.
Importance: Larval migration causes formation of aneurysms and infarcts of intestinal circulation, which may be fatal. Adults may cause anemia.
Diagnosis: Eggs in fecal flotation. Necropsy shows aneurysm of cranial mesenteric artery. Identification of larvae that have hatched in feces achieved by using Baermann apparatus.
Treatment:
Larvae: Ivermectin, 0.2 mg/kg PO
Moxidectin, 0.4 mg/kg PO
Adults: Fenbendazole, 5 mg/kg PO
Ivermectin, 0.2 mg/kg PO
(Most equine wormers are effective.)

Species of Cyathostomum, Cylicocyclus, Cylicocephalus, Gyalocephalus, etc.

Common name: Small strongyle or cyathostome (Strongyloidea).
Size of adult: 7–25 mm in large intestine and cecum.
Size of egg: 90 µm × 50 µm.
Importance: Cause unthriftiness and periodic enteritis due to local migrations.
Diagnosis: Eggs in fecal flotation. Identification of larvae that have hatched in feces achieved with a Baermann apparatus.
Treatment: Benzimidazole/piperazine (see Table 36)
Ivermectin, 0.2 mg/kg PO
Moxidectin, 0.4 mg/kg PO
Piperazine, 5–7 g/100 lb PO
Pyrantel pamoate, 6.6 mg/kg PO

Oxyuris equi

Common name: Pinworm (Oxyuroidea).
Size of adult: 9–150 mm.
Size of egg: 90–100 µm × 40–50 µm in colon and rectum.
Importance: Pruritus of anal region, tail rubbing, and behavioral problems. These worms do not infect other animals.
Diagnosis: Gather eggs by placing cellophane tape across anus; microscopic demonstration of eggs. Eggs in fecal flotation.
Treatment: Moxidectin, 0.4 mg/kg PO
Piperazine, 5.7 g/100 lb. PO
Pyrantel, 12.5 mg/kg PO

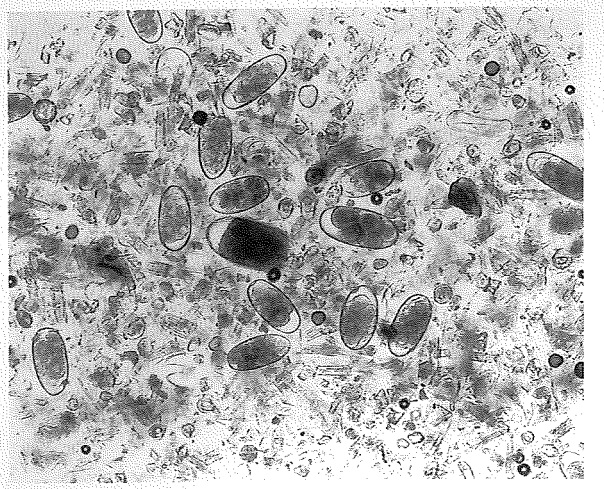


Fig. 151b. Typical strongyle eggs.

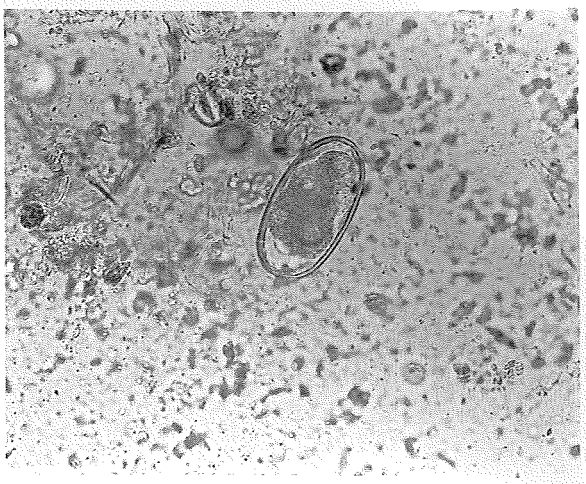


Fig. 151c. Typical strongyle egg.

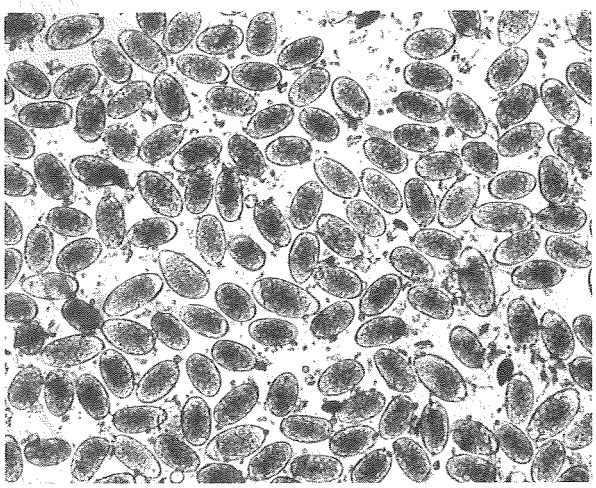


Fig. 152b. Heavy infection of stongyles.

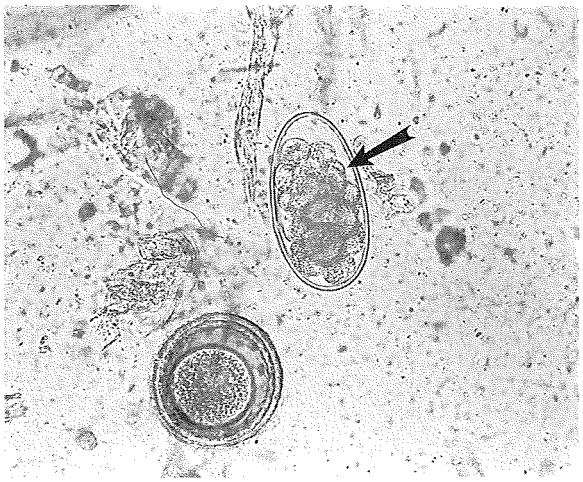


Fig. 152c. Typical strongyle egg (arrow) next to *Parascaris* egg.

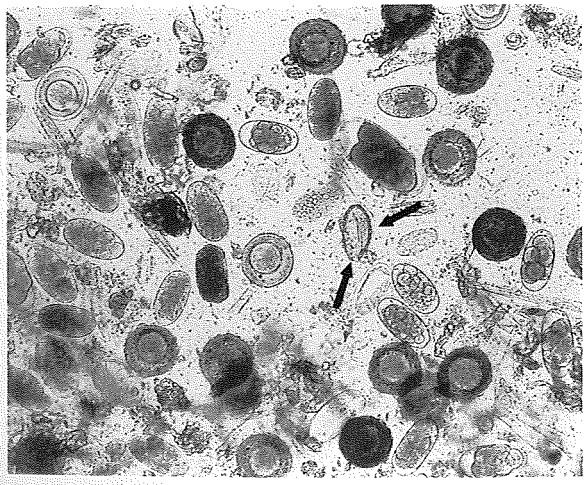


Fig. 153b. *Oxyuris equi* (arrows). Other eggs are strongyles and *Parascaris*.

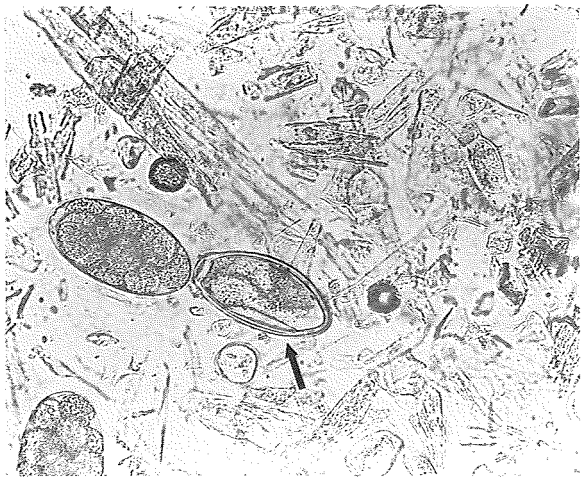


Fig. 153c. *Oxyuris equi* (arrow) next to strongyle egg.

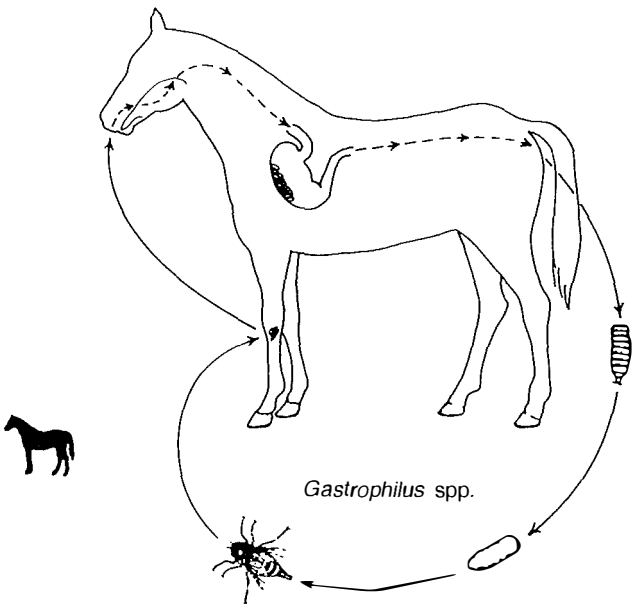


Fig. 154a. *Gastrophilus* spp. have one generation per year.

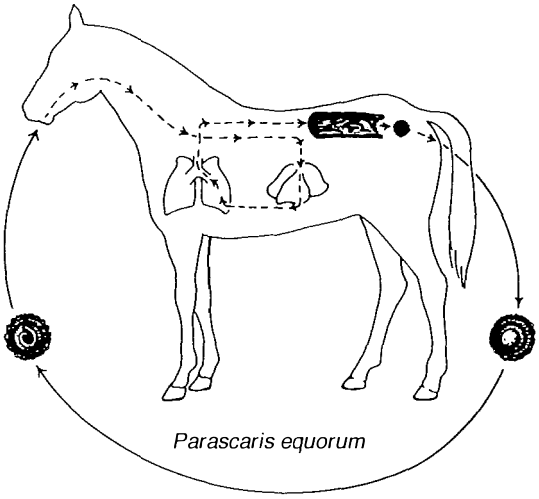


Fig. 155a. *Parascaris equorum*. Prepatent period is 12 weeks.

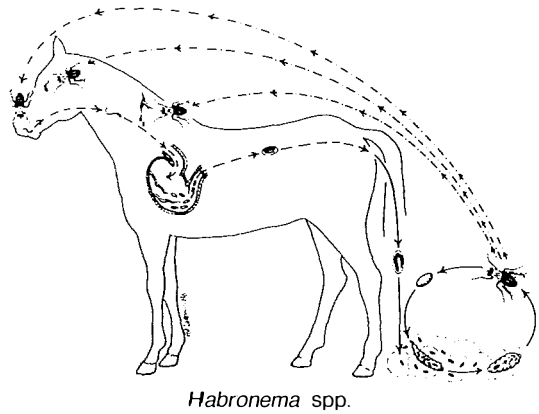


Fig. 156a. *Habronema* spp. Prepatent period is 2 months.

Gastrophilus spp.

Common name: Bot fly (Diptera).
Size of larvae: Approximately 2 cm in stomach.
Importance: Generally nonpathogenic; rarely may cause perforating gastric ulcers. "Worry factor" due to buzzing of female fly as she oviposits.
Diagnosis: Yellow eggs on hair of legs, face. At necropsy larvae are at pyloric or cardiac region of stomach.
Treatment: Carbon disulfide, 5.3 ml/100 kg PO
Dichlorvos, 10 mg/kg PO
Ivermectin, 0.2 mg/kg PO
Moxidectin, 0.4 mg/kg PO
Trichlorfon, 40 mg/kg PO
Remove all eggs as soon as they are laid.

Parascaris equorum

Common name: Ascarid or roundworm (Ascaridoidea).
Size of adult: 15–20 cm in small intestine.
Size of egg: 100 µm.
Importance: Migrating larvae damage liver and lungs. Foals may show intermittent diarrhea and constipation or colic.
Diagnosis: Eggs in fecal flotation.
Treatment: Fenbendazole, 5 mg/kg PO
Piperazine, 5–7 g/100 lb PO × 1/2 dose at 3–4 mo; full dose at 4–5 mo (100–200 mg/kg)
Pyrantel pamoate, 6.6 mg/kg PO
Mebendazole, 8.8 mg/kg PO
Ivermectin, 0.2 mg/kg PO
Moxidectin, 0.4 mg/kg PO
Prevention: Regular worming schedule and proper management.

Habronema spp.

Common name: Stomach worm (Spiruroidea).
Size of adult: 10–15 mm in stomach.
Size of egg: 50–80 µm × 10–20 µm.
Importance: Migrating larvae cause cutaneous granulomatous lesions ("summer sores") and ulcerative conjunctivitis. Adults may contribute to gastric tumors and may cause gastritis.
Diagnosis: Eggs in fecal flotation or skin scraping of lesion may contain larvae in summer sores.
Treatment: Ivermectin, 0.2 mg/kg PO
Moxidectin, 0.4 mg/kg PO

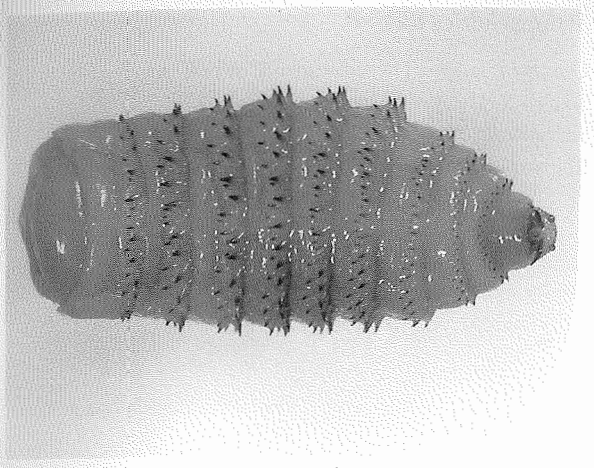


Fig. 154b. *Gastrophilus intestinalis.*

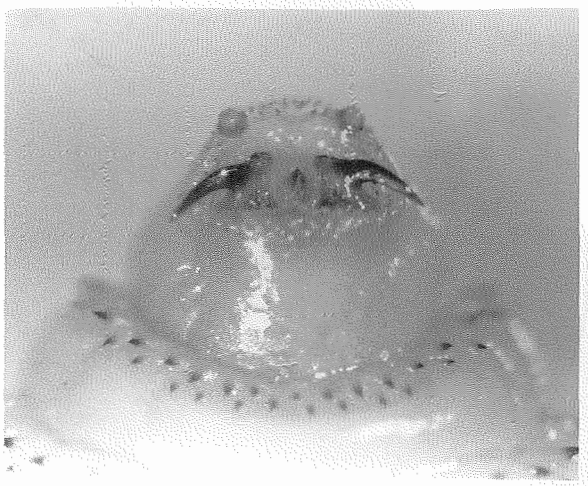


Fig. 154c. *Gastrophilus intestinalis* (anterior end).

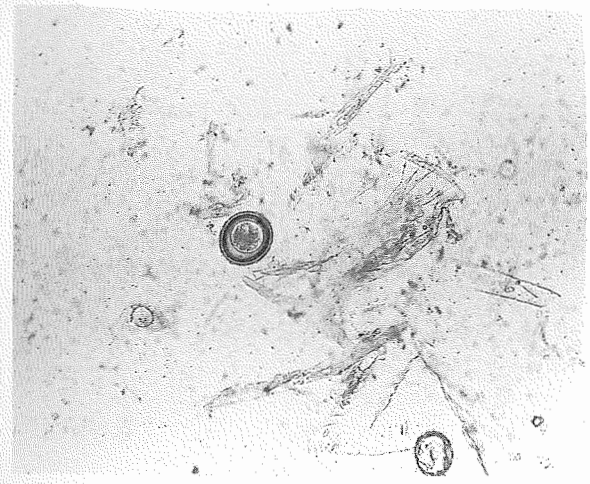


Fig. 155b. *Parascaris equorum.*

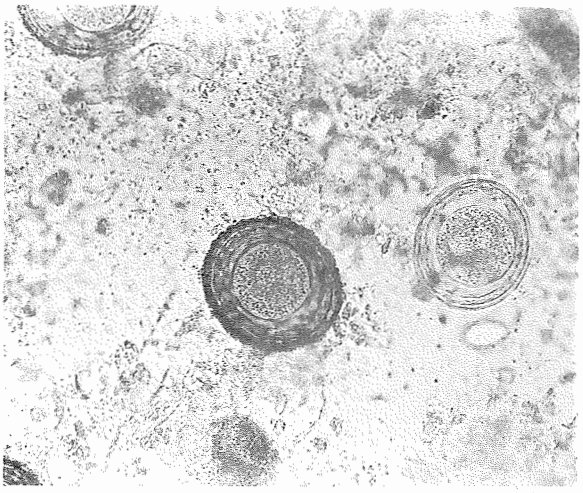


Fig. 155c. *Parascaris equorum.*

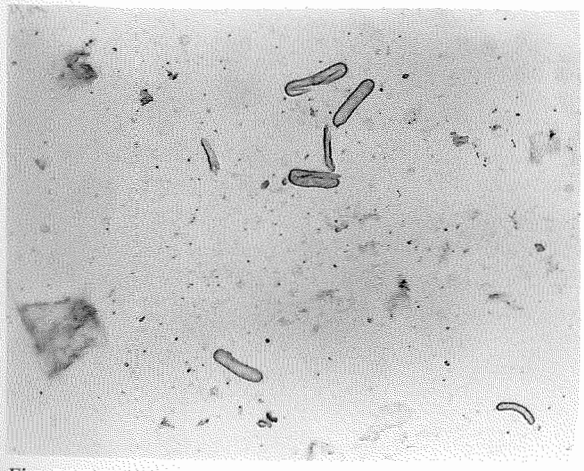


Fig. 156b. *Habronema* sp.

Fig. 156c. *Habronema* sp.

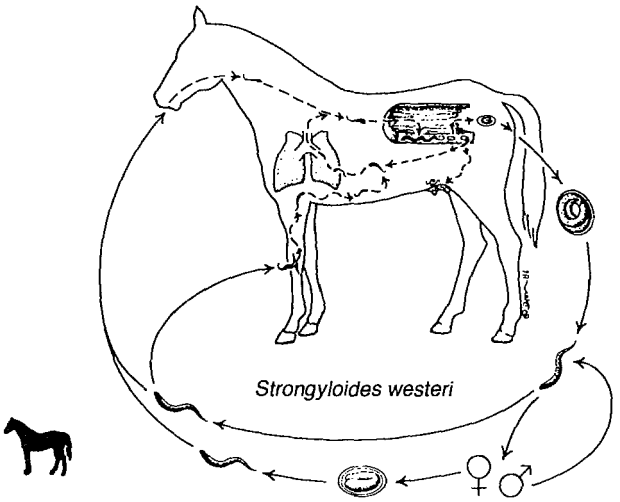


Fig. 157a. *Strongyloides westeri.* Prepatent period is 7–10 days.

Strongyloides westeri

Common name: Threadworm (Rhabditoidea).
Size of adult: 5–10 mm in small intestine.
Size of egg: 50 µm.
Importance: Acute diarrhea in foals 1–3 weeks old; coughing due to lung migration. Zoonotic disease potential.
Diagnosis: Larvated eggs in fecal flotation.
Treatment: Ivermectin, 0.2 mg/kg PO
Oxibendazole, 10 mg/kg PO

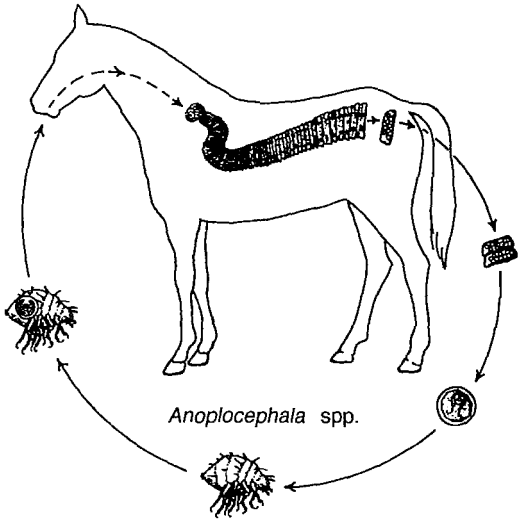


Fig. 158a. *Anoplocephala* spp. Prepatent period is 2 months.

Anoplocephala spp.

Common name: Tapeworm (Anoplocephalidae).
Size of adult: Up to 80 cm in small intestine.
Size of egg: 80 µm × 50 µm.
Importance: May cause ulceration and inflammation of ileocecal valve area; generally nonpathogenic.
Diagnosis: Identification of segments on feces or eggs in fecal flotations.
Treatment: Albendazole, 25 mg/kg PO
Mebendazole, 15 mg/kg PO
Pyrantel pamoate, 13 mg/kg PO (double dose)
Praziquantel, 1.5 mg/kg and Ivermectin, 0.2 mg/kg PO (Equimax™)

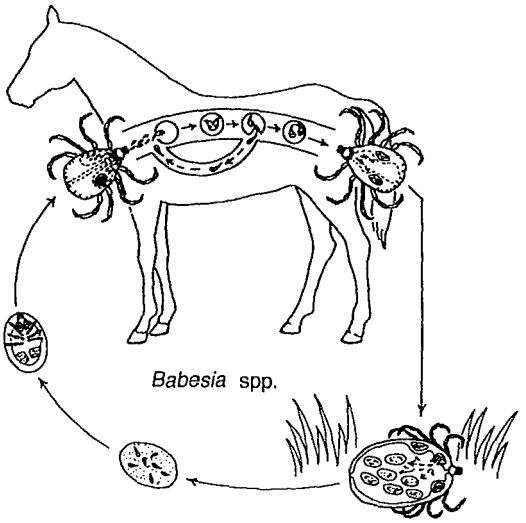


Fig. 159a. *Babesia* spp. Incubation is 10–30 days.

Babesia spp.

Common name: (Apicomplexa).
Size of trophozoites: 2–4 µm long in red blood cells.
Importance: Persistent fever, anemia, icterus, and splenomegaly.
Diagnosis: Microscopic exam of blood smear.
Treatment: Phenamidine, 9 mg/kg IM q 24 h × 2 d
Prevention: Tick control.

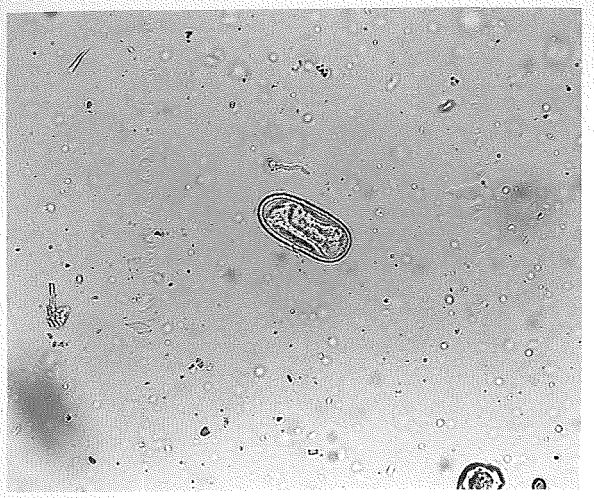


Fig. 157b. *Strongyloides westeri.*

Fig. 157c. *Strongyloides westeri.*

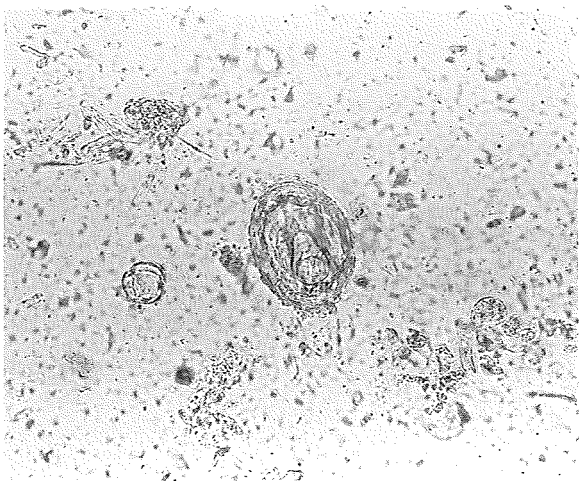


Fig. 158b. *Anoplocephala* sp.

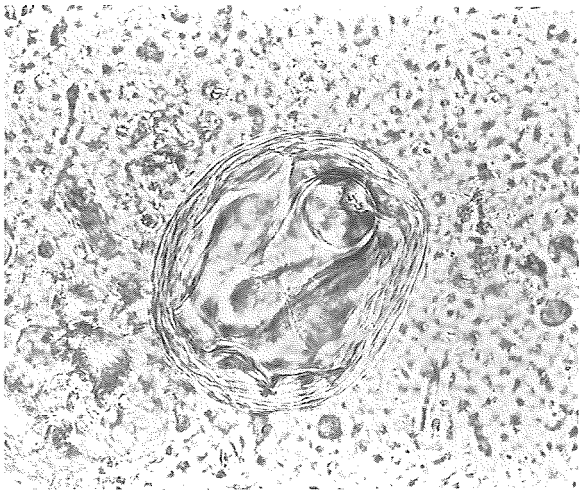


Fig. 158c. *Anoplocephala* sp.

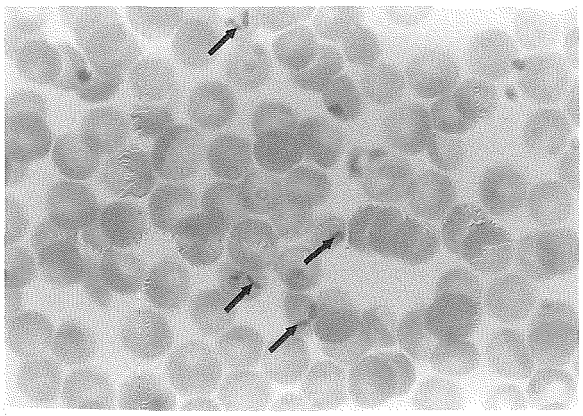


Fig. 159b. *Babesia* sp. (arrows).

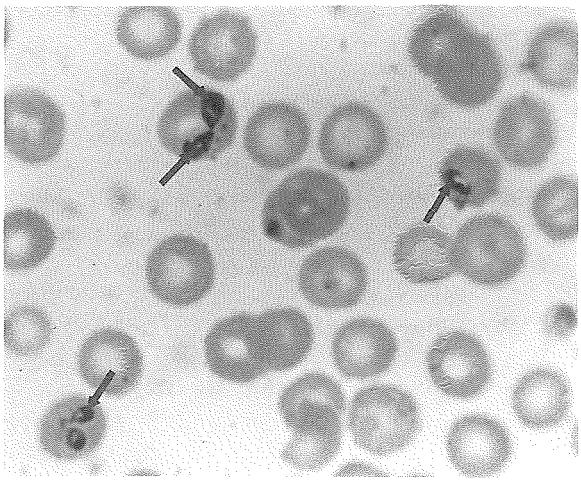


Fig. 159c. *Babesia* sp. (arrows).

External Parasites

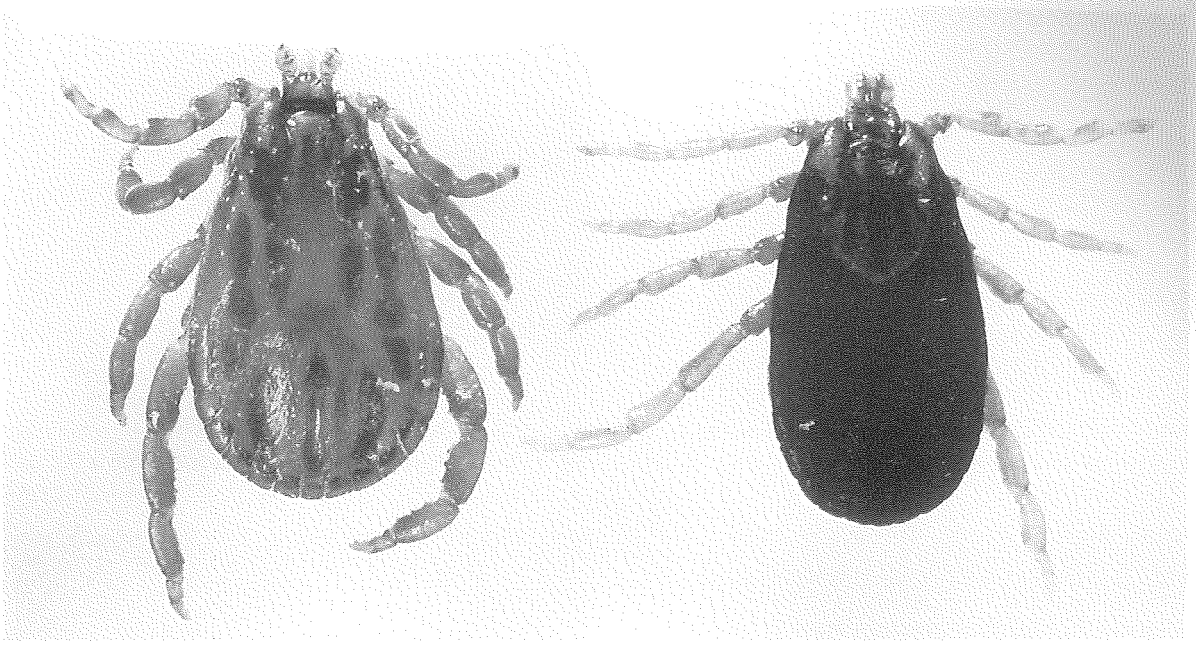


Fig. 159d. *Dermacentor albipictus*, adult male on left, adult female on right. Common on large animals in winter.

Table 37. Major drugs for control of external parasites in horses

Drug (Trade Name)	Parasites	Application
Organophosphates		
Coumaphos (Co-Ral)	Flies, lice, ticks,	Spray, dust
Crotoxyphos (Ciodrin)	Ticks, mites, lice, flies	Dust, spray
Diazinon	Flies, lice, keds, ticks	Dust, spray
Dichlorvos (Vapona)	Flies, stomach bots	Resin granules, resin strips, spray
Dioxathion (Korlan-ronnel)	Flies, keds, lice, ticks	Spray
Malathion (Cythion)	Flies, lice, keds, mites, ticks	Dust, spray
Trichlorfon (Neguvon)	Flies, lice, mites, stomach bots	Oral, injectable, spray
Carbamates		
Carbaryl (Sevin)	Lice, mites, ticks	Dust, spray
Organochlorines		
Lindane	Flies, lice, mites, ticks	Dust, spray
Methoxychlor (Marlate)	Flies, lice, mites, ticks	Dust, spray
Pyrethroids		
Fenvalerate (Ectrin)	Lice, mites, ticks	Spray
Permethrin (Atroban, Expar)	Ticks, flies	Spray
Miscellaneous		
Carbon disulfide	Stomach bots	Oral
Ivermectin (Eqvalan)	Lice, mites, stomach bots	Oral
Moxidectin (Quest)	Lice, mites, stomach bots	Oral
Pyrethrins	Flies	Spray

Note: Read label directions carefully. The label is the most authoritative source of information.

Table 38. Common external parasites on horses

Genus and Species	Common Name	Figure Number
Lice		
Bovicola (Damalinia) equi	Biting louse	Fig. 126, 145
Haematopinus asini, Microthoracius sp.	Sucking louse	Fig. 125, 127, 146
Flies		
Musca domestica	House fly	Fig. 121
Musca autumnalis	Face fly	Fig. 120
Siphona (Haematobia)	Horn fly	Fig. 122
Stomoxys calcitrans	Stable fly	Fig. 123
Tabanus and *Chryops* spp.	Horse fly/deer fly	Fig. 124
Mosquitoes	Several species	
Hypoderma spp.	Cattle grubs	Fig. 116
Mites		
Sarcoptes scabiei	Dry mange	Fig. 133, 147
Psoroptes equi	Scale and wet mange	Fig. 132, 230b
Chorioptes bovis	Tail and hock mange	Fig. 134
Demodex sp.	Nodular mange	Fig. 47
Ticks		
See listings under cattle, Table 31		

Bibliography

Internal Parasites

Baker NF, Miller JE, Madigan JE, et al.: Anthelmintic action of ivermectin, oxibendazole and pyrantel pamoate against thiabendazole-resistant small strongyles of horses. *Equine Pract* 6:8–19, 1984.

Bello TR: Alternative antiparasitic treatment of horses with pyrantel pamoate suspension and ivermectin oral solution compared with horses treated only with ivermectin solution. *J Eq Vet Sci* 16:166–170, 1996.

Bello TR, Abell JE: Are equine tapeworms an emerging disease? A retrospective study. *J Eq Vet Sci* 19:723–727, 1999.

Bello TR, Laningham ET: A controlled trial evaluation of three oral dosages of moxidectin against equine parasites. *J Eq Vet Sci* 14:483–448, 1994.

Benton RE, Lyons ET: Survey in central Kentucky for prevalence of *Anoplocephala perfoliata* in horses at necropsy in 1992. *Vet Parasitol* 55:81–86, 1994.

Blackwell NJ: Colitis in equines associated with strongyle larvae. *Vet Rec* 93:401–402, 1973.

Brown P, Clayton HM: The pathological changes in the livers of foals experimentally infected with *Parascaris equorum*. *J Comp Pathol* 89:115–123, 1979.

Clayton HM, Duncan JL: Experimental *Parascaris equorum* infection of foals. *Res Vet Sci* 23:109–114, 1977.

Clayton HM, Duncan JL: Clinical signs associated with *Parascaris equorum* infection in worm-free pony foals and yearlings. *Vet Parasitol* 4:69–78., 1978.

Clayton HM, Duncan JL: The migration and development of *Parascaris equorum*. *Int J Parasitol* 9:285–292, 1979.

Courtney CH, Asquith RL: Seasonal changes in pasture infectivity by equine cyathostomes in north central Florida. *Equine Vet J* 17:240–242, 1985.

Courtney CH, Sundlof SF: *Veterinary Antiparasitic Drugs, A Comprehensive Compenium of FDA-Approved Antiparasitic Drugs*, Am Assoc Vet Parasitologists, Pub SP96, University of Florida, 224 pages, 1991.

Craig TM, Kunde JM: Controlled evaluation of ivermectin in Shetland ponies. *Am J Vet Res* 42:1422–1424, 1981.

DiPietro JA, Paul A, Todd KS, et al.: Controlled trials of fenbendazole and febantel in ponies with *Parascaris equorum* infections. *J Equine Vet Sci* 4:158–160, 1984.

Drudge JH, Lyons ET, Tolliver SC: Controlled tests of activity of ivermectin against natural infections of migratory large strongyles and other internal parasites of equids. *Am J Vet Res* 45:2267–2271, 1984.

Drudge JH: Clinical aspects of *Strongylus vulgaris* in-

fection in the horse. Emphasis on diagnosis, chemotherapy, and prophylaxis. *Vet Clin North Am Large Anim Pract* 1:251–265, 1979.

Duncan JL, Pirie HM: The life cycle of *Strongylus vulgaris* in the horse. *Res Vet Sci* 13:374–379, 1972.

Duncan JL, Pirie HM: The pathogenesis of single experimental infections with *Strongylus vulgaris* in foals. *Res Vet Sci* 18:82–93, 1975.

Eysker J, Jansen J, Mirck MH: Inhibited development of Cyathostominae in the horse in the early third stage. *Res Vet Sci* 37:355–356, 1984.

French DD, Chapman MR: Tapeworms of the equine gastrointestinal tract. *Compend Contin Ed Pract Vet* 14:655–661, 1992.

Giles CJ, Urquhart KA, Longstaffe JA: Larval cyathostomiasis (immature *Trichonema*-induced enteropathy): A report of 15 clinical cases. *Equine Vet J* 17:196–201, 1985.

Greiner EC, Lane TJ: Effects of the daily feeding of pyrantel tartrate on *Anoplocephala* infections in three horses: A pilot study. *J Eq Vet Sci* 14:43–44, 1994.

Herd RP, Willardson KL, Gabel AA: Epidemiologic approach to the control of horse strongyles. *Equine Vet J* 17:202–207, 1985.

Herd RP, Donham JC: Efficacy of ivermectin against cutaneous *Draschia* and *Habronema* infection (summer sores) in horses. *Am J Vet Res* 42:1953–1955, 1981.

Herd RP, Donham JC: Efficacy of ivermectin against *Onchocerca cervicalis* microfilaria dermatitis in horses. *Am J Vet Res* 44:1102–1105, 1983.

Herd RP, Willardson KL: The seasonal distribution of infective strongyle larvae on horse pastures. *Equine Vet J* 17:235–237, 1985.

Hutchens DE, Paul AJ, DiPietro JA: Treatment and control of gastrointestinal parasites. *Vet Clin North Am Eq Pract* 15:561–573, 1999.

Jasko DJ, Roth L: Granulomatous colitis associated with small strongyle larvae in a horse. *J Am Vet Med Assoc* 185:553–554, 1984.

Jordan ME, Courtney CH: Equine tapeworm. *Eq Prac* 21:10–14, 1999.

Kivipelto J, Nicklin C, Asquith RL: A comparison of two programs (pyrantel tartrate administered daily and 3× pyrantel pamoate administered at 8-week intervals) for the reduction of tapeworm EPG in the horse. *J Eq Vet Sci* 18:125–128, 1998.

Klei TR, Chapman MR, French DD, et al.: Evaluation of ivermectin at an elevated dose against equine cyathostome larvae. *Vet Parasitol* 47:99–106, 1993.

Klei TR, Torbert BJ: Efficacy of ivermectin (22,23-dihydro-avermectin B_1) against parasites in ponies. *Am J Vet Res* 41:1747–1750, 1980.

Lichtenfels JR: Helminths of domestic equids. Illustrated keys to genera and species with emphasis on North American forms. *Proc Helminthol Soc Wash* 42 (special issue):1–92, 1975.

Little SE: Adult tapeworms in horses: clinical significance. *Comp Contin Ed Pract Vet* 21:356–360, 1999.

Lyons ET, Drudge JH, Tolliver SC: Antiparasitic activity of ivermectin in critical tests in equids. *Am J Vet Res* 41:2069–2072, 1980.

Lyons ET, Drudge JH, Tolliver SC: Ivermectin: Activity against larval *Strongylus vulgaris* and *Trichostrongylus axei* in experimental infections in ponies. *Am J Vet Res* 43:1449–1450, 1982.

Lyons ET, Drudge JH, Tolliver SC: Controlled tests with fenbendazole in equids: Special interest on activity of multiple doses against natural infections of migrating stages of strongyles. *Am J Vet Res* 44:1058–1063, 1983.

Lyons ET, Drudge JH, Tolliver SC, et al.: Pyrantel pamoate: Evaluating its activity against equine tapeworms. *Vet Med* 81:280–285, 1986.

Lyons ET, Tolliver SC, Drudge JH: Prevalence of some internal parasites recovered at necropsy of thoroughbreds born in 1982 in Kentucky. *Am J Vet Res* 46:679–683, 1985.

Lyons ET, Tolliver SC, Drudge JH: Further evaluation of pyrantel pamoate at the therapeutic dose rate (6.6 mg base/kg) against *Anoplocephala perfoliata* in horses. *J Helminthol Soc Wash* 64:285–287, 1997.

Lyons ET, Tolliver SC, Drudge JH, Granstrom DE, et al.: Activity of praziquantel against *Anoplocephala perfoliata* (Cestoda) in horses. *J Helminthol Soc Wash* 50:1–4, 1992.

Lyons ET, Tolliver SC, Ennis LE: Efficacy of praziquantel (0.25 mg/kg^{-1}) on the cecal tapeworm (*Anoplocephala perfoliata*) in horses. *Vet Parasitol* 78:287–289, 1998.

Lyons ET, Tolliver SC, Stamper S, et al.: Activity of praziquantel (0.5 mg/kg^{-1}) against *Anoplocephala perfoliata* (Cestoda) in equids. *Vet Parasitol* 56:255–257, 1995.

Monahan CM, Chapman MR, Taylor HW, et al.: Comparison of moxidectin oral gel and ivermectin oral past against a spectrum of internal parasites of ponies with special attention to encysted cyathostome larvae. *Vet Parasitol* 63:225–235, 1996.

Pearson GR, Davies IW, White AL, et al.: Pathological lesions associated with *Anoplocephala perfoliata* at the ileo-cecal junction of horses. *Vet Rec* 132:179–182, 1993.

Proudman CJ, Edwards GB: Are tapeworms associated with equine colic? A case control study. *Eq Vet J* 25:224–226, 1993.

Proudman CJ, French NP, Trees AJ: Tapeworm infection is a significant risk factor for spasmodic colic and ileal impaction colic in the horse. *Eq Vet J* 30:194–199, 1998.

Proudman CJ, Swan JD, Trees AJ: Efficacy of pyrantel embonate and praziquantel against the equine tapeworm *Anoplocephala mamillana*. *Vet Rec* 137:45–46, 1995.

Proudman CJ, Trees AJ: Tapeworms as a cause of intestinal disease in horses. *Parasitol Today* 15:156–159, 1999.

Rodriguez-Bertos A, Corchero J, Castano M, et al.: Pathological alterations caused by *Anoplocephala perfoliata* infection at the ileocecal junction of equids. *J Vet Med* 46:261–269, 1999.

Slocombe JOD, McCraw BM, Pennock PW, et al.: Effectiveness of ivermectin against later 4th stage *Strongylus vulgaris* in ponies. *Am J Vet Res* 43:1525–1529, 1982.

Slocombe JOD, McCraw BM, Pennock PW, et al.: Effectiveness of fenbendazole against later 4th-stage *Strongylus vulgaris* in ponies. *Am J Vet Res* 44:2285–2289, 1983.

Slocombe JOD, McCraw BM: Evaluation of pyrantel pamoate, nitramisole and avermectin B_1 against migrating *Strongylus vulgaris* larvae. *Can J Comp Med* 44:93–100, 1980.

Slocombe JOD: Pathogenesis of helminths in equines. *Vet Parasitol* 18:139–153, 1985.

Torbert BJ, Kramer BS, Klei TR: Efficacy of injectable and oral paste formulations of ivermectin against gastrointestinal parasites in ponies. *Am J Vet Res* 43:1451–1453, 1982.

Uhlinger C, Johnstone C: Failure to reestablish benzimidazole susceptible populations of small strongyles after prolonged treatment with non-benzimidazole drugs. *Equine Vet Sci.* 4:7–9, 1984.

Wescott RB, Jen LW, Hellier LE, et al.: Efficacy of combinations of piperazine and fenbendazole against benzimidazole-resistant small strongyles in horses. *Vet Med Small Anim Clin* 77:247–249, 1982.

Williamson RMC, Gasser RB, Middleton D, et al.: The distribution of *Anoplocephala perfoliata* in the intestine of the horse and associated pathological changes. *Vet Parasitol* 73:225–241, 1997.

Yazwinski TA, Hamm D, Williams M, et al.: Effectiveness of ivermectin in the treatment of equine *Parascaris equorum* and *Oxyuris equi* infections. *Am J Vet Res* 43:1095, 1982.

Protozoan Parasites

Al-Khalidi NW, Dubey JP: Prevalence of *Toxoplasma gondii* infection in horses. *J Parasitol* 65:331–334, 1979.

Al-Khalidi NW, Weisbrode SE, Dubey JP: Pathogenicity of *Toxoplasma gondii* oocysts to ponies. *Am J Vet Res* 41:1549–1551, 1980.

Clark EG, Townsend HGG, McKenzie NT: Equine protozoal myeloencephalitis: A report of two cases from Western Canada. *Can Vet J* 22:140–144, 1981.

Dorr TE, Higgens RJ, Dangler CA, et al.: Protozoal myeloencephalitis in horses in California. *J Am Vet Med Assoc* 185:801–802, 1984.

Dubey JP: *Toxoplasma, Hammondia, Besnoitia, Sarcocystis* and other tissue cyst-forming coccidia of man and animals. In: *Parasitic Protozoa*. Volume 3. New York, Academic Press, Inc. 1977, pp. 101–237.

Dubey JP, Davis GW, Koestner A, et al.: Equine encephalomyelitis due to a protozoan parasite resembling *Toxoplasma gondii*. *J Am Vet Med Assoc* 165:249–255, 1974.

Dubey JP, Streitel RH, Stromberg PC, et al.: *Sarcocystis fayeri* sp. *n.* from the horse. *J Parasitol* 63:443–447, 1977.

Dunlap JS: *Eimeria leuckarti* infection in the horse. *J Am Vet Med Assoc* 156:623–625, 1970.

Erber M, Geisel O: Prevalence and development of two *Sarcocystis* spp. in the horse. *Z Parasitenkd* 65:283–291, 1981.

Eugster AK, Joyce JR: Prevalence and diagnostic significance of *Toxoplasma gondii* antibodies in horses. *Vet Med Small Anim Clin* 71:1469–1473, 1976.

Fayer R, Dubey JP: Development of *Sarcocystis fayeri* in the equine. *J Parasitol* 68:856–860, 1982.

Fayer R, Hounsel C, Giles RC: Chronic illness in a sarcocystis infected pony. *Vet Rec* 113:216–217, 1983.

Fenger CK, Granstrom DE, Gajadhar AA, et al.: Experimental induction of equine protozoal myeloencephalitis in horses using *Sarcocystis* sp. sporocysts from the opossum (*Didelphis virginiana*). *Vet Parasitol* 68:199–213, 1997.

Frechette JL, Marcoux M: *Eimeria leuckarti* in a colt. *Can Vet J* 15:95–96, 1974.

Kirkpatrick CE, Skand DL: Giardiasis in a horse. *J Am Vet Med Assoc* 187:163–164, 1985.

Kistner TP, Ah H-S, Hanson WL: Coccidial oocysts from a horse in Georgia. *J Parasitol* 58:709, 1972.

Levine ND: Taxonomy and review of the coccidian genus *Cryptosporidium* (Protozoa, Apicomplexa). *J Protozool* 31:94–98, 1984.

MarKay RJ: Equine protozoal myeloencephalitis. *Vet Clin N Am Eq Pract* 13:79–96, 1997.

Matuschka FR: Infectivity of sarcocystis from donkey to horse via sporocysts from dogs. *Z Parasitenkd* 69:299–304, 1983.

McQueary CA, Worley DE, Catlin JE: Observations on the life cycle and prevalence of *Eimeria leuckarti* in

horses in Montana. *Am J Vet Res* 38:1673–1674, 1977.

Simpson CF, Mayhew IG: Evidence for *Sarcocystis* as the etiologic agent of equine protozoal myeloencephalitis. *J Protozool* 27:288–292, 1980.

Vetterling, JM, Thompson DE: *Klossiella equi* Baumann, 1946 (Sporozoa Eucoccidia: Adeleina) from equids. *J Parasitol* 58:589–594, 1972.

External Parasites

Besch ED, Griffiths HJ: Demonstration of *Demodex equi* (Railliet, 1985) from a horse in Minnesota. *J Am Vet Med Assoc* 155:82–83, 1956.

Drummond RO: Effectiveness of ivermectin for control of arthropod pests of livestock. *Southwest Entomol* (Suppl. 7):34–42, 1985.

Fadok VA: Parasitic skin diseases of large animals. *Vet Clin North Am Large Anim Pract* 6:3–26, 1984.

Fadok VA, Mullowney PC: Dermatologic diseases of horses. Part I. Parasitic dermatoses of the horse. *Compend Contin Ed Vet Pract* 5:5615–5623, 1983.

Kettle DS: *Medical and Veterinary Entomology*. New York, John Wiley & Sons, 1984.

Klei TR, Torbert B, Chapman MR, et al.: Prevalence of *Onchocerca cervicalis* in equids in the Gulf Coast region. *Am J Vet Res* 45:1646–1647, 1984.

Knapp FW: Arthropod pests of horses. In Williams, RE, et al. (eds): *Livestock Entomology*. New York, John Wiley & Sons, 1985.

Kunkle GA, Greiner EC: Dermatitis in horses and man caused by the straw itch mite. *J Am Vet Med Assoc* 181:467–469, 1982.

Loomis EC: Common ectoparasites and their control. In Robinson, NE (ed): *Current Therapy in Equine Medicine*. Philadelphia, W.B. Saunders Co., 1983.

Reinemeyer CR, Scholl PJ, Andrews FM, et al.: Efficacy of moxidectin equine oral gel against endoscopically-confirmed *Gasterophilus nasalis* and *Gasterophilus intestinalis* (Diptera: Oestridae) infections in horses. *Vet Parasitol* 88:287–291, 2000.

Scholl PJ, Chapman MR, French DD, et al.: Efficacy of moxidectin 2% oral gel against second- and third-instar *Gasterophilus intestinalis* De Geer. *J Parasitol* 84:656–657, 1998.

Scott DW, White KK: Demodicosis associated with systemic glucocorticoid therapy in two horses. *Equine Pract* 5:31–32, 1983.

Section 8

PARASITES OF PIGS

Fecal Eggs and Oocysts

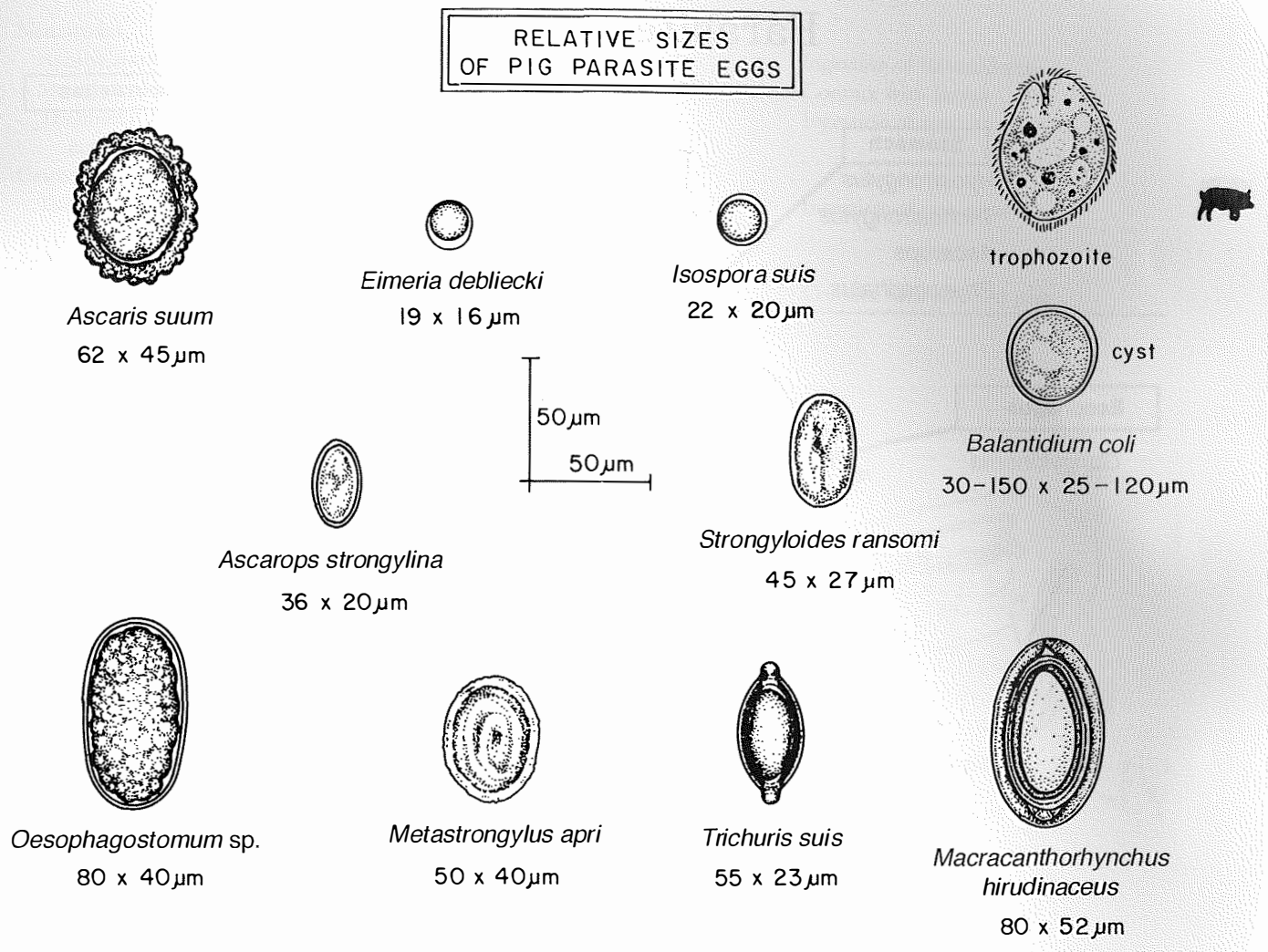


Fig. 160. Common parasite eggs and oocysts found in pig feces.

Location of Major Parasites

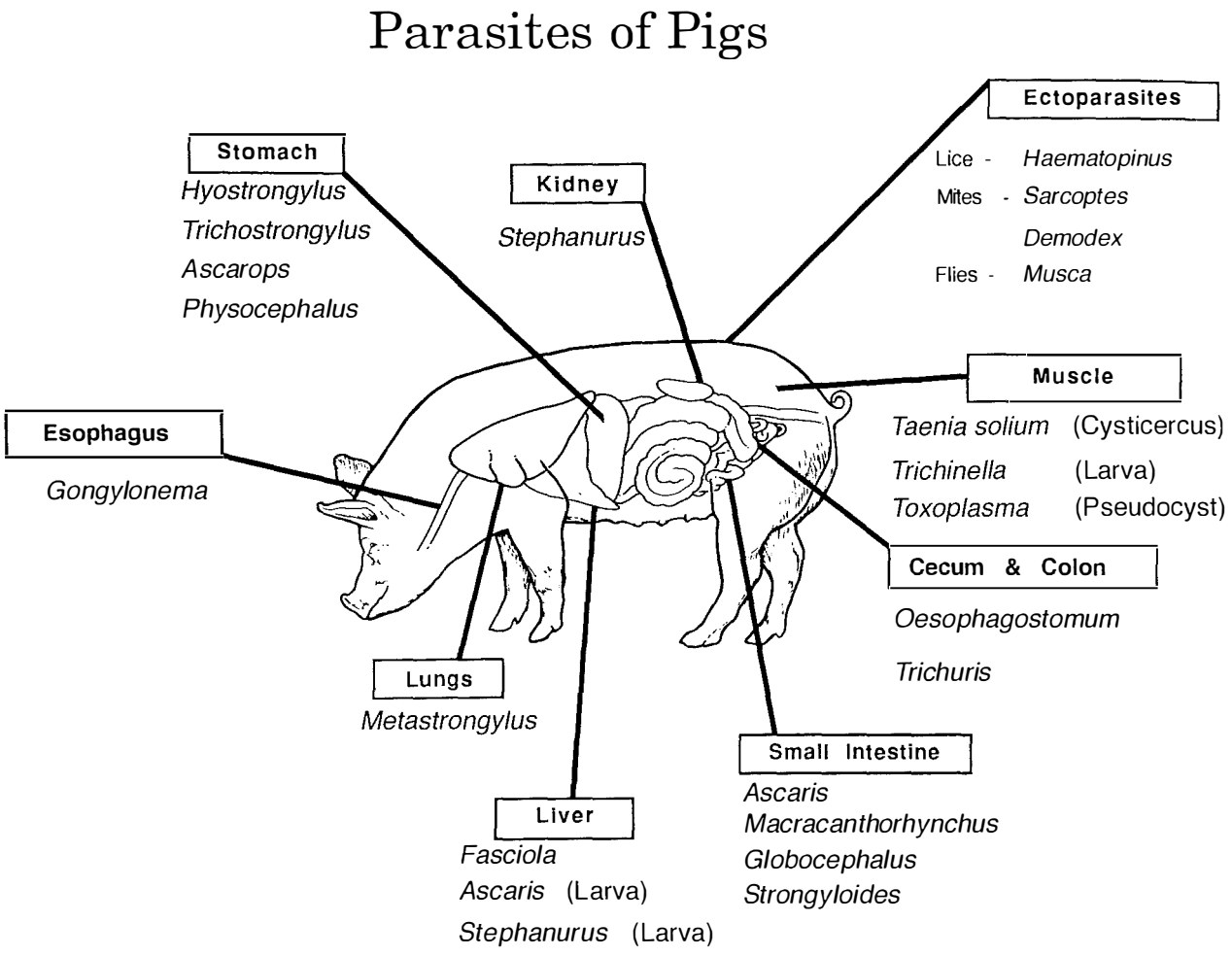


Fig. 161. Location of the major parasites found in pigs.

Zoonotic Diseases

Table 39. Major zoonotic parasites associated with pigs

Organism	Disease	Method of Infection
Protozoa		
Sarcocystis suihominis	Sarcosporidiosis	Ingestion of raw meat
Toxoplasma gondii	Toxoplasmosis	Ingestion of raw meat
Trypanosoma cruzi	Trypanosomiasis	Contact with arthropod vector
Nematodes		
Ascaris suum	Ascariasis	Ingestion of larvated eggs
Strongyloides spp.	Cutaneous larva migrans	Contact with larvae
Trichinella spiralis	Trichinosis	Ingestion of raw meat
Cestodes		
Taenia solium	Taeniasis-cysticercosis	Ingestion of raw meat
Arthropods		
Sarcoptes scabiei	Acariasis	Contact with infected pigs

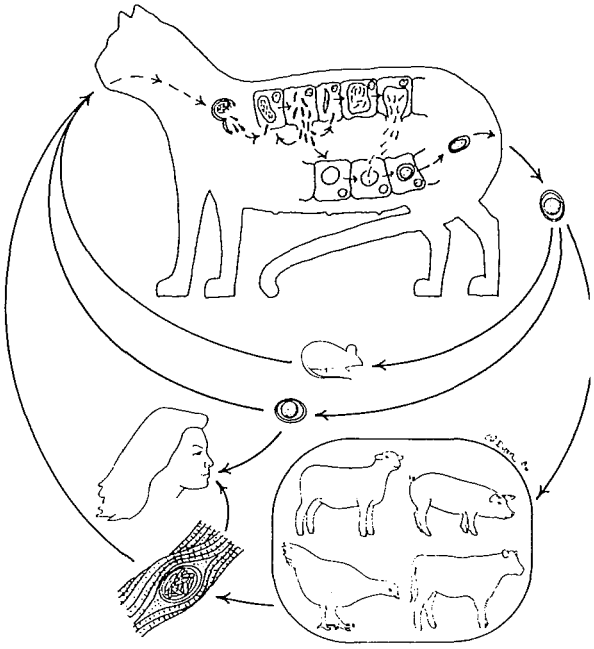


Fig. 162. *Toxoplasma gondii.*

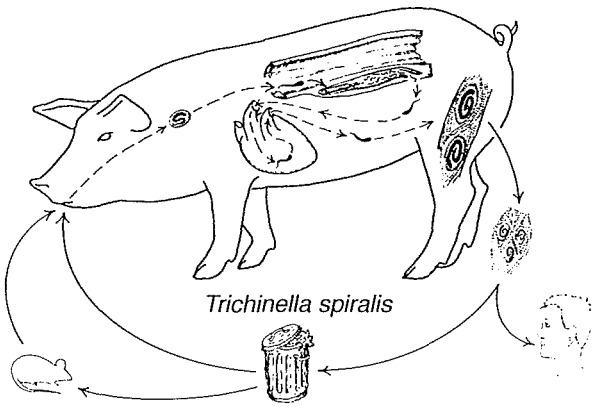


Fig. 163. *Trichinella spiralis.*

Drugs

Table 40. Efficacy of anthelmintics in swine

Drug	Dose (mg/kg PO)	Efficacy against Parasites (%)						
		Ascaris suum	*Oesophagostomum* spp.	*Trichuris suis*	*Metastrongylus* spp.	*Hyostrongylus rubidus*	*Strongyloides ransomi*	*Stephanurus dentatus*
Piperazine	275–440	75–100	0	0	0	—	0	0
Pyrantel tartrate	Preventative: 96 g/ton feed Therapeutic: 800 g/ton feed at 1 lb. feed/ 40 lbs. BW, repeat 75–100 lbs. BW	96–100	99–100	0	0	—	0	0
Hygromycin B	12 g/ton feed to be fed for 4–6 weeks	95–100	95–100	85–100	0	—	—	0
Dichlorvos	100 q 24 h × 30 d prior to farrowing; or 0.05% of ration × 2 d	92–100	95–100	90–100	0	99–100	60–87	0
Doramectin	0.3 mg/kg (IM)	100	99	80	100	99	99	100
Levamisole	8 99–100	80–100	26–80	90–100	94–100	80–95	83	
Fenbendazole	3–25 q 24 h × 3 d	92–100	100	66–100	97–100	99–100	0–98	100
Ivermectin	0.3 mg/kg	100	63–99	0–91	99–100	86–100	66–100	100

(See Courtney and Sundlof, 1991.)

Table 41. Major drugs for control of external parasites in pigs

Drug (Trade Name)	Parasites	Application
Organophosphates		
Coumaphos (Co-Ral)	Fleas, flies, lice, ticks,	Dip, spray, dust
Crotoxyphos (Ciodrin)	Ticks, mites, lice, flies	Dust, spray
Diazinon	Flies, lice, ticks	Dip, dust, spray
Dioxathion (Delnav)	Flies, lice, ticks	Dip, spray
Fenchlorphos (Korlan-ronnel)	Flies, lice, mites, ticks	Dust, spray
Fenthion (Tiguvon)	Flies, lice	Pour-on
Malathion (Cythion)	Fleas, flies, lice, mites, ticks	Dip, dust, spray
Tetrachlorvinphos (Rabon)	Flies, lice	Dust, spray
Trichlorfon(Neguvon)	Flies, lice, mites	Injectable, spray
Organochlorines		
Lindane	Flies, lice, mites, ticks	Dust, spray
Methoxychlor (Marlate)	Flies, lice, mites, ticks	Dust, spray
Toxaphene	Flies, lice, mites, ticks	Dip, dust, spray
Miscellaneous		
Ivermectin (Ivomec)	Lice, mites	Injectable (SC, IM) or in feed
Pyrethins	Flies, fleas, lice	Spray
Pyrethroids	Flies, fleas, lice	Spray

Note: Read label directions carefully. The label is the most authoritative source of information.

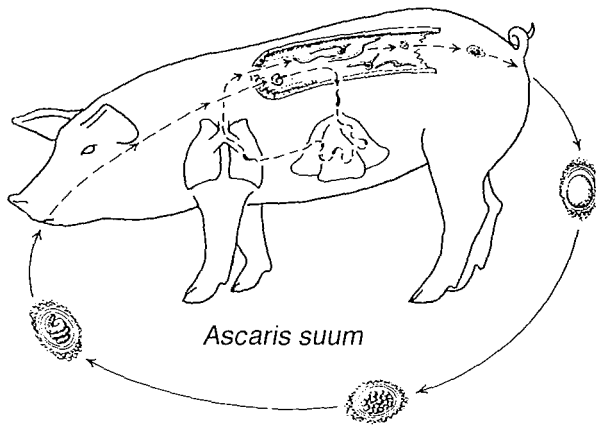


Fig. 164a. *Ascaris suum*. Prepatent period is 8 weeks.

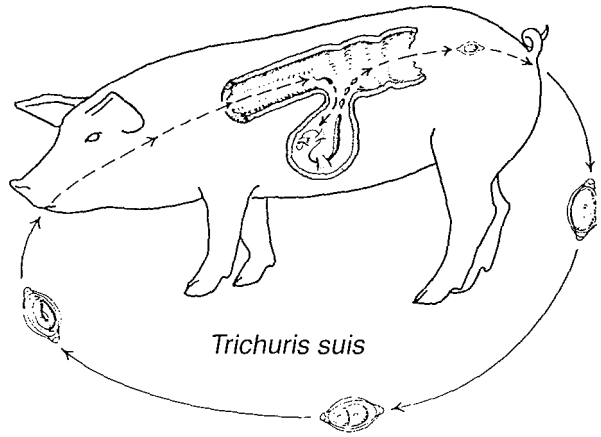


Fig. 165a. *Trichuris suis*. Prepatent period is 6 weeks.

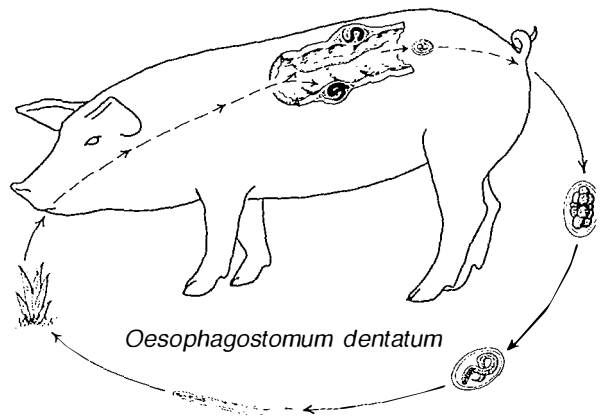


Fig. 166a. *Oesophagostomum dentatum*. Prepatent period is 40 days.

Internal Parasites

Ascaris suum

Common name: Ascarid or roundworm (Ascaridoidea).
Size of egg: 85 µm × 80 µm.
Importance: Pathogenicity varies. In young pigs, stunting and poor growth, coughing, "milk-spots" in liver; iron-deficient pigs get "thumps". In adults, reduced weight gain, intestinal or bile duct blockage, potential zoonotic disease.
Diagnosis: Eggs in fecal flotation. Adults found in small intestine and "milk spots" in liver seen at necropsy.
Treatment: Dichlorvos, 12–22 mg/kg PO
Doramectin, 0.3 mg/kg IM
Fenbendazole, 3 mg/kg q 24 h × 3 d
Hygromycin B, 12 g/ton of feed
Ivermection, 0.3 IM, SC, or in feed
Levamisole, 5–8 mg/kg PO (after overnight fast)
Piperazine, 110 mg/kg PO in feed or water

Trichuris suis

Common name: Whipworm (Trichuroidea).
Size of egg: 55 µm × 25 µm.
Importance: Stunting, bloody diarrhea, prolapse, poor growth.
Diagnosis: Eggs in fecal flotation. Adults are found in large intestine at necropsy.
Treatment: Change quarters.
Dichlorvos, 12–22 mg/kg PO
Fenbendazole, 3 mg/kg q 24 h × 3 d
Hygromycin B, 12 g/ton of feed
Ivermectin, 0.3 mg/kg IM, SC, or in feed (variable results)

Oesophagostomum dentatum

Common name: Nodular worm (Strongyloidea).
Size of egg: 70 µm × 40 µm.
Importance: Nodules in gut wall may cause ill-thrift or enteritis; condemnation of intestines at slaughter.
Diagnosis: Eggs in fecal flotation. Adults in large intestine at necropsy.
Treatment: Dichlorvos, 12–22 mg/kg PO
Doramectin, 0.3 mg/kg IM
Fenbendazole, 3 mg/kg q 24 h × 3 d
Hygromycin B, 12 g/ton feed
Ivermectin, 0.3 mg/kg IM, SC, or in feed
Levamisole, 5–8 mg/kg PO (after overnight fast)
Pyrantel tartrate, 800 g/ton feed for 1 feeding per day
Prevention: Pyrantel tartrate, feed 96 g/ton daily.

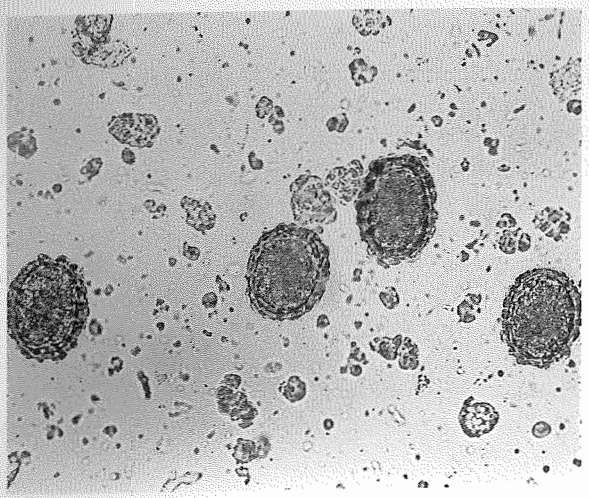


Fig. 164b. *Ascaris suum.*

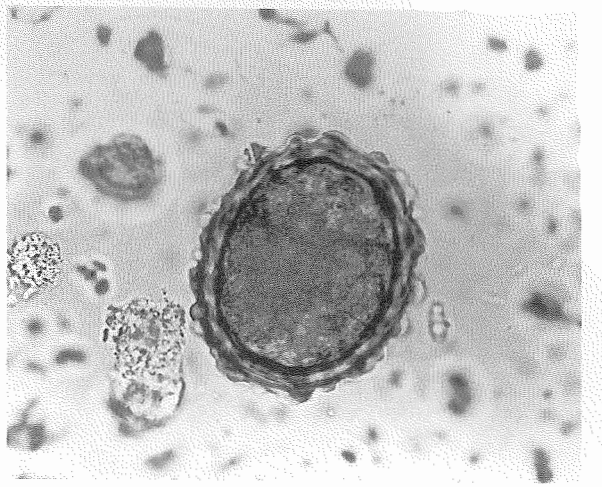


Fig. 164c. *Ascaris suum.*

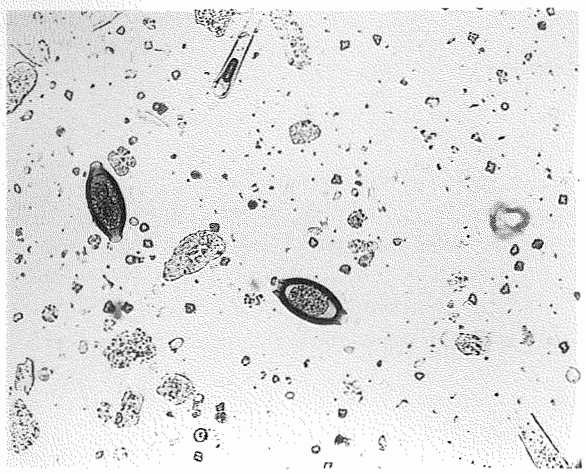


Fig. 165b. *Trichuris suis.*

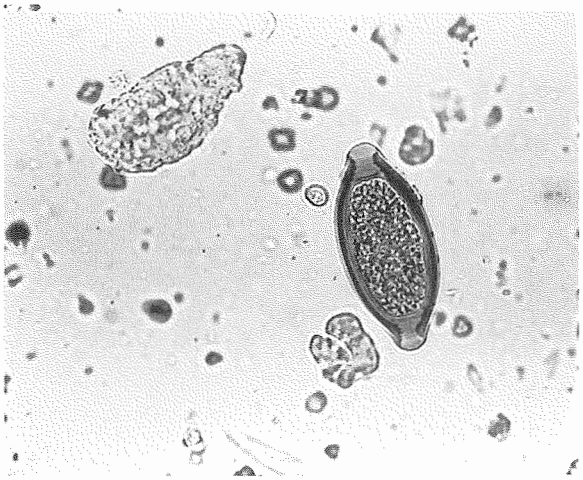


Fig. 165c. *Trichuris suis.*

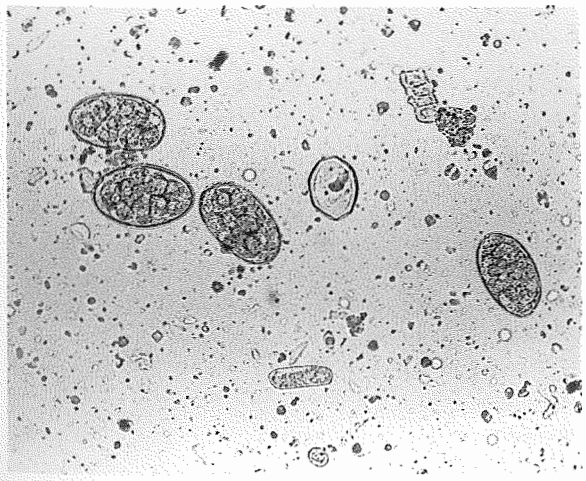


Fig. 166b. *Oesophagostomum dentatum.*

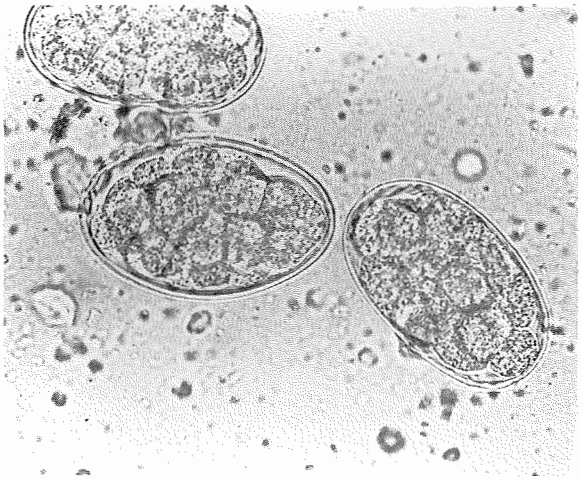


Fig. 166c. *Oesophagostomum dentatum.*

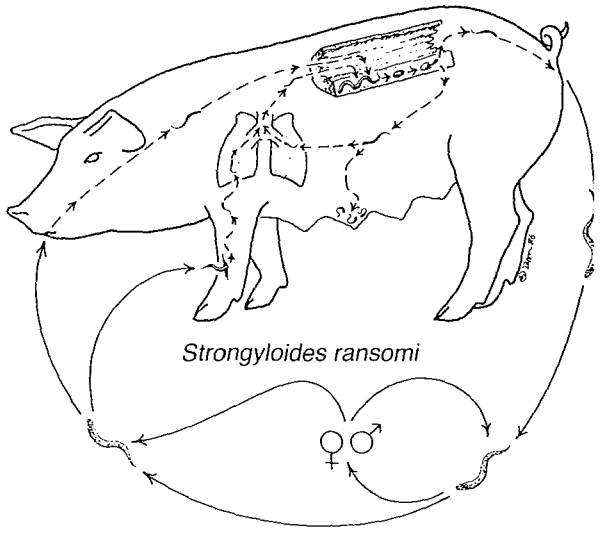


Fig. 167a. *Strongyloides ransomi.* Prepatent period is 5–7 days.

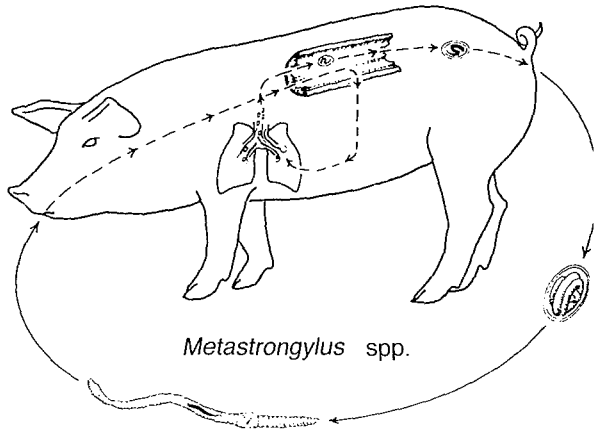


Fig. 168a. *Metastrongylus* spp. Prepatent period is 1 month.

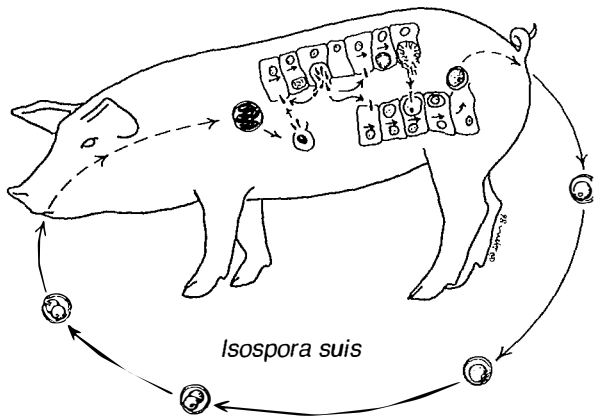


Fig. 169a. *Isospora suis.* Prepatent period is 2 weeks.

Strongyloides ransomi

Common name: Threadworm (Rhabditoidea).
Size of adults: 3–5 mm.
Size of egg: 50 µm × 30 µm.
Importance: In piglets, acute mucoid enteritis and bloody diarrhea, transmammary oral or percutaneous transmission. Emaciation and anemia results in stunting; 70–80% mortality results in severe economic loss. In adult pigs, mangelike symptoms.
Diagnosis: Fecal flotation. At necropsy mucosal scrapings of small intestine contain adult females.
Treatment: Management.
Dichlorvos, 1 g/sow q 24 h for last 30 days of gestation
Doramectin, 0.3 mg/kg IM
Ivermectin, 0.3 mg/kg, SC, or in feed
Levamisole, 5–8 mg/kg PO (after overnight fast)
Prevention: Proper management.

Metastrongylus spp.

Common name: Lungworm (Metastrongyloidea).
Size of adults: 2–5 cm.
Size of egg: 55 µm × 40 µm.
Importance: Coughing, poor growth. Lungworms enhance other diseases.
Diagnosis: Larvated eggs in fecal flotation. At necropsy adults are found in lungs and areas of consolidation at the tips of the diaphragmatic lobes of the lungs.
Treatment: Fenbendazole, 3 mg/kg q 24 h × 3 d
Doramectin, 0.3 mg/kg IM
Ivermectin, 0.3–0.5 mg/kg IM, SC, or in feed
Levamisole, 5–8 mg/kg PO (after overnight fast)

Isospora suis

Common name: Coccidia (Apicomplexa).
Size of oocyst: 16–20 µm × 19–22 µm.
Importance: In piglets, diarrhea and decreased weight gain. Adults are resistant carriers.
Diagnosis: Oocysts in fecal flotation. (Test must be repeated; may not shed oocyts until 10 days after infection.) Oocysts in intestines seen histologically.
Treatment: Decoquinate, 1 mg/kg q 24 h × 21 d to sows before and after farrowing.
Sulfamethazine 0.5% in feed, or 130 mg/kg PO then 65 mg/kg q 12 h × 4 d
Prevention: Proper management.

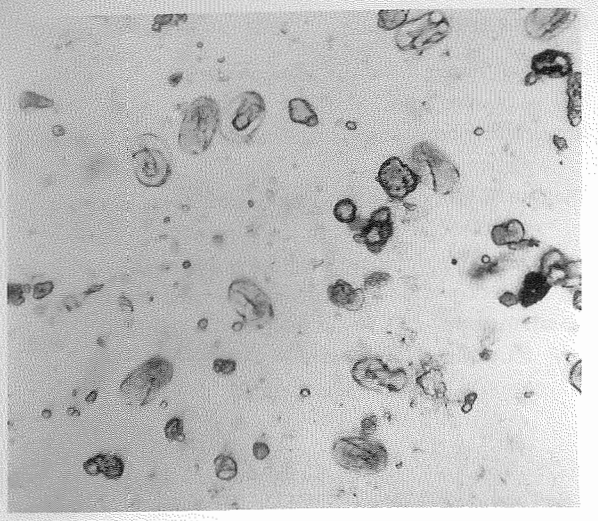


Fig. 167b. *Strongyloides ransomi*.

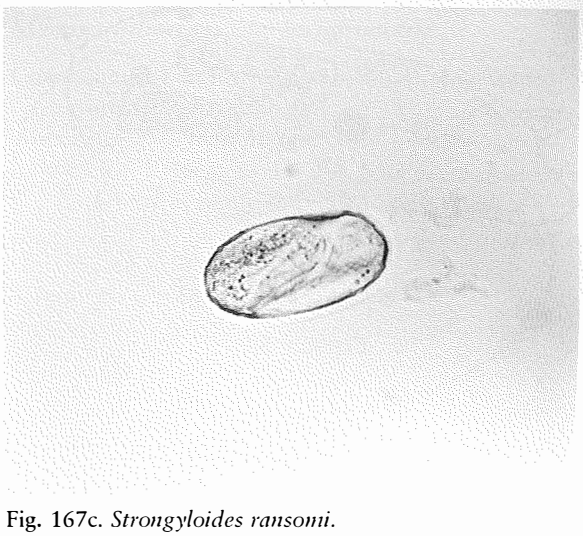


Fig. 167c. *Strongyloides ransomi*.

Fig. 168b. *Metastrongylus* sp.

Fig. 168c. *Metastrongylus* sp.

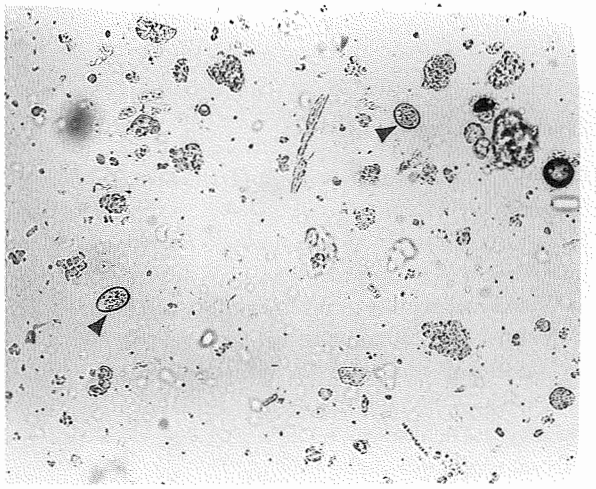


Fig. 169b. *Isospora suis* (arrowheads).

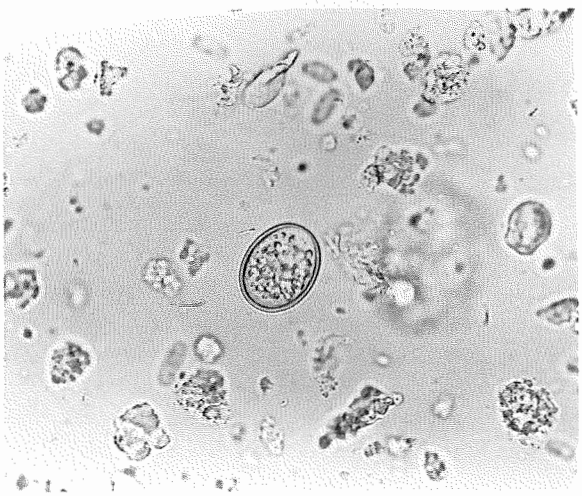


Fig. 169c. *Isospora suis*.

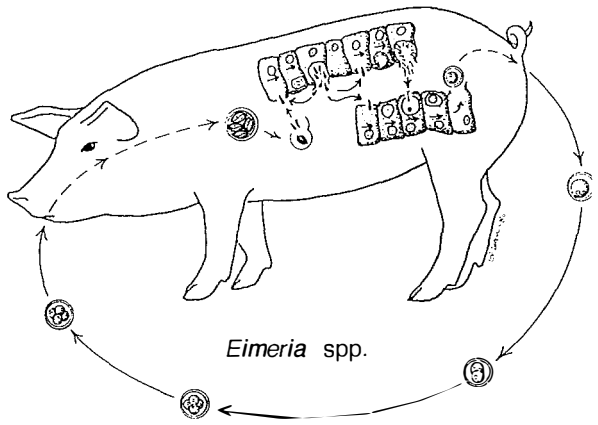


Fig. 170. *Eimeria* spp. Prepatent period is 7 days.

Eimeria spp.

Common name: Coccidia (Apicomplexa).
Size of oocyst: 15–25 µm.
Importance: Similar to *Isospora* spp., but not as pathogenic.
Diagnosis: Oocysts in feces; very similar to *Isospora* spp. Oocysts found in intestine at necropsy.
Treatment: Decoquinate 1 mg/kg q 24 h × 21 d to sows before and after farrowing (also for prevention).
Sulfamethazine, 0.5% in feed, or 130 mg/kg PO, then 65 mg/kg q 12 h × 4 d
Prevention: Proper management.

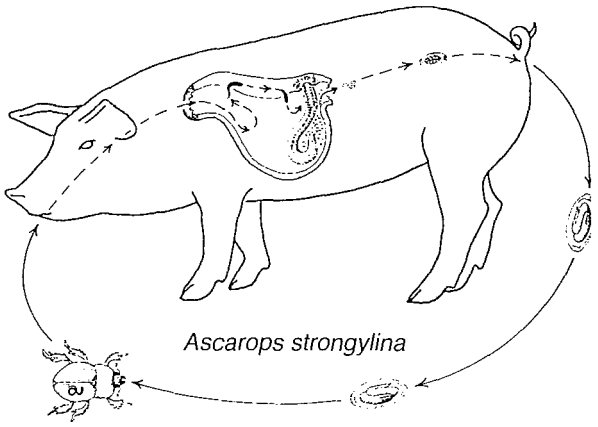


Fig. 171. *Ascarops strongylina*. Prepatent period is 6 weeks.

Ascarops strongylina

Common name: Stomach worm (Spiruroidea).
Size of egg: 20 µm × 40 µm.
Importance: Dung beetle is intermediate host. Nonpathogenic, unless present in large numbers; causes gastritis in adult pigs.
Diagnosis: Fecal sedimentation shows embryonated ova. Eggs do not float well. Adults found in stomach at necropsy
Treatment: Dichlorvos, 12–22 mg/kg PO
Doramectin, 0.3 mg/kg IM
Ivermectin, 0.3 mg/kg IM, SC, or in feed
Prevention: Proper management.

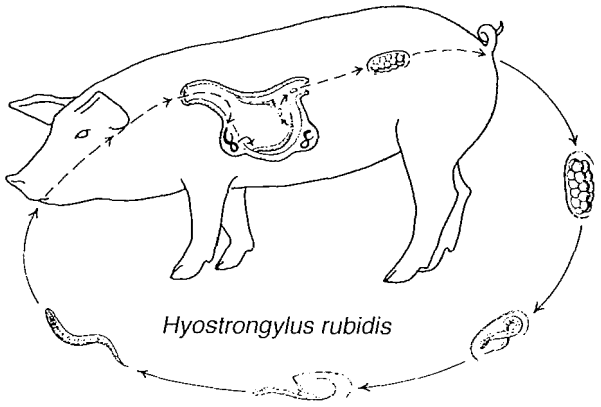


Fig. 172. *Hyostrongylus rubidus*. Prepatent period is 3 weeks.

Hyostrongylus rubidis

Common name: Stomach worm (Trichostrongyloidea).
Size of adults: 1 cm.
Size of egg: 65 µm × 35 µm; these do not float well.
Importance: May cause anemia, poor appetite, gastritis, and melena due to invasion of gastric glands.
Diagnosis: Fecal flotation shows larvated ova. At necropsy adults are thin red worms in gastric mucosa.
Treatment: Dichlorvos, 12–22 mg/kg PO
Doramectin, 0.3 mg/kg IM
Ivermectin, 0.3 mg/kg IM

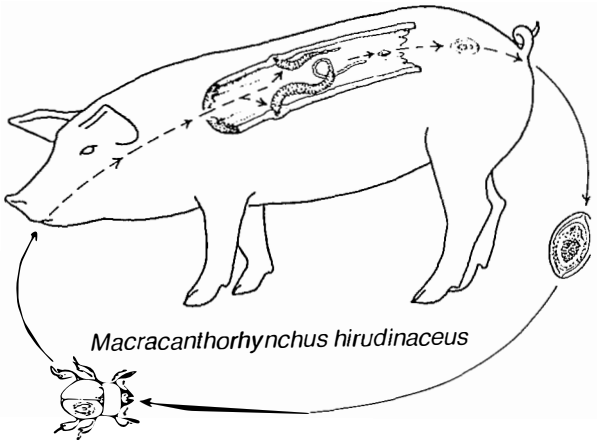


Fig. 173. *Macracanthorhynchus hirudinaceus*. Prepatent period is 3–4 months.

Macracanthorhynchus hirudinaceus

Common name: Spiny-headed worm, thorny-headed worm (Acanthocephala).
Size of egg: 100 µm × 50 µm.
Importance: Uncommon in USA. May cause peritonitis. The head is firmly embedded in the mucosa.
Diagnosis: Fecal flotation. Adults are found attached to the small intestine at necropsy.
Treatment: Dichlorvos, 10 mg/kg PO
Prevention: Keep pigs off dirt, away from beetles.

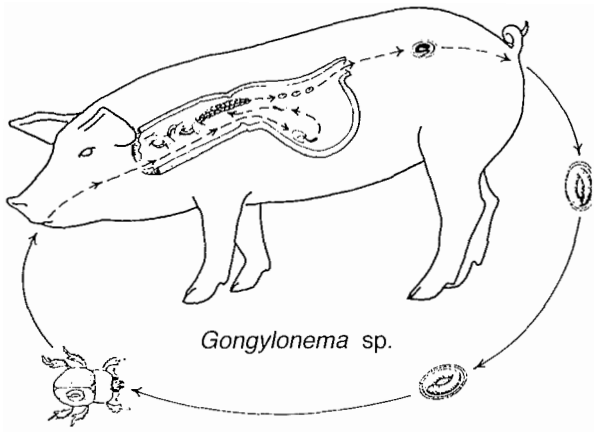


Fig. 174. *Gongylonema* sp. Prepatent period is unknown.

Gongylonema sp.

Common name: Gullet or esophageal worms (Spiruroidea).
Size of egg: 58 µm × 32 µm.
Importance: Relatively nonpathogenic.
Diagnosis: Eggs occasionally in feces. Adults found in mucosa of esophagus at necropsy.
Treatment: None known.

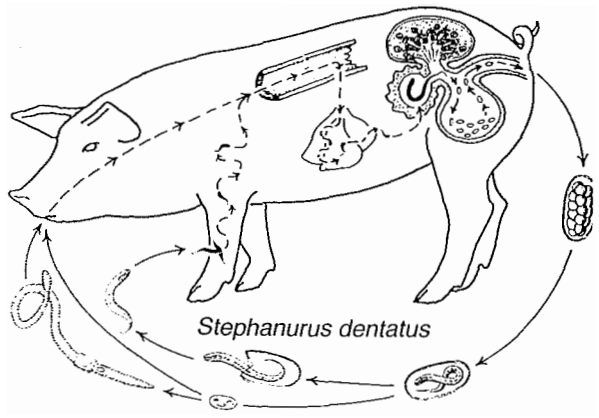


Fig. 175. *Stephanurus dentatus*. Prepatent period is 8–16 months.

Stephanurus dentatus

Common name: Swine kidney worm (Strongyloidea).
Size of egg: 100 µm × 60 µm.
Importance: Loss of weight.
Diagnosis: Eggs are in urine. At necropsy adults are found in cysts in perirenal fat and pelvis of kidney. Larvae found in liver.
Treatment: Use uninfected gilts for breeding.
Ivermectin, 0.3–0.5 mg/kg IM, SC, or in feed
Doramectin, 0.3 mg/kg IM

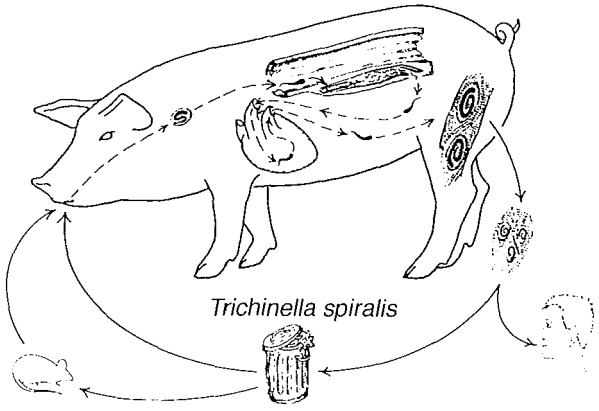


Fig. 176. *Trichinella spiralis.* Twenty days for larvae to be infective. Larvae to adult in 4 days.

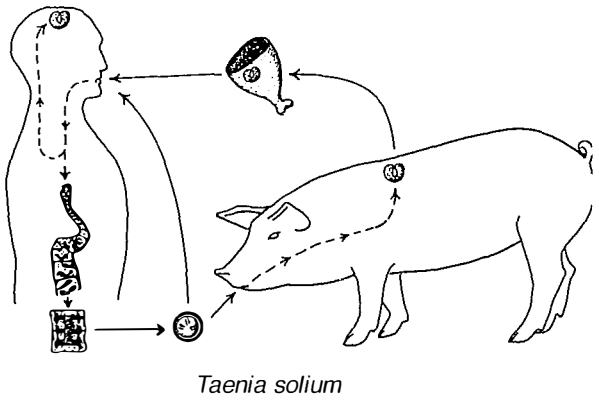


Fig. 177. *Taenia solium.* Prepatent period is 2 months.

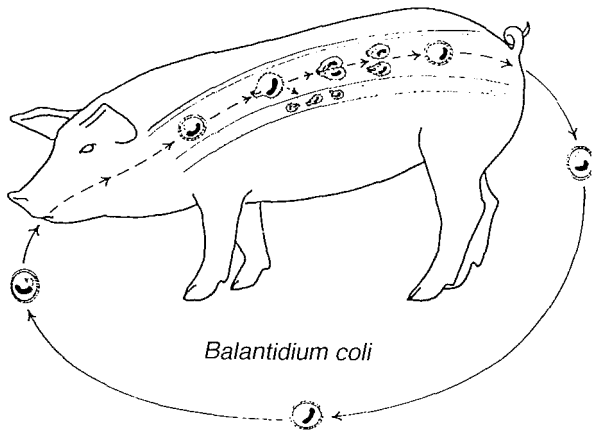


Fig. 178. *Balantidium coli.* Life cycle is 6–14 days.

Trichinella spiralis

Common name: Trichina worm (Trichuroidae).
Size of larva: 100–1,300 µm × 6–40 µm.
Importance: Infects all animals, especially wildlife.
Diagnosis: In humans, death, stiffness, muscle pain. Detection of larvae in muscle biopsy by squeezing muscle between two glass slides, or digesting muscle in 1% acid pepsin solution. Eosinophilia is supportive in a diagnosis. Serologic tests and skin tests are helpful.
Histology: (See Fig. 233.)
Treatment:
Humans:
Albendazole, 20 mg/kg q 24h × 5–7 days
Mebendazole, 50 mg/kg q 8 h × 10+ d
Corticosteroids in severe disease
Pigs: None
Prevention: Do not feed uncooked garbage to pigs. Cook all meat to 77°C (170°F) or 66°C for 3 minutes. Freeze meat to –15°C (5°F) for 21 days, –23°C (–10°F) for 10 days, or –30°C (–22°F) for 6 days.
Note: *Trichinella* in wildlife is not killed by freezing.

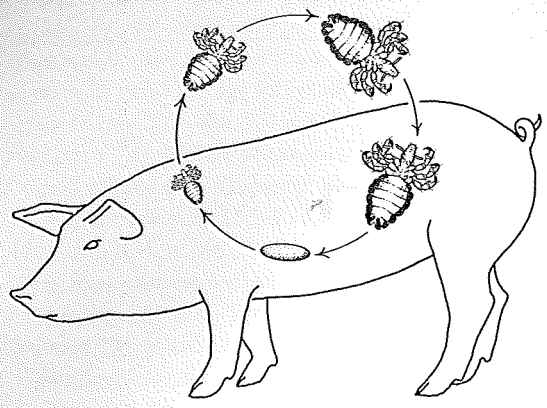
Taenia solium

Common name: Pork tapeworm (Taeniidae). Adults only in humans.
Size of egg: 35 × 25 µm.
Importance: Cysticerci are in pig skeletal and cardiac muscle. When eaten by humans, the adult tapeworm develops. Humans also can develop cysticercosis. No major pathogenicity in pigs.
Diagnosis: Observation of cysticerci in pigs at necropsy; serological tests in humans and pigs, eggs in feces of infected humans.
Treatment: In humans: Niclosamide, adults 2 g; children 1.0–1.5 g.
Prevention: Management to prevent pig ingestion of human feces. Cook pork to 45–50∞C (113–122∞F) for 20 minutes. Freeze pork to –10∞C (14∞F) for 4 days.

Balantidium coli

Common name: None (Ciliophora).
Size of trophozoite: 30–150 µm.
Size of cyst: 40 to 60 µm.
Importance: Pig is the usual host, usually considered a commensal, but can cause mild to severe enteritis. This is a zoonotic infection.
Diagnosis: Clinical signs, and large numbers of organisms in fecal flotation or smear. Lesions seen at necropsy.
Treatment: In humans: Metronidazole, 750 mg q 8 h x 5 d
Pigs: Tetracycline antibiotics (200 mg/gal H_2O)

External Parasites



Haematopinus suis

Fig. 179a. Life cycle of *Haematopinus suis*.

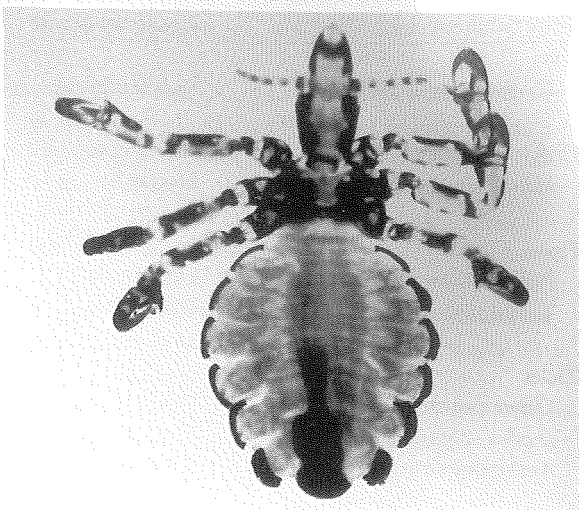
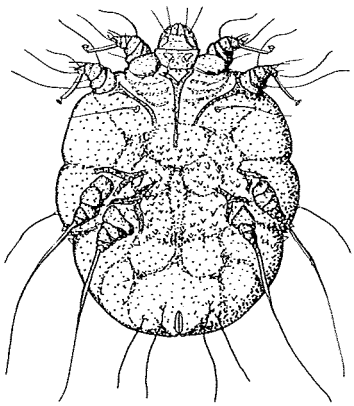


Fig. 179b. *Haematopinus suis*.

Haematopinus suis

Common name: Hog louse (Insecta-Anoplura).
Size of adult: 5–7 mm. Life cycle is 3–4 weeks.
Importance: Irritation, anemia, may transmit Eperythrozoan suis (a rickettsia).
Diagnosis: Examination of skin for adult eggs, nymphs, and adult lice.
Treatment: Amitraz, coumaphos, crotoxyphos, diazinon, dioxathion, fenchlorphos, fenvalerate, ivermectin, lindane, malathion, methoxychlor, phosmet, permethrin, pyrethrum, pyrethrins, pyrethroids, tetrachlorvinphos, trichlorfon.



Sarcoptes scabiei

Fig. 180a. *Sarcoptes scabiei*.

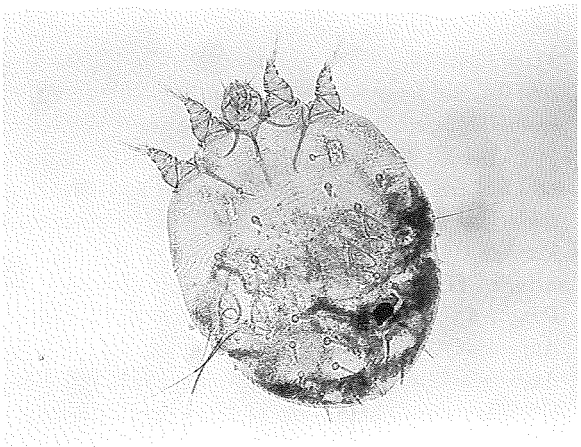


Fig. 180b. *Sarcoptes scabiei*.

Sarcoptes scabiei

Common name: Mange mite (Arachnida-Sarcoptidae).
Size of adult: 350–450 µm. Life cycle is 3 weeks.
Importance: Irritation, anemia, weight loss, constant scratching, and self mutilation.
Diagnosis: Skin scraping
Treatment: Amitraz, crotoxyphos, fenchlorphos, fenvalerate, ivermectin, lindane, methoxychlor, permethrin, phosmet, toxaphene.

Table 42. List of common external parasites of pigs

Genus and Species	Common Name	Figure
Lice		
Haematopinus suis	Sucking louse	Fig. 179
Flies		
Musca domestica	House fly	Fig. 121
Fleas		
Pulex irritans	Human flea	Fig. 44
Tunga penetrans	Digger flea	Fig. 44
Ticks		
Dermacentor spp.	Wood ticks	Figs. 128–131
Ixodes scapularis	Black-legged tick	Figs. 128–131
Amblyomma spp.	Southern ticks	Figs 128–131
Mites		
Sarcoptes scabiei	Mange mite	Fig. 180
Demodex phylloides	Follicle mite	Fig. 47

Bibliography

Batte EG: A review and update of swine parasite control. *J Am Vet Med Assoc* 170:343–344, 1977.

Bennett DG, and Copeman DB: Gastrointestinal helminth infections in feeder pigs. *Am J Vet Res* 31:1093–1096, 1970.

Cargill CF, and Dobson KJ: Experimental *Sarcoptes scabiei* infestation in pigs: (1) Pathogenesis *Vet Rec* 104:11–14, 1979.

Cargill CF, and Dobson KJ: Experimental *Sarcoptes scabiei* infestation in pigs: (2) Effects on production. *Vet Rec* 104:33–36, 1979.

Courtney CH, Sundlof SF: *Veterinary Antiparasitic Drugs, A Comprehensive Compendium of FDA-Approved Antiparasitic Drugs*, American Association of Veterinary Parasitologists, Publication SP96, University of Florida, Gainesville, 224 Pages, 1991.

Foreyt WJ, Todd AC, Foreyt KM: Fascioloides magna (Bassi, 1875) in feral swine from southern Texas. *J Wildl Dis* 11:554–559, 1975.

Lindsay DS, Current WL, Ernst JV, et al.: Diagnosis of neonatal porcine coccidiosis caused by *Isospora suis*. *Vet Med Small Anim Clin* 78:89–95, 1983.

Lindsay DS, Ernst JV, Current WL, et al.: Prevalence of oocysts of *Isospora suis* and *Eimeria* spp. from sows on farms with and without a history of neonatal coccidiosis. *J Am Vet Med Assoc* 185:419–421, 1984.

Lindsay DS, Current WL, and Taylor JR: Effects of experimental *Isospora suis* infection on morbidity, mortality, and weight gains of nursing pigs. *Am J Vet Res* 46:1511–1512, 1985.

Logan NB, Weatherley AJ, Jones RM: Activity of doramectin against nematode and arthropod parasites of swine. *Vet Parasit* 66:87–94, 1997.

Lord, WD, and Bullock WL: Swine ascariasis in humans. *N Engl J Med* 306:1113, 1982.

Marti OG, Stewart TB, and Hale OM: Comparative efficacy of fenbendazole, dichlorvos, and levamisole HCl against gastrointestinal nematodes of pigs. *J Parasitol* 64:1028–1031, 1978.

Murrell KD, Gamble HR, and Schad GA: Experimental transmission of *Trichinella spiralis* to swine by infected rats. *Proc Helminthol Soc Wash* 51:66–70, 1984.

Polley LR, and Mostert PE: *Ascaris suum* in Saskatchewan pigs: An abattoir survey of prevalence and intensity of infection. *Can Vet J* 21:307–309, 1980.

Schad GA, Kelly M, Leiby DA, et al.: *Trichinella spiralis* in Mid-Atlantic slaughterhouses: Relationship to hog marketing systems. *Prev Vet Med* 3:391–399, 1985.

Schantz PM: Trichinosis in the United States, 1947–1981. *Food Technol* 37:83–86, 1983.

Schillhorn van Veen TW, and Gibson CD: Anthelmintic activity of ivermectin in pigs naturally infected with *Ascaris* and *Trichuris*. *Am J Vet Res* 44:1732–1733, 1983.

Sheahan BJ: Experimental *Sarcoptes scabiei* infection in pigs: Clinical signs and significance of infection. *Vet Rec* 94:202–209, 1974.

Sheahan BJ, O'Connor PJ, and Kelly EP: Improved weight gains in pigs following treatment for sarcoptic mange. *Vet Rec* 95:169–170, 1974.

Steelman CD: Effects of external and internal arthropod parasites on domestic livestock production. *Ann Rev Entomol* 21:155–178, 1976.

Stewart TB, Fox MC, Miles SE: Doramectin efficacy against gastrointestinal nematodes in pigs. *Vet Parasitol* 66:101–108, 1996.

Stewart TB, Marti OG, and Hale OM: Efficacy of fenbendazole against five genera of swine parasites. *Am J Vet Res* 42:1150–1162, 1981.

Stewart TB, Marti MS, and Hale OM: Efficacy of ivermectin against five genera of swine nematodes and the hog louse, *Hematopinus suis*. *Am J Vet Res* 42:1425–1426, 1981.

Stewart TB, Marti OG, and McCormick WC: Efficacy of ivermectin against the swine kidney worm, *Stephanurus dentatus*. *Am J Vet Res* 42:1427–1428, 1981.

Stewart TB, Marti OG, and McCormick WC: Efficacy of fenbendazole against the swine kidney worm, *Stephanurus dentatus*. *Am J Vet Res* 42:1627–1629, 1981.

Stewart TB, Bidner TD, Southern LL, et al.: Efficacy of fenbendazole against migrating *Ascaris suum* larvae in pigs. *Am J Vet Res* 45:984–986, 1984.

Stuart BP, Gosser HS, Allen CB, et al.: Coccidiosis in swine: Dose and age response to *Isospora suis*. *Can J Comp Med* 46:317–320, 1982.

Whiteman CE, Glock RD: In Bickford AA and Scwartz KJ (eds): *Swine Disease Manual*. Pioneer Impressions, Inc., Fort Collins, CO, 1995, 223 pages.

Section 9

PARASITES OF BIRDS

Fecal Eggs and Oocysts

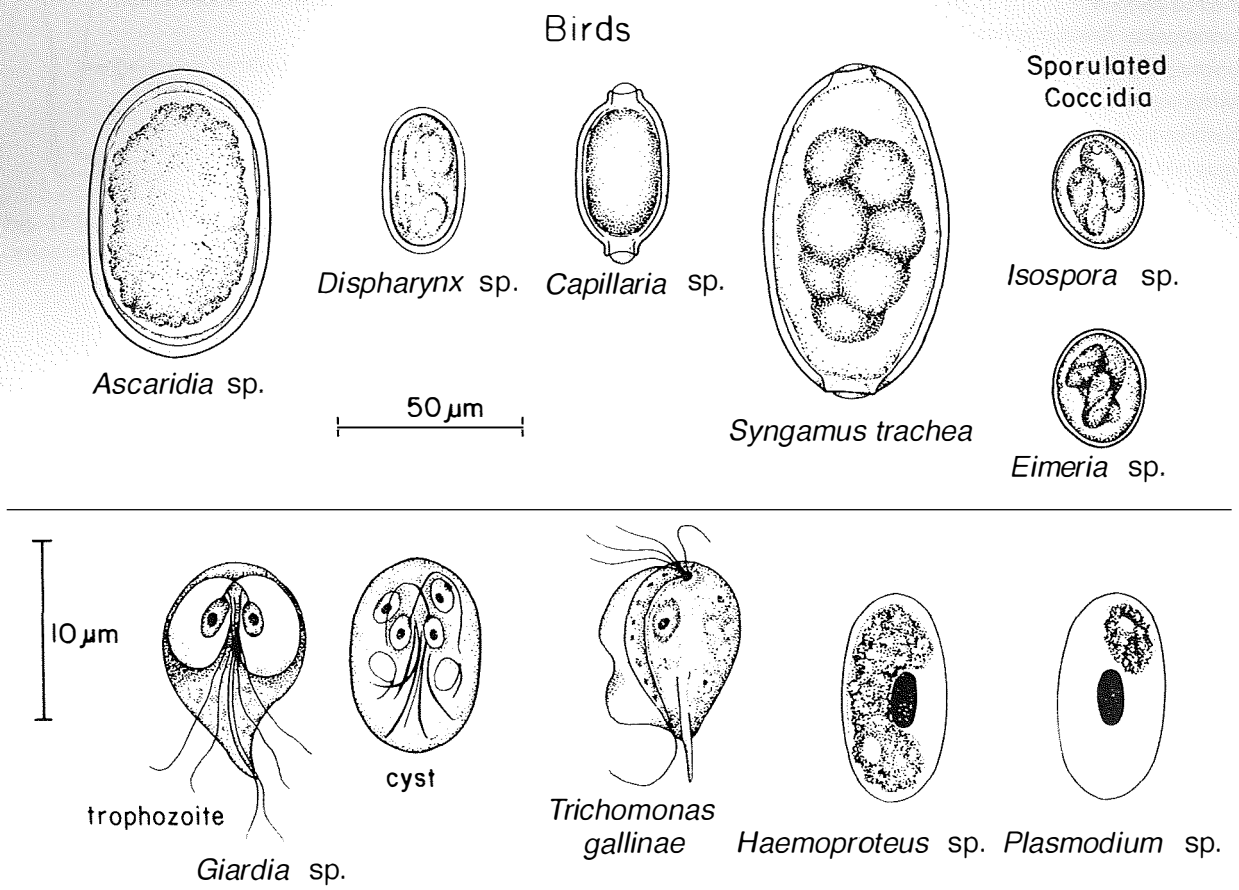


Fig. 181. Common parasite eggs and oocysts found in bird feces.

Location of Major Parasites

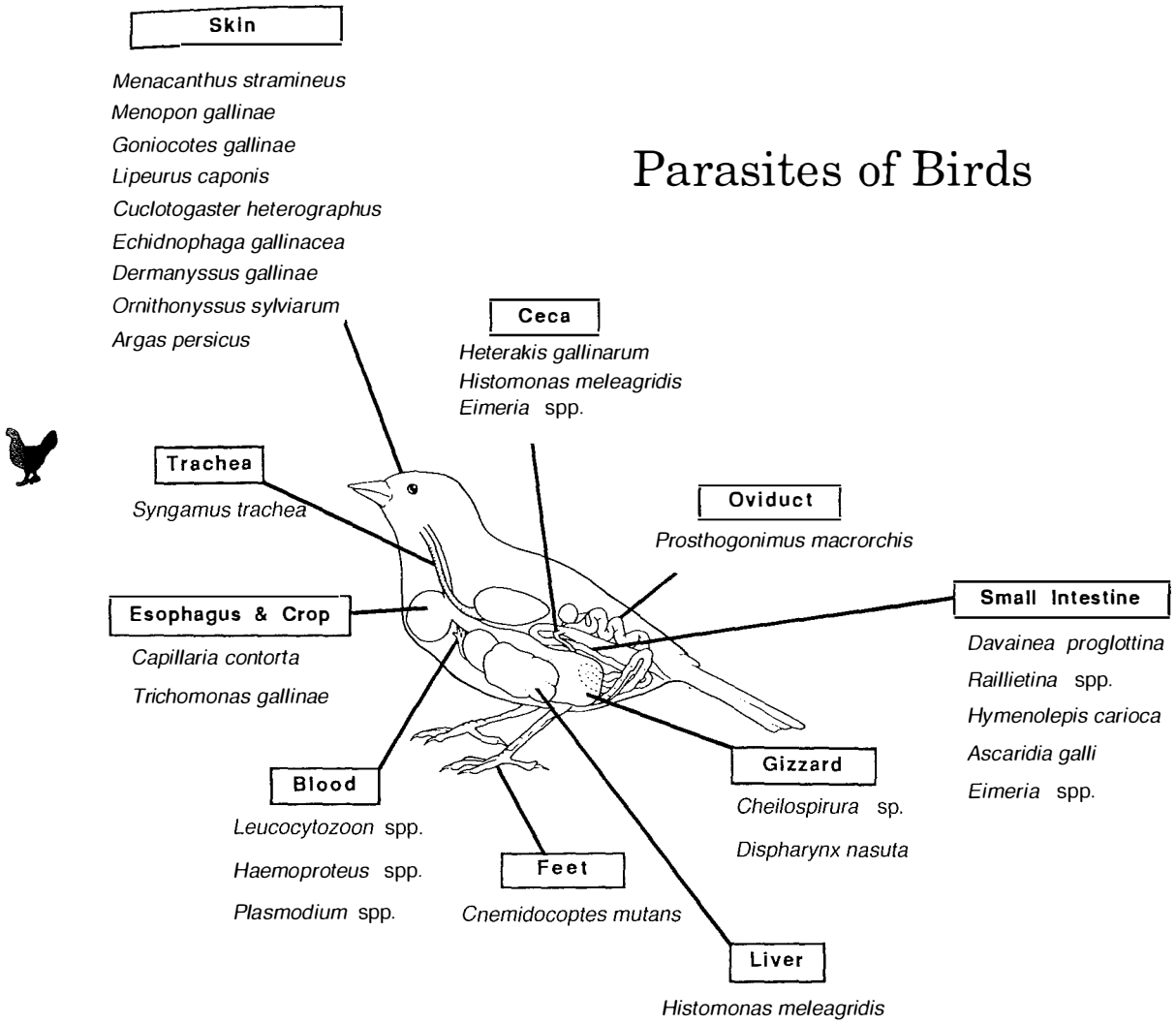


Fig. 182. Location of the major parasites found in birds.

Zoonotic Diseases

Table 43. Major zoonotic diseases associated with birds

Organism	Disease	Method of Infection
Protozoa		
Toxoplasma gondii	Toxoplasmosis	Ingestion of raw meat
Trematodes		
Schistosomatids	Cercarial dermatitis	Contact with cercariae in water
Arthropods		
Biting lice	Transient pediculosis	Contact with infected birds

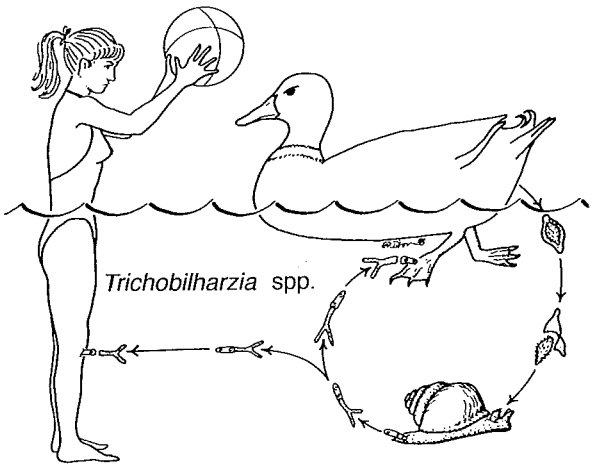


Fig. 183. *Trichobilharzia* spp. Adult flukes in ducks, cercariae in water, cause swimmer's itch in humans.

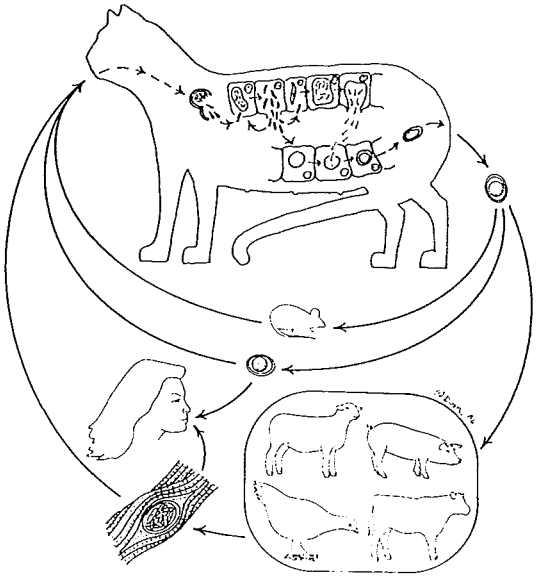


Fig. 184. *Toxoplasma gondii.*

Coccidia in Birds

Table 44. Major pathogenic species of coccidia affecting chickens, turkeys, ducks, and geese

Species Affected	Average size (μm)	Prepatent Period	Region of Intestine
Chickens			
Eimeria acervulina	18 × 15	4 days	Upper small intestine
Eimeria brunetti	25 × 19	5 days	Lower small intestine, rectum
Eimeria maxima	30 × 21	5 days	Middle and lower small intestine
Eimeria mivati	16 × 13	4 days	Upper small intestine
Eimeria necatrix	20 × 17	6–7 days	Middle to entire small intestine
Eimeria tenella	22 × 19	6–7 days	Ceca
Turkeys			
Eimeria adenoeides	26 × 17	4 days	Ceca
Eimeria dispersa	26 × 21	5 days	Entire small intestine
Eimeria gallopavonis	27 × 17	4 days	Lower small intestine, rectum
Eimeria meleagridis	19 × 16	4 days	Middle half of small intestine
Ducks			
Eimeria aythyae	20 × 16	Unknown	Small intestine
Eimeria burcephalae	20 × 16	Unknown	Small intestine
Eimeria somateriae	32 × 14	Unknown	Kidney
Eimeria truncata	17 × 21	5–6 days	Kidney
Tyzzeria perniciosa	12 × 10	6 days	Entire small intestine
Geese			
Eimeria anseris	22 × 17	7 days	Posterior small intestine
Eimeria kotlani	31 × 24	Unknown	Cecum and rectum
Eimeria truncata	17 × 21	5–6 days	Kidney

Drugs

Table 45. Major anticoccidial drugs in chickens and turkeys

Drug	Level in Feed (ppm)	Drug	Level in Feed (ppm)
Amprolium	125–250	Nitrofurazone	55
Clopidol	125–250	Nitromide	250
Halofuginone	3	Sulfadimethoxine	125
Lasalocid	75–125	Sulfaquinoxyline	150–250
Monensin	60–100	Salinomycin	50–75
Nicarbazine	100–200	Zoalene	125

Table 46. Efficacy of anthelmintics for chickens

		Efficacy against Parasites (%)			
Drug	Dose (mg/kg PO)	*Ascaridia*	*Capillaria*	*Heterakis*	Cestodes
Cambendazole	10 mg	95–100	—	—	—
	30	95–100	—	—	—
	50	95–100	95–100	95–100	—
	70	95–100	95–100	95–100	—
Coumaphos	40 ppm q 24 h × 10 d[a]	95–100	95–100	95–100	—
Fenbendazole	5	—	—	95–100	—
	15	—	95–100	95–100	—
	8 q 24 h × 3 d	95–100	—	—	—
	60 q 24 h × 3 d	95–100	95–100	—	—
	30 q 24 h × 6 d	95–100	95–100	—	—
Haloxon	50–100	—	80–100	—	—
Ivermectin	0.1	—	95–100	—	—
Levamisole	20	95–100	—	—	—
	40	95–100	95–100	—	—
Mebendazole	10 q 24 h × 3 d[a]	95–100	—	—	—
	20 q 24 h × 3 d[a]	95–100	95–100	—	—
	60 q 24 h × 3 d[a]	95–100	95–100	—	—
Niclosamide	50	—	—	—	0–100
Phenothiazine	1,000	—	—	80–100	—
Piperazine	250	95–100	—	—	—
	5,000 ppm[b]	95–100	—	—	—
	3,000 ppm[a]	80–100	—	—	—
Pyrantel	15	95–100	—	—	—
	100	95–100	—	0–80	—
	120	95–100	95–100	0–80	—

Dash indicates not affected or unknown efficacy.
[a]Administer in drinking water.
[b]Administer in feed.

Table 47. Efficacy of anthelmintics for pheasants, turkeys, pigeons, and geese

Drug	Dose (mg/kg PO)	Efficacy against Parasites (%)				
		Ascaridia	*Capillaria*	*Heterakis*	*Amidostomum*	Cestodes
Pheasants						
Febantel	10	95–100	—	95–100		—
Fenbendazole	60 ppm q 24 h × 6 d[a]	—	95–100	95–100		—
Mebendazole	60 ppm q 24 h × 6 d[a]	95–100	95–100	95–100		—
Niclosamide	50 or 125[a]	—	—	—		0–100
Turkeys						
Levamisole	30	95–100	80–100	95–100		—
	300 ppm × 1 d[b]	95–100	0–100	95–100		—
Niclosamide	50 or	—	—	—		0–100
	125[a]	—	—	—		0–100
Piperazine	4,000 ppm q 6 h[b]	95–100	—	—		—
	4,000 ppm q 24 h × 2 d[a]	95–100	—	—		—
Pigeons						
Fenbendazole	7.5	95–100	—	—		—
	100 ppm q 24 h × 3 d	95–100	95–100	—		—
Haloxon	50	—	95–100	—		—
Levamisole	20–40	95–100	95–100	—		—
Niclosamide	200	—	—	—		0–100
Geese						
Disophenol	10 SC				95–100	—
Fenbendazole	5				95–100	—
	60 ppm q 24 h × 6 d[a]				95–100	—
Levamisole	15				95–100	—
Mebendazole	10 q 24 h × 3 d				95–100	—
	60 ppm q 24 h × 3 d[a]				95–100	—
Niclosamide	50 or				—	0–100
	125[a]				—	0–100
Pyrantel	50				95–100	—
Trichlorphon	75				95–100	—

Dash indicates not effective or unknown efficacy.

[a]Administer in food.

[b]Administer in drinking water.

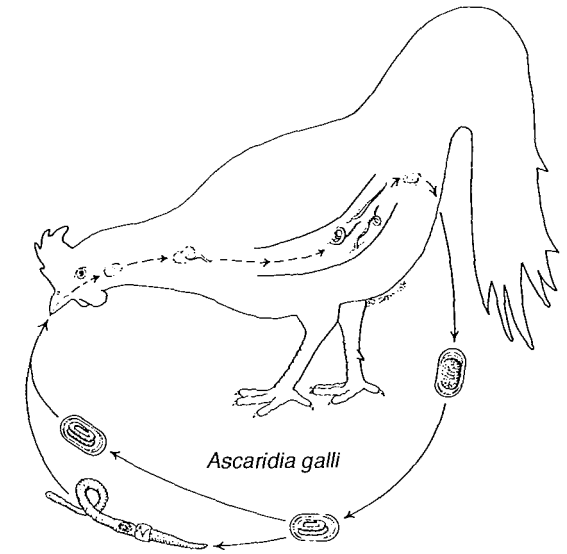


Fig. 185a. *Ascaridia galli.* Prepatent period is 29–50 days.

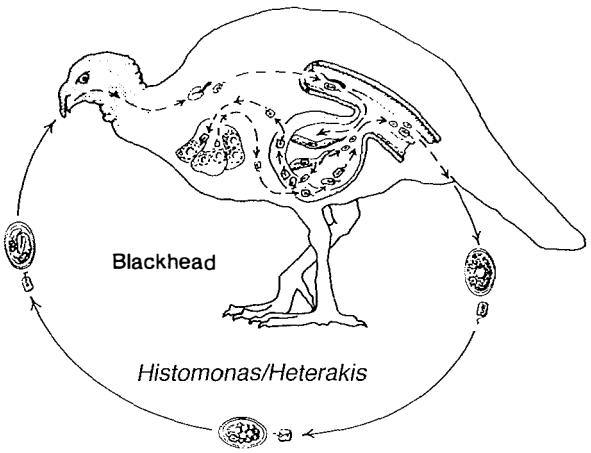


Fig. 186a. *Heterakis gallinarum.* Prepatent period is 24–36 days.

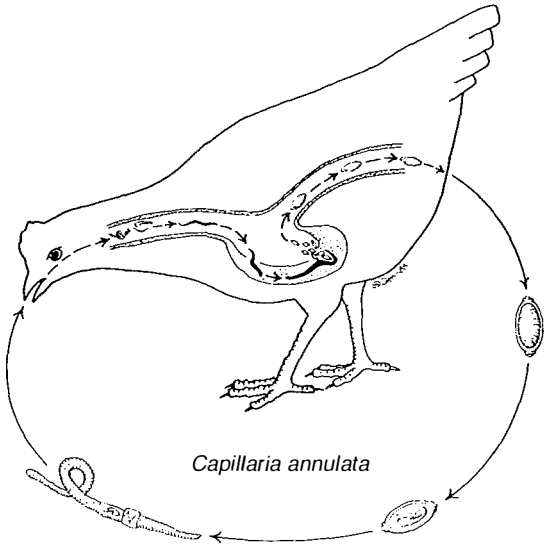


Fig. 187a. *Capillaria annulata.* Prepatent period is 1–2 months.

Internal Parasites

Ascaridia galli

Common name: Ascarid or roundworm (Ascaridoidea).
Size of adults: 12–18 cm.
Size of egg: 85 µm × 50 µm.
Importance: May decrease egg production, weight gain; diarrhea, emaciation, anemia in heavy infections.
Diagnosis: Eggs in fecal flotation. Adults found in small intestine at necropsy.
Treatment: Fenbendazole, 10–50 mg/kg once, repeat in 10 days
Levamisole, 15 mg/kg PO; for poultry, 40–50 mg/kg PO
Piperazine, 100–500 mg/kg and repeat in 3 weeks

Heterakis gallinarum

Common name: Cecal worm (Ascaridoidea).
Size of adults: 2–4 cm in cecum.
Size of egg: 70 µm × 40 µm.
Importance: Transmits *Histomonas meleagridis*, the protozoan agent of blackhead disease in turkeys.
Diagnosis: Eggs in fecal flotation. Adults found in cecum at necropsy.
Treatment: Fenbendazole, 10–50 mg/kg repeat in 10 d
Levamisole, 40–50 mg/kg PO
Prevention for blackhead disease: Nitrofurazoladone, 7 cc/5,000 cc H2O
Metronidazole, 25 mg/kg q 12 h × 5 d
Benzimidazoles, before and during exposure
(See Hegnigi, et al., 1999.)

Capillaria spp.

Common name: Several species (Trichuroidea).
Size of adult: 5–15 mm.
Size of egg: Approximately 50 µm × 25 µm. Several species have different eggs.
Importance: May cause emaciation, diarrhea, hemorrhagic enteritis, and death.
Diagnosis: Eggs in fecal flotation. Adults found in crop lining and small intestine at necropsy.
Treatment: Fenbendazole, 10–50 mg/kg q 24 h × 5 d
Mebendazole, 25 mg/kg q 12 h × 5 d
Ivermectin, 0.4 mg/kg PO or IM

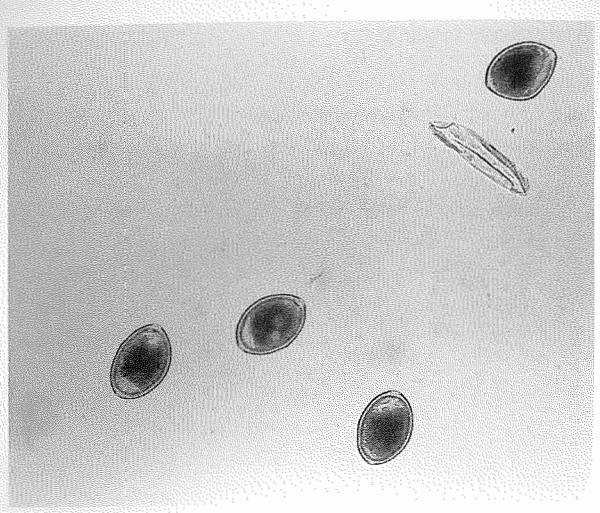


Fig. 185b. *Ascaridia galli.*

Fig. 185c. *Ascaridia galli.*

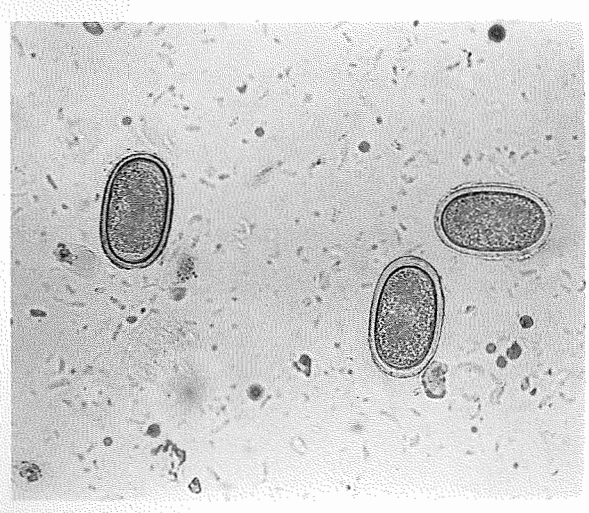


Fig. 186b. *Heterakis gallinarum.*

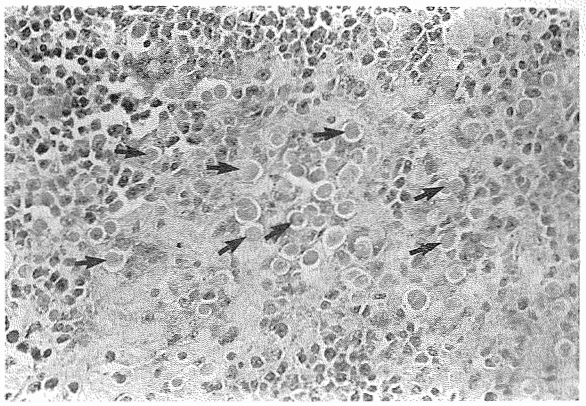


Fig. 186c. *Histomonas meleagridis* (the flagellated protozoan in a liver section). See arrows. This protozoan parasite is carried by *Heterakis gallinarum.*

Fig. 187b. *Capillaria* sp.

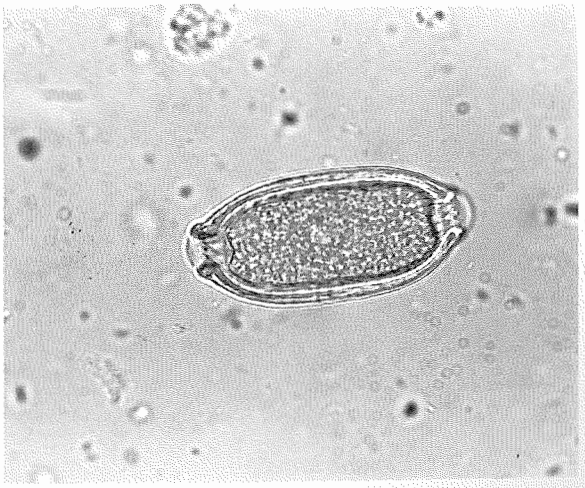


Fig. 187c. *Capillaria* sp.

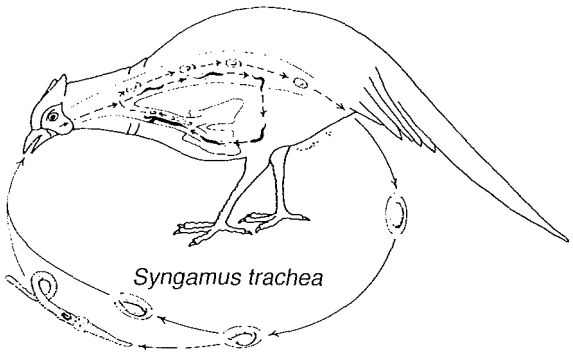


Fig. 188a. *Syngamus trachea*. Prepatent period is 2 weeks.

Syngamus trachea

Common name: Gapeworm (Strongyloidea).
Size of adult: 2–5 cm in trachea.
Size of egg: 90 µm × 50 µm.
Importance: Causes "gaping" (labored breathing), suffocation, and death.
Diagnosis: Swabs of tracheal lesions, egg in fecal flotation. Adults found in small intestine at necropsy.
Treatment: Fenbendazole, 30 mg/kg × 5 d

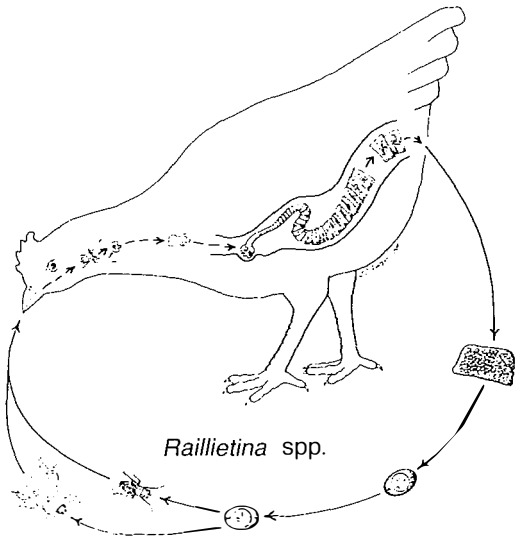


Fig. 189a. Tapeworms (several kinds). Prepatent period is 2–3 weeks.

Raillietina spp., *Choanotaenia* spp., etc.

Common name: Tapeworm (Anoplocephalidae). Many genera infect birds (Raillietina, Choanotaenia, etc.).
Size of adult: Varies depending on genera. Adult in small intestine.
Size of egg: 70–90 µm.
Importance: Vary from nonpathogenic to enteritis, ill-thrift, paralysis, and death.
Diagnosis: Proglottids or ova in feces.
Treatment: Niclosamide, 50 mg/kg PO
Praziquantel, 6 mg/kg and repeat in 10–14 d.

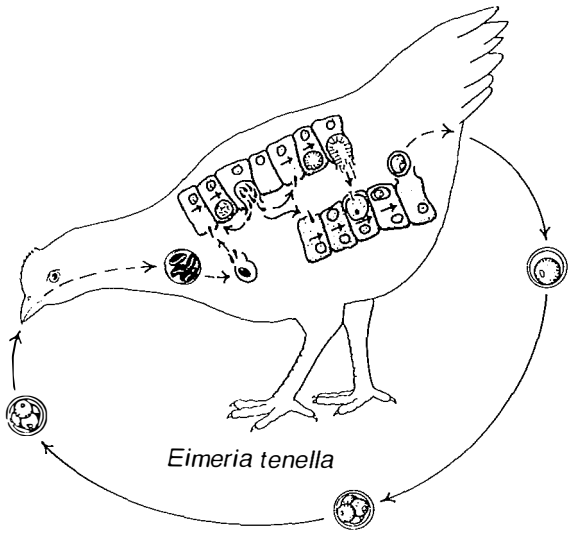


Fig. 190a. *Eimeria* spp. Prepatent period is 7–10 days.

Eimeria spp.

Common name: Coccidia (Apicomplexa).
Size of oocyst: See Table 44. Oocysts in small intestine.
Importance: Hemorrhagic diarrhea.
Diagnosis: Clinical signs and oocysts in fecal flotation.
Treatment: Amprolium, 0.012–0.024% in water q 24 h × 3–5 d
Sulfadimethoxine, 0.006%–0.05% q 24 h × 6 d
Sulfonamides (enteric), 55 mg/kg PO q 24 h as needed

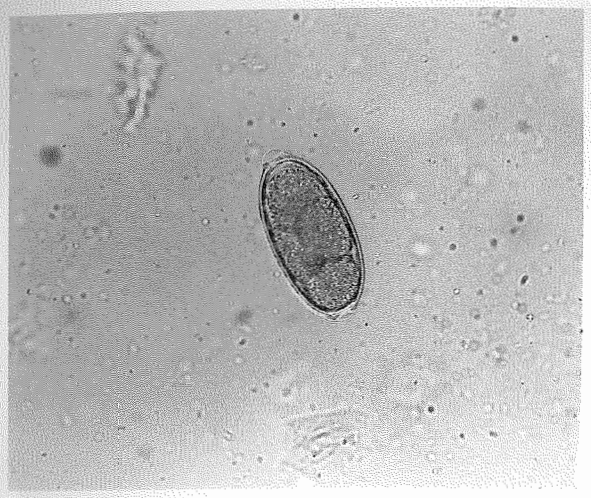


Fig. 188b. *Syngamus trachea.*

Fig. 188c. *Syngamus trachea.*

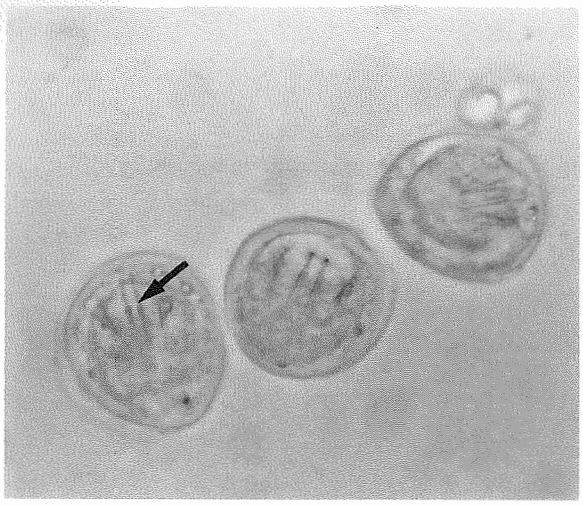


Fig. 189b. Tapeworms. Note hooks in egg (arrow).

Fig. 189c. Tapeworms. Note hooks in eggs (arrows).

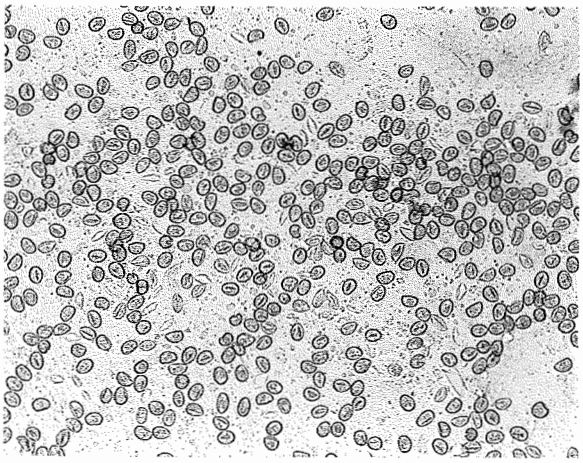


Fig. 190b. *Eimeria* spp.

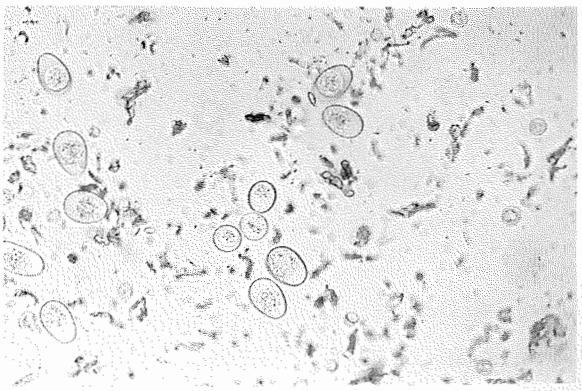
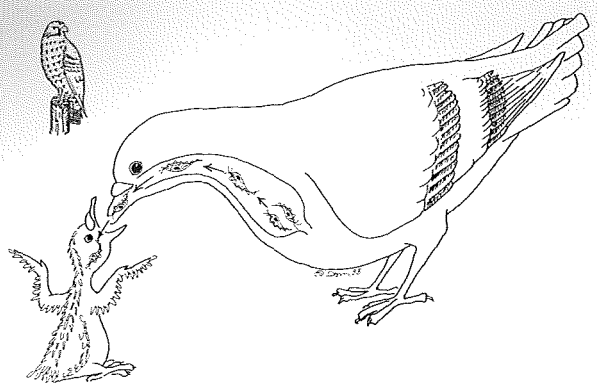


Fig. 190c. *Eimeria* spp.



Trichomonas gallinae

Fig. 191a. *Trichomonas gallinae.*

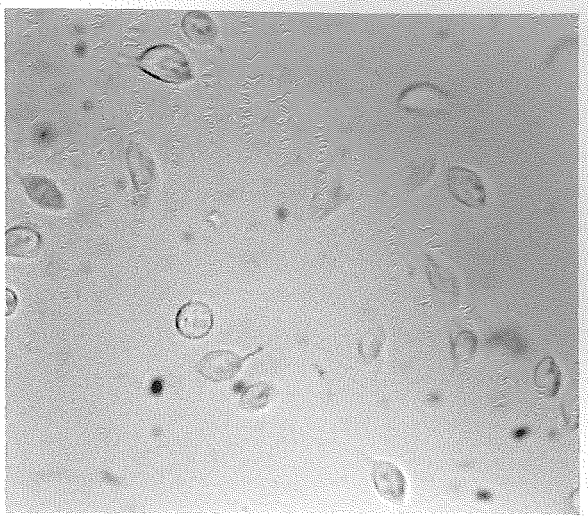
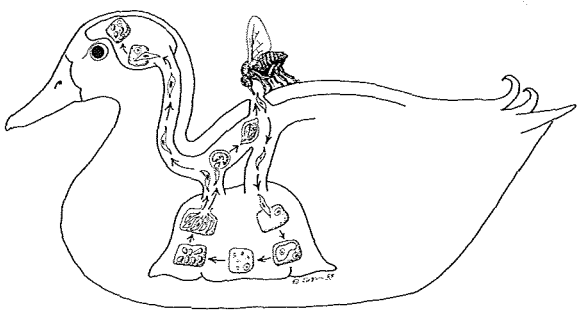


Fig. 191b. *Trichomonas gallinae.*

Trichomonas gallinae

Common name: Canker in pigeons, frounce in raptors (Mastigophora).
Size of trophozoite: 5–19 µm × 2–9 µm.
Importance: Weight loss, oral and enteric mucosal lesions.
Diagnosis: Flagellated organisms in wet smears from mouth or crop. Lesions with cheesy exudate in mouth.
Treatment: Dimetridazole, 0.06–0.08% in water × 7 d or 50 mg/kg PO
Ipronidazole, 500 mg/gal water × 7 d
Carnidazole (Spartrix), 10 mg/adult bird, 5 mg/newly weaned bird
Metronidazole, 60 mg/kg PO



Leucocytozoon spp.

Fig. 192a. *Leucocytozoon* spp.

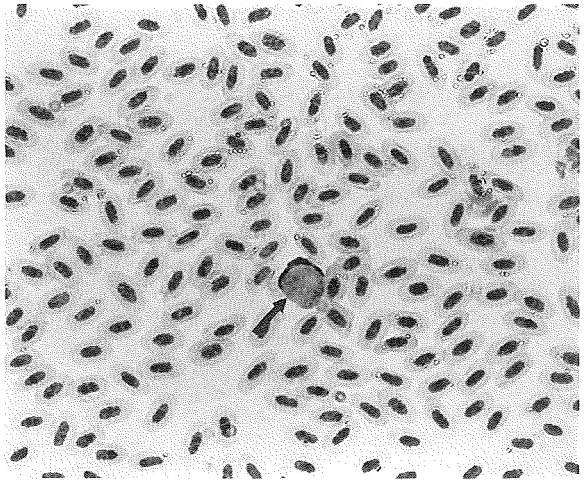


Fig. 192b. *Leucocytozoon* sp. (arrow).

Leucocytozoon spp.

Common name: None (Apicomplexa).
Size of organism: Gametocyte 14–15 µm × 5–6 µm in white blood cells, usually lymphocytes.
Importance: May cause decreased productivity and lethargy. Death in young birds.
Diagnosis: Blood smear. Gametes occur in blood within 7 days. Schizonts can be found in tissues.
Treatment: Clopidol, 0.0125–0.025% in feed for turkeys.

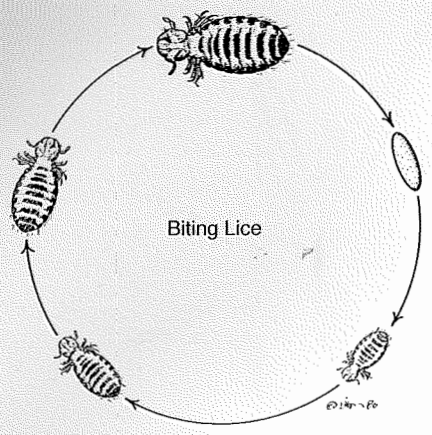


Fig. 193a. Biting lice.

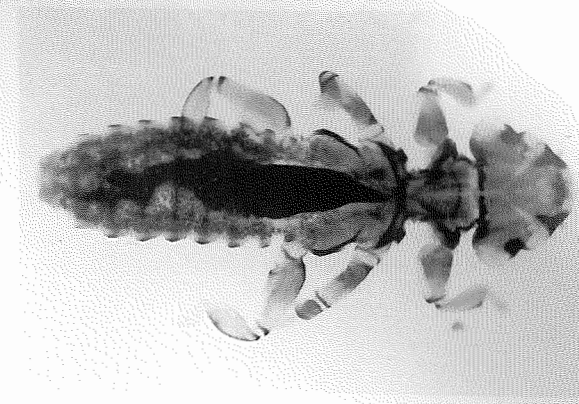
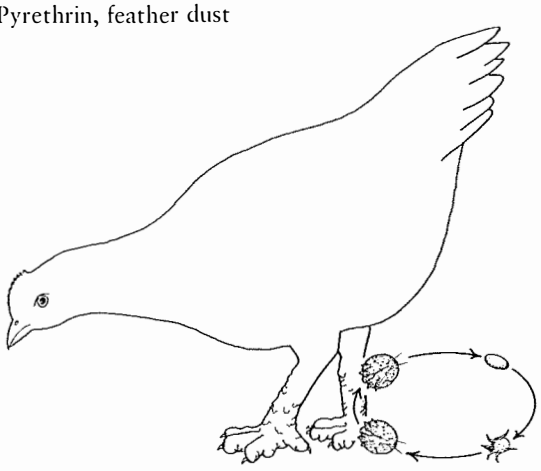


Fig. 193b. Biting louse.

External Parasites

Goniocotes spp., *Menopon* spp., *Menacanthus* spp., etc.

Common name: Biting lice (Insecta-Mallophaga). There are many species of biting lice in birds, sucking lice are not present.
Size of adult: 2–4 mm.
Importance: Irritant, may be debilitating.
Diagnosis: Examination of skin and feathers. For adults, nymph and eggs (nits).
Treatment: Carbaryl, roost sprays (5%)
Coumaphos, roost sprays
Malathion, feather and litter dust (poultry)
Pyrethrin, feather dust



Cnemidocoptes mutans

Fig. 194a. *Cnemidocoptes mutans.*

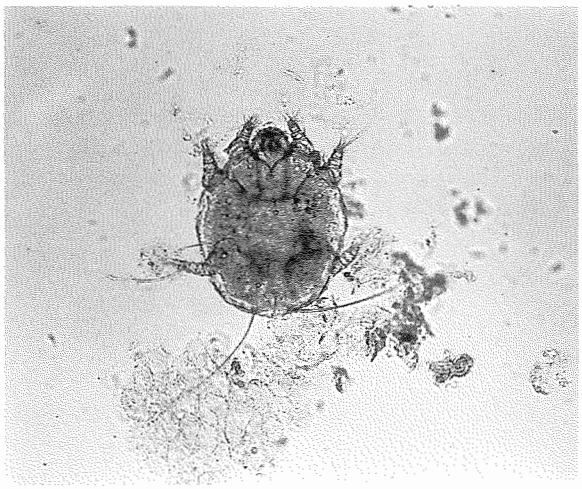


Fig. 194b. *Cnemidocoptes mutans.*

Cnemidocoptes (Knemidocoptes) mutans

Common name: Leg and face mites (Arachnida-Sarcoptidae).
Size of adult: 400 μm.
Importance: Proliferative lesions of face, back, vent or legs, especially in old chickens and psitticines.
Diagnosis: Skin scrapings of affected areas for adults, nymphs, and eggs (nits).
Treatment: Benzyl benzoate, 10% topical solution once a week × 4 weeks.
Crotamiton, apply topically once a week × 4 weeks.
Ivermectin, 0.2 mg/kg PO or IM

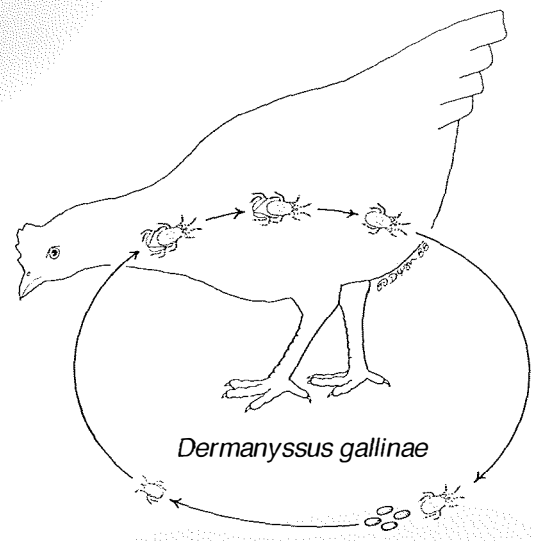


Fig. 195a. *Dermanyssus gallinae.*

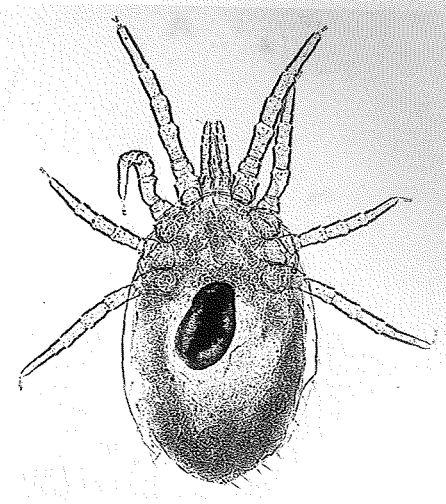


Fig. 195b. *Dermanyssus gallinae.*

Dermanyssus spp.

Common name: Feather mites (Arachnida-Dermanyssidae)
Size of adult: 1.0 mm.
Importance: Pruritus, decreased production, debilitation, anemia.
Diagnosis: Observation of mites (adults, nymphs, larvae, eggs) in feathers. Night observation is best. Life cycle is 9–12 days.
Treatment: Treat host and environment.
Coumaphos, (0.5%) dust topically × 3 d
Malathion, (4%) dust topically × 3 d

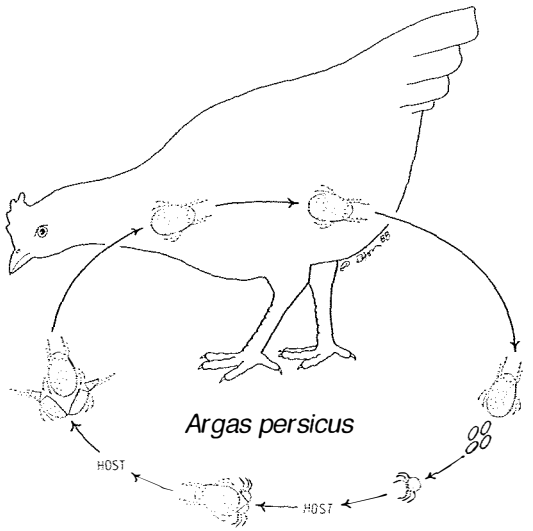


Fig. 196a. *Argas persicus.*

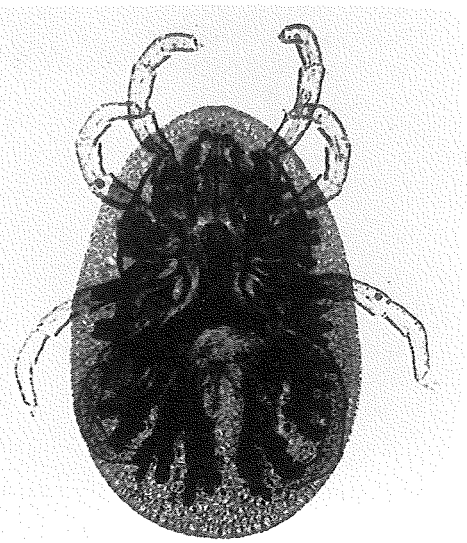


Fig. 196b. *Argas persicus.*

Argas persicus

Common name: Ticks (Arachnida-Argasidae).
Size of adult: 7 × 5 mm.
Importance: Decreased production, anxiety, anemia, vector for fowl spirochaetosis.
Diagnosis: Soft ticks on birds at night or in environment. Birds afraid to go in chicken house. Life cycle is 1 month.
Treatment: Treat host and environment. Premises at 1–2 gal/1,000 ft² with carbaryl 2% spray, or malathion 1–3% spray, or sprays containing pyrethroids or coumaphos.

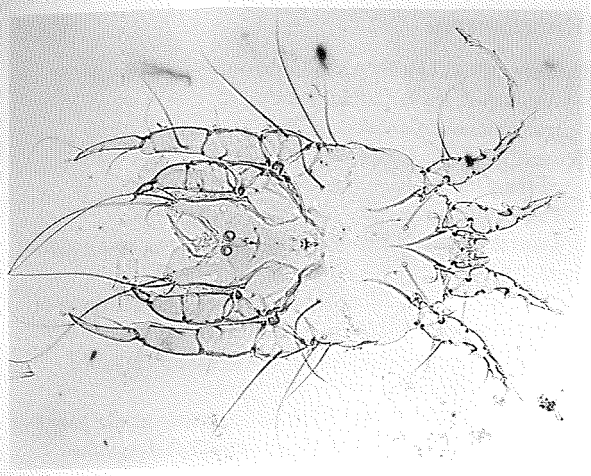


Fig. 197. *Protalges (Fainalges)* sp. (feather mite, 360 µm × 225 µm) from a parakeet.

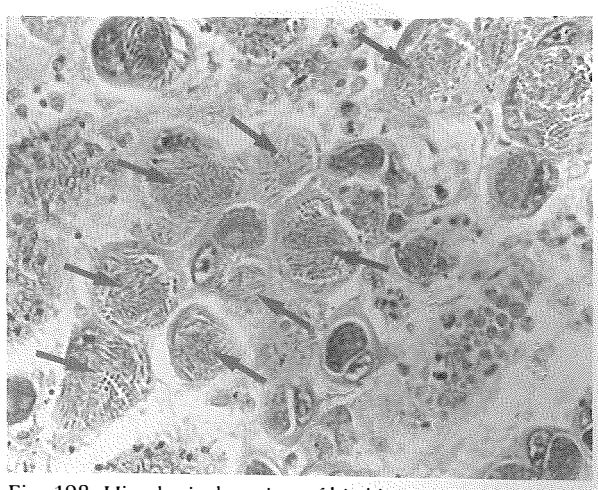


Fig. 198. Histological section of bird intestine with coccidiosis (schizonts at arrows).

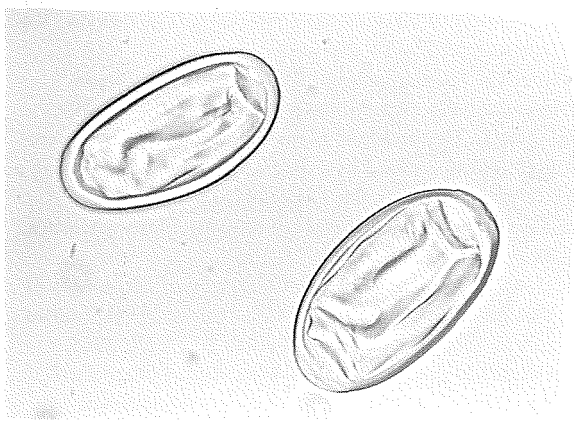


Fig. 199. *Dispharynx* sp. larvated eggs (40 µm × 20 µm). Adult nematodes in gizzard or proventriculus.

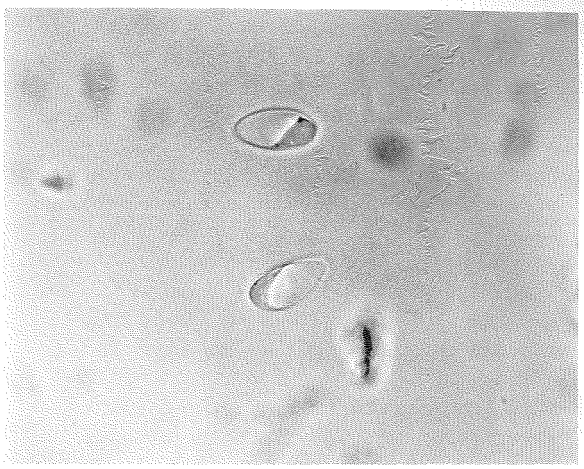


Fig. 200a. *Giardia* sp. cysts in sugar fecal flotation (15 µm). *Giardia* sp. is found in many birds.

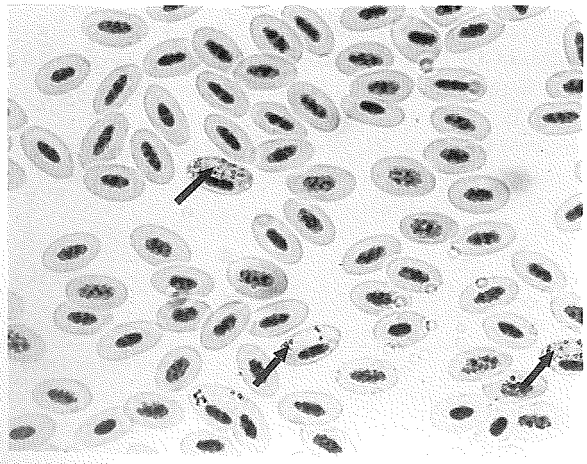


Fig. 200b. *Haemoproteus* sp. in erythrocytes (Protozoa-Apicomplexa) (arrows).

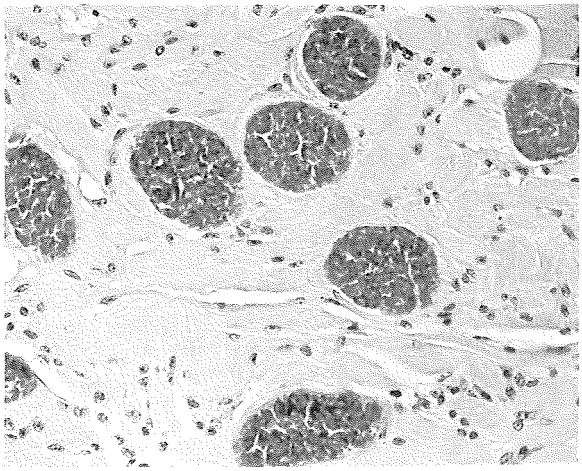


Fig. 200c. *Sarcocystis* sp. (pseudocyst) in muscle (Protozoa-Apicomplexa).

Bibliography

Textbooks

Davis JW, Anderson RC (eds): *Parasitic Diseases of Wild Animals*. Ames, Iowa, Iowa State University Press, 1971.

Davis JW, Anderson RC, Karstad LH, Trainer DO (eds): *Infectious and Parasitic Diseases of Wild Birds*. Ames, Iowa, Iowa State University Press, 1971.

Dunn, AM: *Veterinary Helminthology*. London, William Heinemann Medical Books Ltd., 1978.

Flynn RS: *Parasites of Laboratory Animals*. Ames, Iowa, Iowa State University Press, 1973.

Fowler ME (ed): *Zoo & Wild Animal Medicine*. 2nd edition. Philadelphia, W.B. Saunders Co., 1986.

Gaafer SM, Howard WE, Marsh RE (eds): *Parasites, Pests, and Predators*. New York, Elsevier, 1985.

Gordon RF, Jordan FTW (eds): *Poultry Diseases*. London, Bailliere Tindall, 1982.

Kranz GW: *A Manual of Acarology*. 2nd edition. Corvallis, Oregon State University Book Stores, 1962.

Lapage E (ed): *Monnig's Veterinary Helminthology and Entomology*. 5th edition. Baltimore, William & Wilkins, 1962.

Levine ND: *Protozoan Parasites of Domestic Animals and of Man*. 2nd edition. Minneapolis, Burgess Publishing Co., 1973.

Olsen OW: *Animal Parasites: Their Biology and Life Cycles*. 2nd edition. Minneapolis, Burgess Publishing Co., 1967.

Petrack ML (ed): *Diseases of Cage and Aviary Birds*. Philadelphia, Lea & Febiger, 1982.

Richie BW, Harrison GJ, Harrison LR: *Avian Medicine: Principles and Application*. Lake Worth, Florida, Wingers Publishing Inc., 1994.

Soulsby EJL: Helminths, *Arthropods and Protozoa of Domesticated Animals (Monnig)*. Philadelphia, Lea & Febiger, 1968.

Wallach JD, Boever WJ: *Diseases of Exotic Animals*. Philadelphia, W.B. Saunders Co., 1983.

Wobeser GA: *Diseases of Wild Waterfowl*. New York, Plenum Press, 1981.

Miscellaneous

Bennett GF, and Fallis AM: Blood parasites of birds in Algonquin Park, Canada, and a discussion of their transmission. *Canad. J. Zool.* 38:321–273, 1960.

Bennett GF, Garnham PCC, and Fallis AM: On the status of the genera *Leucocytozoon* Ziemann, 1898 and *Haemoproteus* Kruse, 1890 (Haemosporidiida: Leucocytozoidae and Haemoproteidae). *Canad J Zool* 43:927–932, 1965.

Current WL, Upton SJ, and Haynes TB: The life cycle of *Cryptosporidium baileyi* n. sp. (Apicomplexa, Cryptosporidiidae) infecting chickens. *J Protozool* 33:289–296, 1986.

Fain A, and Hyland KE: The mites parasitic in the lungs of birds. The variability of *Sternostoma tracheacolum* Lawrence, 1948, in domestic and wild birds. *Parasitology* 52:401–424, 1962.

Hegngi FN, Doerr J, Cummings TS, et al.: The effectiveness of benzimidazole derivatives for the treatment and prevention of histomonosis (blackhead) in turkeys. *Vet Parasitol* 81:29–37, 1999.

Keymer IF: The diagnosis and treatment of common psittacine diseases. *Mod Vet Pract* 39:22–30, 1958.

Leibovitz L: Unusual bird-parasite cases and overall parasite incidence found in a diagnostic laboratory during a five-year period. *Avian Dis* 6:141–144, 1962.

Manson-Bahr P: The life history of avian filaria parasites. *Bull Br Orn Club* 74:75–77, 1954.

McDonald ME: *Annotated Bibliography of Helminths of Waterfowl (Anatidae)*. U.S. Department of the Interior. Special Scientific Report—Wildlife No. 125, 1969.

McDonald ME: *Catalogue of Helminths of Waterfowl*. U.S. Department of the Interior. Special Scientific Report No. 126, 1969b.

McDonald ME: *Key to Trematodes Reported in Waterfowl*. U.S. Department of the Interior, Fish and Wildlife Service, Resource Publication No. 142, Washington, DC, 1981.

Peirce MA, and Bevan BJ: Blood parasites of imported psittacine birds. *Vet Rec* 100:282–284, 1977.

Radford CD: The mites (*Acarina: Analgesidae*) living on or in the feathers of birds. *Parasitology* 42:199–230, 1953.

Scholtens RG, New JC, Johnson S: The nature and treatment of giardiasis in parakeets. *J Am Vet Med Assn* 180:170–173, 1982.

Section 10

PARASITES OF RATITES (Ostriches, Emus, and Cassowaries)

Location of Major Parasites

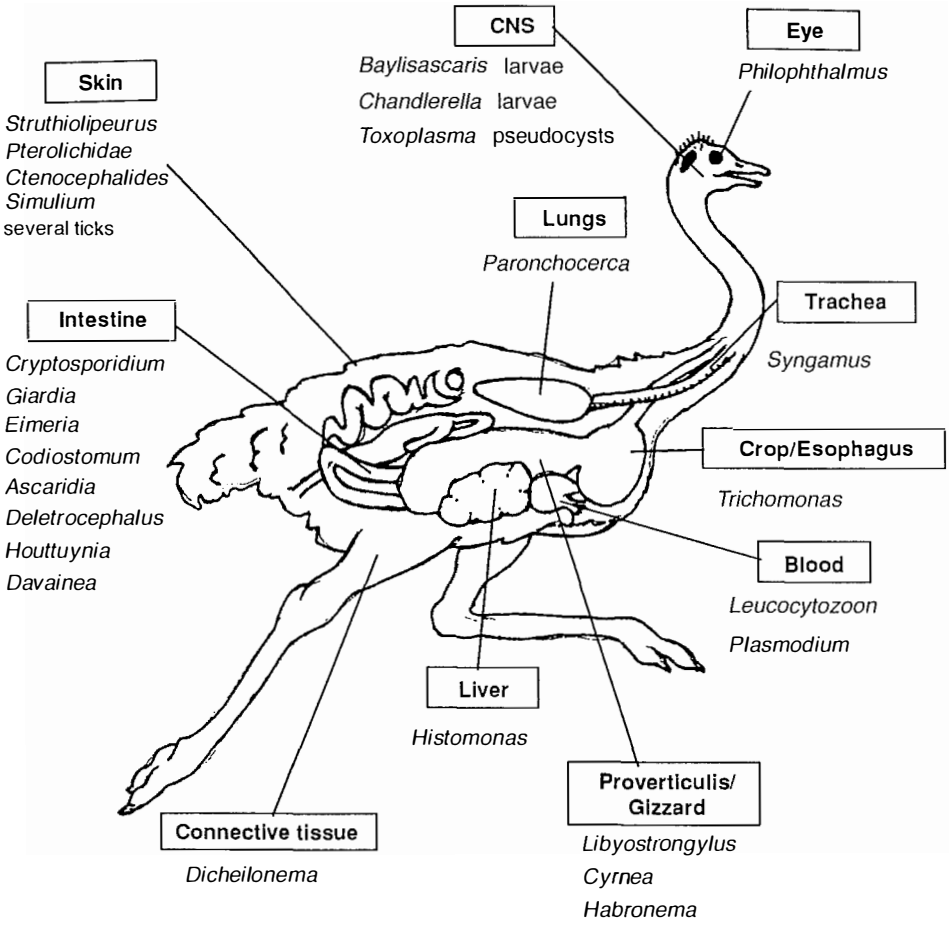


Fig. 201. Locations of parasites in ratites (ostrich, emu, rhea and cassowary).

Drugs

Table 48. Anthelmintics for ratites

Internal parasites
Fenbendazole, 15 mg/kg PO or in feed (nematodes and cestodes)
Ivermectin, 0.2 mg/kg SC or PO (nematodes)
External parasites
Carbaryl (5%) dust is used for most external parasites (ticks, mites, lice, fleas)
Ivermectin, 0.2 mg/kg SC or PO (ticks, mites, lice)

Common Parasites

Table 49. Parasites of ratites

Parasite	Ratite
Protozoa	
Cryptosporidium	Ostrich, and likely to be found in all ratites
Toxoplasma gondii	All ratites
Histomonas meleagridis	Ostrich, rhea
Giardia	Ostrich, emu
Trichomonas	Ostrich, emu
Leucocytozoon struthionis	Ostrich
Plasmodium struthionis	Ostrich
Eimeria spp.	Emu, and likely to be found in all ratites
Isospora spp.	Ostrich
Trematodes	
Philophthalmus gralli	Ostrich
Cestodes	
Houttuynia struthionis	Ostrich
Davainea spp.	Emu, cassowary, rhea
Nematodes	
Libyostrongylus spp. (wireworms)	Ostrich
Codiostomum struthionis	Ostrich
Syngamus trachea	Ostrich, emu, rhea
Dicheilonema spp. (filarial worm in connective tissue)	Ostrich, rhea
Chandlerella quiscali (larval stage in CNS)	Emu
Baylisascaris sp. (larval stage in CNS)	Ostrich, emu
Paronchocerca struthiononus	Ostrich
Struthiofilaria megalocephala	Ostrich
Cyrnea colini	Ostrich
Ascaridia orthocerca	Rhea
Deletrocephalus spp.	Rhea
Habronema (*Spiroptera*) *incerta*	Rhea
Dromaestrongylus bicuspis (small intestine)	Emu
External parasites	
Lice	
Struthiolipeurus spp. (biting lice)	Ostrich, rhea
Mites	
Pterolichidae spp. (quill mites)	Ostrich
Gabucinia spp.	Ostrich, rhea
Paralges pachynemis	Ostrich, rhea
Ticks	
Ticks from a variety of mammalian, avian, and reptile hosts have been reported to infest ratites. These include:	
Amblyomma spp.	
Argas persicus	
Haemophysalis spp.	
Otobius megnini	
Rhipicephalus spp.	
Fleas	
Ctenocephalides felis	Ostrich
Flies	
Simulium spp.	Ostrich

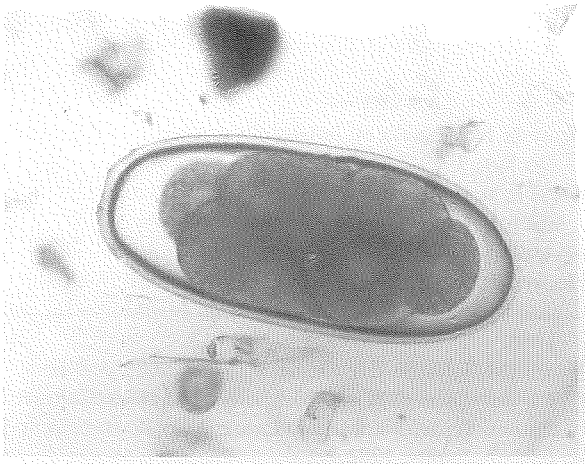


Fig. 202. *Deletrocephalus* sp. egg from a rhea (170 µm × 75 µm).

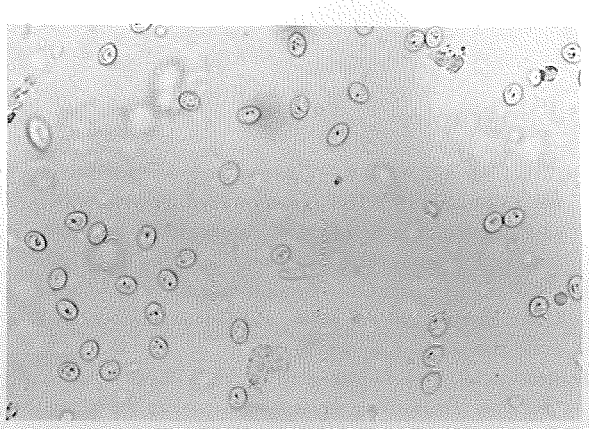


Fig. 203. *Cryptosporidium* sp. oocysts from a rhea (5 µm × 5 µm).

Fig. 204. *Ascaridia* sp. egg from a rhea (85 µm × 50 µm).

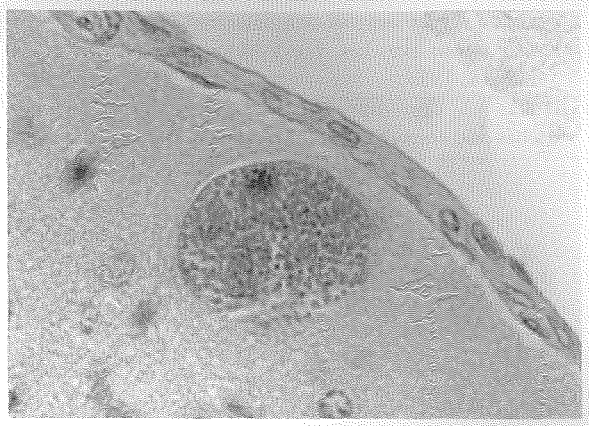


Fig. 205. Pseudocyst of *Toxoplasma gondii* from the brain of a rhea (psuedocyst is 25 µm).

Bibliography

Bartlett CM, Anderson RC: *Paronchocerca struthionus* from ostriches (*Struthio camelus*) with a redescription of Paronchocerca ciconiarum (Peters, 1936) and a review of the genus. *Can J of Zoo* 64:2480–2491, 1986.

Borst GHA, Lambers GM: Typhlohepatitis in ostriches (*Struthio camelus*) caused by *Histomonas* infection. *Tij voor Dierg* 110:536, 1985.

Bowthorpe G, Voss G: Breeding the rhea (*Rhea americana*) and emu (*Dromiceius novaehollandiae*) at Winnipeg Zoo. *Int Zoo Year* 8:147–150, 1968.

Farr MM: Further observations on survival of the protozoan parasite *Histomonas maleagridis*, and eggs of poultry nematodes in feces on infected birds. *Cornell Vet* 51:3–13, 1961.

Fockema A, et al.: Anthelmintic efficacy of fenbendazole against *Libyostrongylus douglassi* and *Houttuynia struthionis* in ostriches. *J of S African Vet Assoc* 56:47–48, 1985.

Gajadhar AA: *Cryptosporidium* species in imported ostriches and consideration of possible implications for birds in Canada. *Can Vet J* 334:115–116, 1993.

Greve JH, Harrison GJ: Conjunctivitis caused by eye flukes in captive-reared ostriches. *JAVMA* 177:909–910, 1980.

Grow A: Exotic ticks on imported ostriches. *Foreign Anim Dis Rep,* 17:5–7,1989.

Gruss B, et al.: The anthelmintic efficacy of resorantel against *Houttuynia struthionis* in ostriches. *J of S African Vet Assoc* 59:207–208, 1988.

Hoover JP, et al.: Quill mites in an ostrich with rhinitis, sinusitis, and air sacculitis. *Com Anim Pract* 2:23–26, 1988.

Jensen JM, Johnson JH, Weiner ST: *Husbandry and medical management of ostriches, emus and rheas.* College Station, Texas, Wildlife and Exotic Animal Teleconsultants, 1992.

Malan FS, et al.: Resistance of *Libyostrongylus douglassi* in ostriches to levamizole. *J of S African Vet Assoc* 59:202–203, 1988.

Mertins JW, Schlater JL: Exotic ectoparasites of ostriches recently imported into the United States. *J of Wildl Dis* 27:180–182, 1991.

Ritchie BW, Harrison GJ, Harrison LR: *Avian Medicine.* Lake Worth, Florida, Wingers Publishing, Inc., 1994.

Soulsby EJL, Monnig HO: *Helminths, arthropods and protozoa of domesticated animals.* 7th edition. London, Bailliere Tindall, 1982.

Section 11

PARASITES OF LABORATORY ANIMALS

Drugs

Table 50. Coccidiostats used in rabbits

Drug	Dosage
Monensin	0.002–0.004% in feed
Sulfaquinoxaline	0.04% in water; 125–250 ppm in feed
Sulfamethazine	8 g/gal water; 0.5–1.0% in feed
Sulfadimethoxine	75–100 mg/kg
Decoquinate	62.5 ppm in feed
Lasalocid	120 ppm in feed

Table 51. Dewormers for use in hedgehogs

Parasite	Drug	Dose/Route
Nematodes	Ivermectin	0.2 mg/kg PO; SQ once; repeat q 2 weeks
	Fenbendazole	10–25 mg/kg PO once; repeat q 2 weeks
	Mebendazole	15 mg/kg PO once; repeat q 2 weeks
Cestodes	Praziquantel	7 mg/kg PO; SQ once; repeat q 2 weeks
Flagellates	Metronidazole	25 mg/kg PO BID
Fleas	Pyrethrins/carbamates	Topically
Mites	Amitraz	0.3% topically weekly for 2–3 weeks
	Ivermectin	0.2 mg/kg PO; SQ

Common Parasites

Table 52. *Eimeria* species (protozoa) infecting rabbits

Species	Mean Size of Oocyst (μm)	Prepatent Period (days)	Pathogenicity
E. stiedae	37 × 20	15–18	Variable
E. irresidua	38 × 26	7–8	Diarrhea
E. magna	35 × 24	6–7	Diarrhea
E. media	31 × 18	6–7	Moderate
E. perforans	21 × 15	5	Nonpathogenic
E. exigua	15 × 13	Unknown	Unknown
E. intestinalis	27 × 18	10	Diarrhea
E. matsubayashii	25 × 18	7	Slight
E. neoleporis	39 × 20	12	Diarrhea
E. coecicola	29 × 18	9–10	Unknown
E. flavescens	32 × 21	9	Diarrhea

Table 53. Common parasites in laboratory animals

Parasite	Genus and Species	Comments
Rabbits		
Nematodes		
	Passalurus ambiguous (pinworm)	Pinworm (Fig. 209)
	Obeliscoides cuniculi	Found in the stomach
Tapeworms		
	Cittotaenia variabilis, *C. ctenoides*	Larval tapeworms (cysticerci) may be in the liver, free in the peritoneal cavity, and attached to the omentum
	Mosgovoyia spp.	
	Monoecocestus americana	
Trematodes		
	Hasstilesia tricolor	Nonpathogenic
	Fasciola hepatica	Rare
Mites		
	Cheyletiella spp.	Fur mite, walking dander; common (Fig. 211)
	Psoroptes cuniculi	Causes mange in the ears; common (Fig. 210)
	Listrophorus spp.	Fur mite; not common (Figs. 212, 213)
Hamsters		
Protozoa		
	Spironucleus (Hexamita) muris	A flagellated protozoan that may cause enteritis
	Giardia sp.	A common flagellated protozoan. Cysts and trophozoites found in the small intestine and feces
	Tritrichomonas spp.	Flagellated protozoan, usually nonpathogenic; 15 × 10 µm *Encephalitozoon*, *Pneumocystis*, *Entomoeba*, *Chilomastix*, etc.; uncommon
	Balantidium sp.	A ciliated protozoan, usually nonpathogenic; uncommon
	Cryptosporidium	May cause diarrhea. Oocysts detected in feces
Nematodes		
	Syphacia sp. (pinworms)	Eggs approximately 115 × 40 µm Other nematodes are rare in hamsters in North America
Cestodes		
	Hymenolepis nana (direct life cycle)	Eggs of *H. nana* are 50 × 40 µm
	H. diminuta (indirect life cycle using insects as intermediate hosts).	Eggs of *H. diminuta* are 50 × 65 µm
	Larval tapeworms	Cysticerci of *Taenia taeniaeformis* may be in the liver
Mites		
	Demodex spp.	May cause alopecia and dry, scaly skin; very common
	Notoedres sp.	May cause skin lesions
	Ornithonyssus bacoti	Blood-sucking mites from birds and rodents (Fig. 207)
	Liponyssus bacoti	Blood-sucking mites from birds and rodents
Gerbils		
Protozoa		
	Giardia sp.	May cause diarrhea. Cysts and trophozoites can be detected in feces
Nematodes		
	Dentostomella translucida (pinworms)	If in contact with mice or rats (Fig. 221)
	Syphacia spp. (pinworms)	

Table 53. Commom parasites in laboratory animals (*continued*)

Parasite	Genus and Species	Comments
Mites		
	Demodex spp.	May cause skin lesions
	Liponyssoides sp.	Blood-sucking mites from birds and rodents
Cestodes		
	Hymenolepis spp.	May cause debilitation
Mice		
Protozoa		
	Trypanosoma musculi	Flagellates in the blood
	Toxoplasma gondii	Cysts in the tissues
	Sarcocystis muris	Sarcocysts in the muscles
	Klossiella muris	*Coccidia* in the kidneys
	Encephalitozoan cuniculi	Microsporidia in the brain
	Pneumocystis carinii	Trophozoites and cysts in lungs and other tissues
	Giardia muris	Trophozoites and cysts in small intestine and feces
	Spironucleus (Hexamita) muris	Flagellated protozoa in small intestine and feces
	Tritrichomonas muris	Nonpathogenic flagellate in the gastrointestinal tract
	Eimeria falciformis	Pathogenic coccidian. Oocysts are detected in the feces
	Cryptosporidium muris; C. parvum	May cause diarrhea, especially in young animals. Oocysts are 7 × 5 µm *(C. muris)* and 5 × 3 µm *(C. parvum)*
	Entomoeba muris	Nonpathogenic organism
Nematodes		
	Syphacia obvelata (pinworm)	Adults are 1.1–3.4 mm in the large intestine High number of worms may be pathogenic Eggs are 134 × 36 µm
	Aspicularis tetraptera (pinworm)	Adults are 2.0–4.7 mm in the large intestine High number of worms may be pathogenic Eggs are 90 × 41 µm
Cestodes		
	Hymenolepis diminuta	Adults 20–60 mm long × 4 mm wide. This tapeworm has no hooks on the scolex; requires an intermediate insect host
	Hymenolepis nana	Adults 25–40 mm long × 1 mm wide. It has hooks on the scolex (armed rostellum); does not require an intermediate host
	Hymenolepis microstoma	Found in the bile duct
	Taenia taeniaeformis	Intermediate cysticercus stage in the liver of mice
Fleas		
	Xenopsylla cheopis (oriental rat flea) *Nosopsyllus fasciatus* (northern rat flea) *Leptosylla segnis* (mouse flea)	Transmits plague
Lice		
	Polyplax serrata (mouse louse)	Sucking louse (Fig. 214)
	Hoplopleura spp.	Sucking louse
Mites		
	Ornithonyssus bacoti (tropical rat mite) *Ornithonyssus sylviarum* (northern fowl mite)	Any of these mites can be found on mice. Mites often cause skin conditions and irritation (Fig. 207)

Table 53. Common parasites in laboratory animals (*continued*)

Parasite	Genus and Species	Comments
	Liponyssoides sanguineous (house mouse mite)	
	Haemogamasus pontiger	
	Eulaelaps stabularis	
	Laelaps echidnus (spiny rat mite)	
	Haemolaelaps spp.	
	Myobia musculi (fur mite)	
	Radfordia affinis (fur mite)	
	Psorergates simplex (hair follicle mite) (Fig. 216)	
	Notoedres musculi	
	Demodex musculi	
	Myocoptes musculinus (Fig. 215)	
Rats		
Protozoa		
	Trypanosoma lewisi	In blood (nonpathogenic)
	Toxoplasma gondii	Cysts in various tissues
	Sarcocystis muris	Cysts in muscles
	Encephalitozoan (Nosema) cuniculi	Microsporidian, often nonpathogenic
	Pneumocystis carinii	Trophozoites, cysts, precysts, and intracystic bodies in lungs
	Giardia muris	Cysts and trophozoites in feces. Low pathogenicity
	Spironucleus (Hexamita) muris	Flagellated protozoan (8 × 3 µm) causes duodenitis. There are many nonpathogenic flagellates in rats
	Eimeria nieschultzi	Oocysts are 22 × 17 µm. It causes diarrhea, weakness, emaciation, and death in young rats
	Entomoeba muris	Found in the cecum and colon (nonpathogenic)
Nematodes		
	Syphacia muris (pinworm)	In the cecum and colon. Causes reduced growth. Males are 1–1.5 mm long; females are 3–6 mm long. Eggs are 140 × 45 µm
	Aspicularis tetraptera (pinworm)	Bigger worms than *Syphacia muris*. Males are 2–4 mm; females are 3–4 mm. Eggs are 80 × 40 µm
	Heterakis spumosa	Found in the cecum and colon of wild rats. Has a typical ascarid-like egg (60 × 50 µm). Nonpathogenic
Cestodes		
	Hymenolepis nana	Found in the small intestine. Called the dwarf tapeworm because it is usually 20–40 mm long, by 1 mm wide. Hooks are present on the rostellum. Life cycle is direct or indirect (using insects as intermediate hosts) Can infect humans
	Hymenolepis diminuta	Found in the small intestine. Called the rat tapeworm. It is much larger than *H. nana* (20–60 mm long × 4 mm wide). There are no hooks on the rostellum
Lice		
	Polyplax spinulosa	The spined rat louse is common in laboratory and wild rats. Sucks blood and causes irritation, anemia, and debilitation

Table 53. Commom parasites in laboratory animals (*continued*)

Parasite	Genus and Species	Comments
Mites		
	Radfordia ensifera (also *Myobia ratti*)	Fur mite of rats. Commonly occurs on wild rats. May cause irritation and ill health
	Notoedres muris	Ear mange mite resembles *Sarcoptes scabiei,* and are burrowing mites that cause mange. Scabby lesions are primarily on the head, face, nose, ears, and tail
	Laelaps echidninus	The spiny rat mite uncommon on laboratory rats. Lives in bedding and feeds on rats at night. Long, red mites, approximately 1 mm long, with long legs. Usually nonpathogenic, but can transmit *Hepatozoon muris*
Guinea Pigs		
Protozoa		
	Cryptosporidium wrairi	May cause diarrhea and death
	Giardia caviae	Flagellated protozoans. Trophozoites 12 × 5 µm. Trophozoites and cysts can be found in feces. Nonpathologic
	Eimeria caviae	Oocysts are 19 × 16 µm. These coccidia may cause diarrhea and weight loss. Sulfas may be helpful in controlling this infection
	Toxoplasma gondii	Cysts in various tissues
	Sarcocystis caviae	Cysts in various muscles
		Numerous nonpathogenic flagellated protozoa found in the gastrointestinal tract
Nematodes		
	Praspidodera uncinata	Found occasionally in the cecum. Unlikely to cause disease. Guinea pigs also experimental hosts for *Trichinella spiralis, Dictyocaulus viviparus, D. filaria, Metastrongylus apri, Parelaphostrongylus tenuis,* and ascarids
Lice		
	Gliricola lindolphi, G. procelli	Fairly common, but not very pathogenic (Fig. 218)
	Gyropus ovalis	
	Trimenopon hispidium	
Fleas		
	Nosophyllus fasciatus	Uncommon unless there is a flea problem in the household
	Pulex irritans	
	Ctenocephalides felis	
	Rhopalopsylla clavicola	
Mites		
	Demodex caviae	
	Chirodiscoides caviae (Fig. 225)	
	Myocoptes musculinus	
	Notoedres muris	
	Trixacarus caviae (Fig. 219)	
Hedgehogs		
Nematodes		
	Capillaria aerophila	Found in the lungs

Table 53. Commom parasites in laboratory animals (*continued*)

Parasite	Genus and Species	Comments
	Crenosoma sp.	Found in the lungs
	Capillaria hepatica	Found in the liver (necrotic areas filled with eggs)
Fleas		
	Archaeopsylla erinacei	
Mites		
	Caparini sp.	
	Chorioptes sp.	
	Otodectes cynotis	
	Ornithonyssus sp.	May cause severe skin irritation; may bite humans in the household
Ticks		
	Ixodes hexagonus	
	Amblyomma nuttalli	

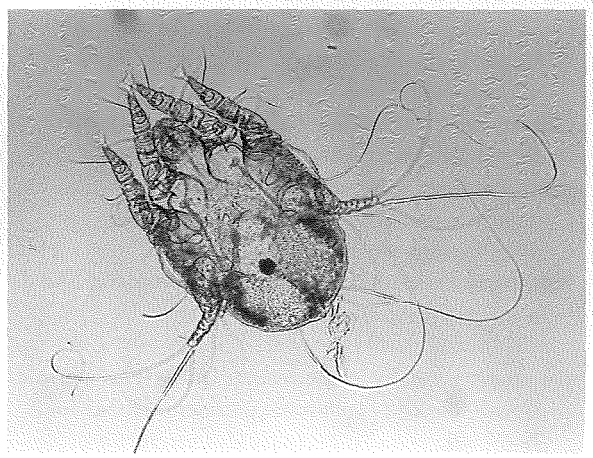


Fig. 206 *Otodectes cynotis* causes body mange in hedgehogs.

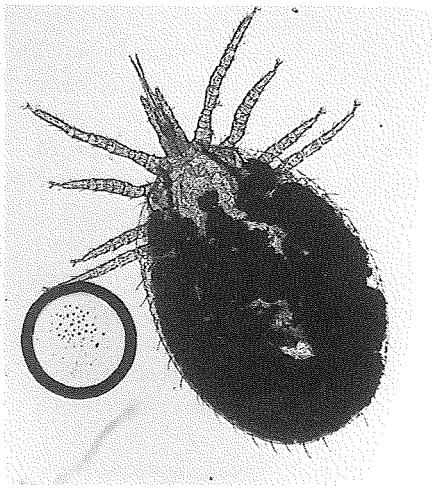


Fig. 207 *Ornithonyssus* sp. (mite) on a hedgehog. These mites suck blood and cause irritation.

Fig. 208 Hepatic coccidiosis (*Eimeria steidae*) in rabbits.

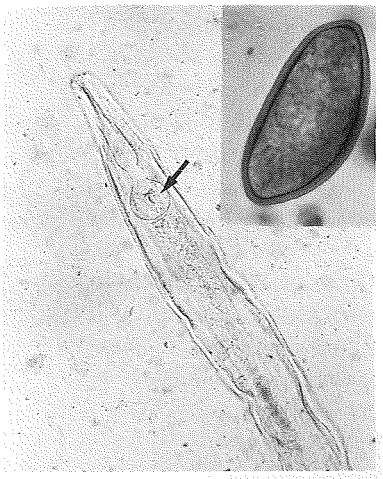


Fig. 209 *Passalurus ambiguous* (pinworm) in rabbits. Adult with bulbous esophagus (arrow). Inset is egg 100 µm × 43 µm.

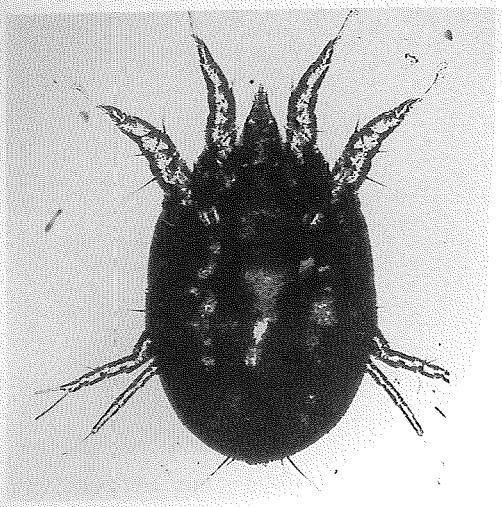


Fig. 210 *Psoroptes* spp. (ear mites) in rabbits.

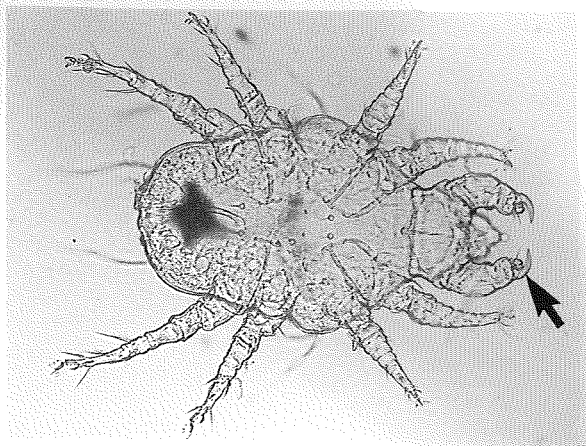


Fig. 211 *Cheyletiella* spp. (fur mite) in rabbits. Note the prominent palpal hooks (arrow).

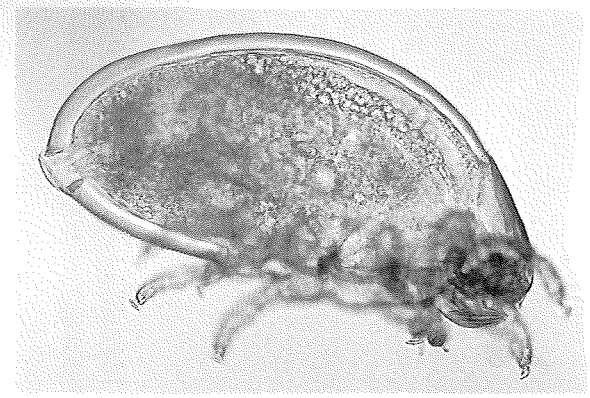


Fig. 212 *Listrophorus* sp., a fur mite of rabbits (lateral view).

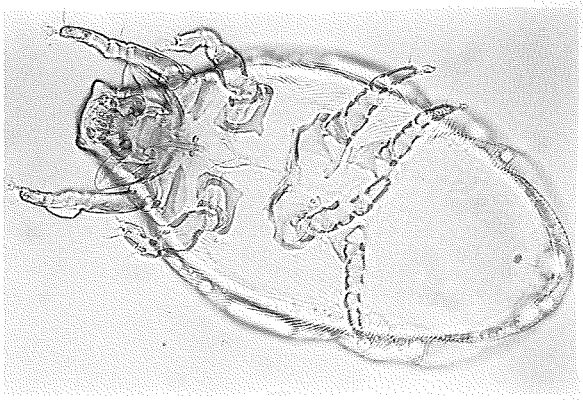


Fig. 213 *Listrophorus* sp. (ventral view).

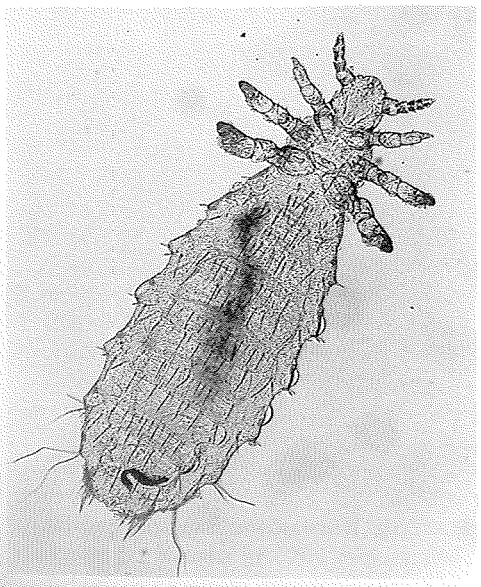


Fig. 214 *Polyplax serrata*, the mouse louse.

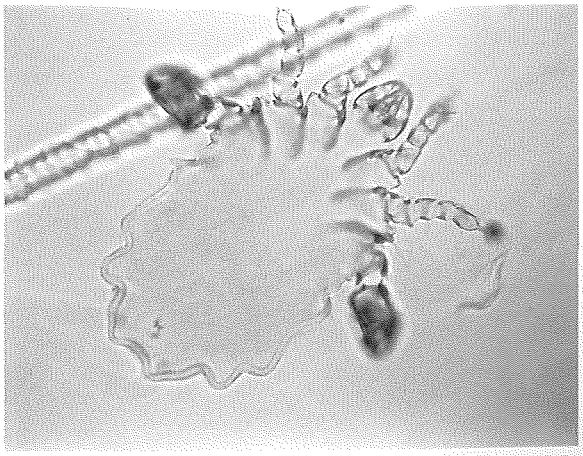


Fig. 215 *Myocoptes musculinus* (mite) is common on mice.

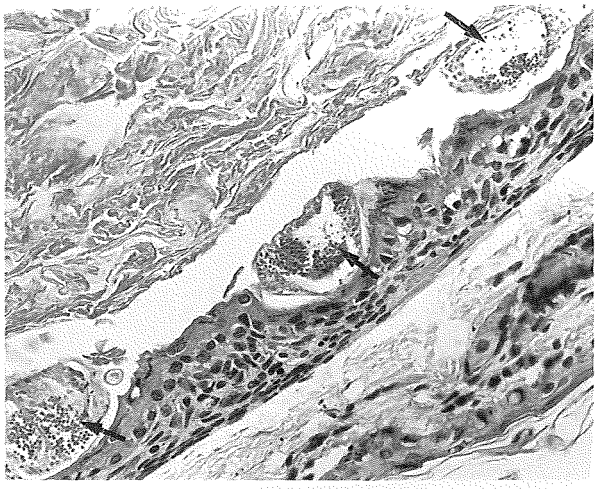


Fig. 216 *Psorergates simplex* hair follicle mite in section of skin of mouse (arrows).

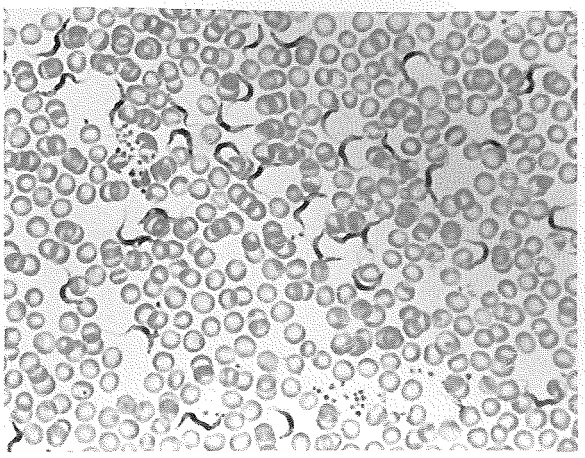


Fig. 217 *Trypanosoma* sp. in blood of mice and rats.

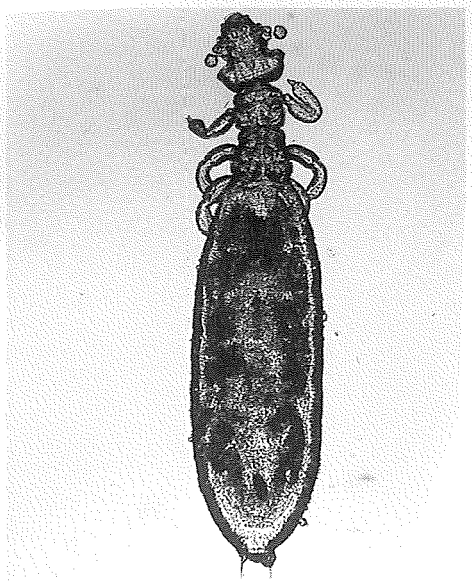


Fig. 218 *Gliricola*, the common biting louse of guinea pigs.

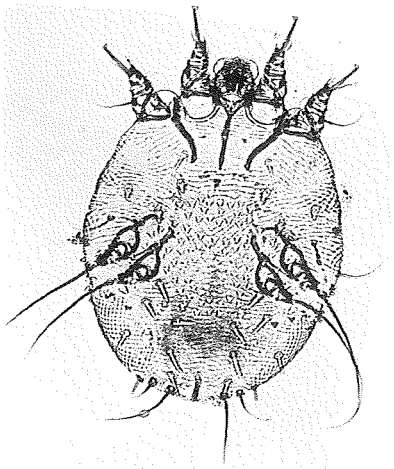


Fig. 219 *Trixacarus caviae* from guinea pig.

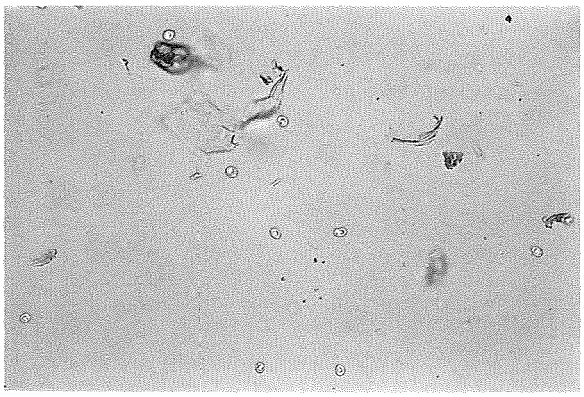


Fig. 220 *Cryptosporidium* sp. (hamster).

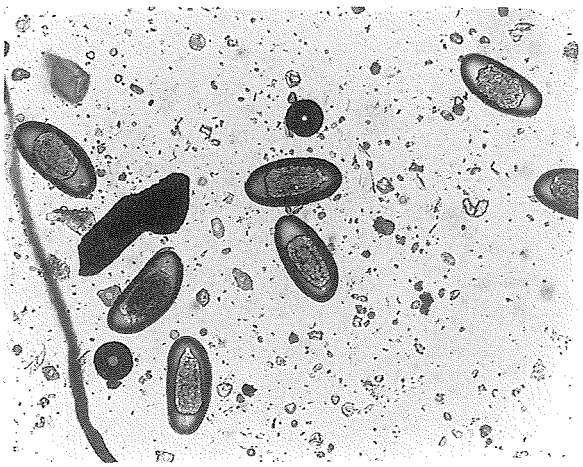


Fig. 221 Pinworm eggs (*Dentostomella* spp.) in a gerbil.

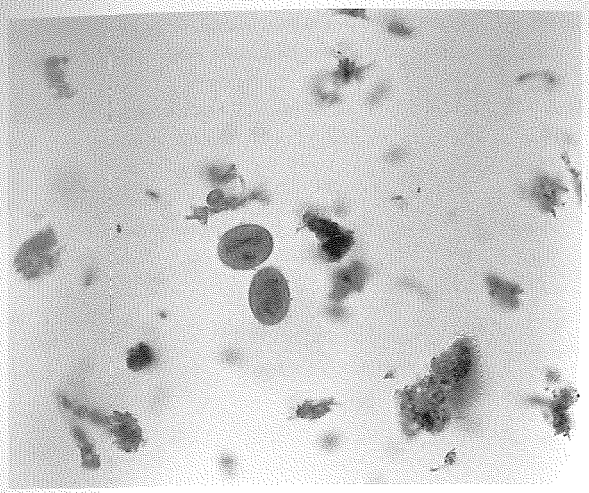


Fig. 222 *Giardia* cysts in a mouse.

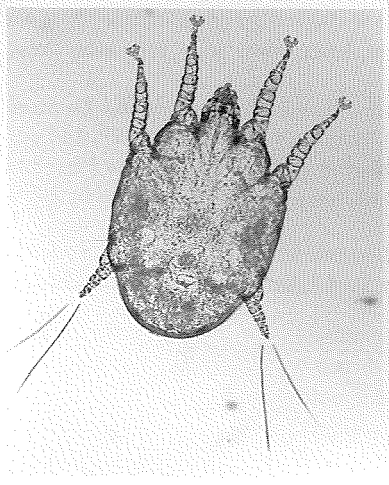


Fig. 223 *Otodectes cynotis* in the ears of a ferret.

Fig. 224 *Chirodiscoides caviae* (a mite), found on guinea pigs.

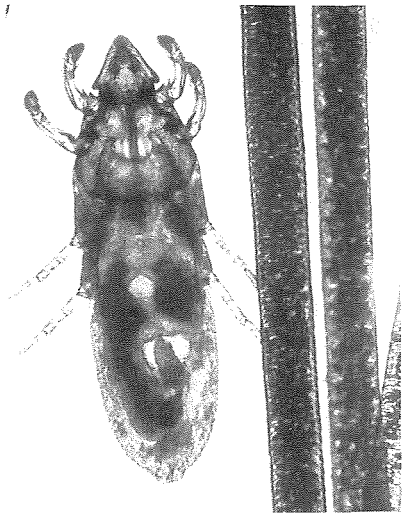


Fig. 225 *Chirodiscoides caviae* (enlarged view).

Bibliography

Brockie RE: The hedgehog mange mite, *Caparinia tripilis* in New Zealand. *N Z Vet* J 22:243–247, 1974.

Duwel D, Brech K: Control of oxyuriasis in rabbits by fenbendazole. *Lab Anim* 15:101–105, 1981.

Fitzgerald PR: Efficacy of monensin or amprolium in the prevention of hepatic coccidiosis in rabbits. *J Protozool* 19:332–334, 1972.

Flecknell P (ed): *Manual of Rabbit Medicine and Surgery.* Ames, Iowa, Iowa State University Press,160 pp., 2000.

Flynn RJ: *Parasites of Laboratory Animals.* Ames, Iowa, Iowa State University Press, 1973.

Graczyk TK, Cranfield MR, Dunning C, et al.: Fatal cryptosporidiosis in a juvenile captive African hedgehog (*Atelerix albiventris*). *J Parasitol* 84:178–180, 1998.

Harkness JE, Wagner JE: *The Biology and Medicine of Rabbits and Rodents.* 4th edition. Baltimore, Williams & Wilkins, 1995.

Hsu CK: Parasitic Diseases. In HL Foster et al. (eds): *The Mouse in Biomedical Research. II. Diseases.* New York, Academic Press, 1982, pp. 359–372.

Kummel BA, Estes SA, Arlan LG: *Trixacarus caviae* infestation of guinea pigs. *J Am Vet Med Assoc* 177:903–908, 1980.

Letcher JD: Amitraz as a treatment for acariasis in African hedgehogs (*Atelerix albiventris*). *J Zoo Anim Med* 19:24–29, 1988.

Lloyd M (ed.): *Ferrets: Health, Husbandry and Diseases.* Ames, Iowa, Iowa State University Press, 1999, 208 pp.

Malley D: Use of a frontline spray in rabbits. *Vet Rec* 140:664, 1997.

Oge H, Avaz E, Ide T, Dalgic S: The effect of doramectin, moxidectin and netobimin against natural infections *Syphacia muris* in rats. *Vet Parasitol* 88:299–303, 2000.

Okerman L: *Diseases of Domestic Rabbits.* 2nd edition. Ames, Iowa, Iowa State University Press, 1994, 160 pp.

Percy DH, Barthold SW: *Pathology of Laboratory Rodents and Rabbits*. Ames, Iowa, Iowa State University Press, 1993.

Richardson V: Rabbits: *Health, Husbandry and Diseases*. Ames, Iowa, Iowa State University Press, 1999, 184 pp.

Richardson VCG: *Diseases of Domestic Guinea Pigs*. 2nd edition. Ames, Iowa, Iowa State University Press, 2000, 152 pp.

Richardson VCG: *Diseases of Small Domestic Rodents*. Ames, Iowa, Iowa State University Press, 1997, 240 pp.

Smith AJ: Husbandry and medicine of African hedgehogs (*Atelerix albiventris*). *J Small Exotic Anim Med* 2:21–28, 1992.

Staley EC, Staley EE, Behr MJ: Use of permethrin as a miticide in the African hedgehog (*Atelerix albiventris*). *Vet Hum Toxicol* 36:138, 1994.

Zenner L: Effective eradication of pinworms (*Syphacia muris*, *Syphacia obvelata* and *Aspiculuris tetraptera*) from a rodent breeding colony by oral anthelmintic therapy. *Lab Anim* 32:337–342, 1998.

Section 12

PARASITES OF WILDLIFE

Important Parasites of Wildlife

Table 54. Important parasites of selected wildlife species

Host	Genus and Species	Location	Common Name
Bears	*Baylisascaris transfuga*	Intestine	Ascarid
	Sarcoptes sp.	Skin	Mange mite
	Trichinella spiralis	Muscles	Trichina worm
	Ursicoptes americanus	Skin	Mange mite
Beaver	*Giardia* sp.	Intestine	Beaver fever
	Platypsyllus and *Prolabidocarpus*	Skin	Beaver beetles
	Schizocarpus mingandi	Skin	Mites
	Stichorchis sp.	Cecum	Cecal fluke
Bighorn sheep	*Otobius megnini*	In ear canal	Spinous ear tick
	Protostrongylus spp.	Lung	Lungworms
	Psoroptes ovis	Skin	Scabies
	Skrjabinema ovis	Large intestine	Pinworm
Bison	*Dictyocaulus viviparus*	Lungs	Lungworm
	Fasciola hepatica	Liver	Liver fluke
	Fascioloides magna	Liver	Deer liver fluke
	Haemonchus contortus	Abomasum	Large stomach worm
	Oesophagostomum radiatum	Large intestine	Nodular worm
	Ostertagia ostertagi	Abomasum	Brown stomach worm
Caribou/ Reindeer	*Besnoitia* sp.	Skin	Protozoan cyst
	Cephenemyia trompe	Nasal sinus	Bot fly larva
	Cysticercus of *Taenia krabbei*	Muscle	Measles
	Dictyocaulus hadweni	Lungs	Lungworm
	Oedemagena tarandi	Under skin	Bots/warbles
	Parelaphostrongylus tenuis	Spinal cord	Meningeal worm
Coyote/Fox	*Dracunculus insignis*	Under the skin	Subcutaneous worm
	Echinococcus multilocularis	Intestine	Alveolar hydatid tapeworm
	Filaroides (*Oslerus*) *osleri*	Trachea	Tracheal worm
	Otodectes cynotis	Ears	Ear mite
	Physaloptera spp.	Stomach	Stomach worm
	Sarcoptes scabiei	Skin	Mange mite
Ducks	*Amidostomum* spp.	Gizzard lining	Gizzard worms
	Leucocytozoon simondi	Blood	Leucocytozoonosis
	Sarcocystis rileyi	Muscles	Rice belly
	Several tapeworms, trematodes, acanthocephala (see McDonald, 1969a, 1969b, 1981 in bird Bibliography.)	Intestine	Several

Table 54. Important parasites of selected wildlife species (*continued*)

Host	Genus and Species	Location	Common Name
Elk	*Dictyocaulus* spp.	Lungs	Lungworm
	Elaeophora schneideri	Arteries	Bloodworm
	Fascioloides magna	Liver	Deer liver fluke
	Parelaphostrongylus tenuis	Spinal cord/brain	Meningeal worm
	Psoroptes sp.	Skin	Mange mite
Fish	*Anasakis* spp. (larvae)	Muscle	Cod worm
	Diphyllobothrium latum	Pleurocercoid in muscle	Broadfish tapeworm
	Diplostomum spp. (metacercaria)	Eye	Eye fluke
	Nanophyetus salmincola (metacercaria)	Kidney, eye, heart, etc.	Salmon poisoning fluke
	Phocanema spp. (larvae)	Flesh	Cod worm
Mink	*Alaria* spp.	Intestine	Fluke
	Euparyphium spp.	Intestine	Fluke
	Nanophyetus salmincola	Intestine	Fluke
	Paragonimus kellicotti	Lungs	Lung fluke
	Dioctophyma renale	Kidney	Kidney worm
	Filaroides martis	Lungs	Lungworm
	Physaloptera spp.	Stomach	Stomach worm
	Skrjabingylus nasicola	Nasal sinus	Nasal worm
Moose	*Dermacentor albipictus*	Skin	Moose or winter tick
	Fascioloides magna	Liver	Liver fluke
	Parelaphostrongylus tenuis	Spinal cord	Meningeal worm
	Taenia krabbei (cysticercus)	Muscle	Measles
Mountain goat	*Parelaphostrongylus odocoilei*	Muscle	Muscle worm
	Protostrongylus spp.	Lungs	Lungworm
	Skrjabinema ovis	Intestine	Pinworm
Mule deer	*Cephenemyia* spp.	Retropharyngeal pouches	Throat bots
	Elaeophora schneideri	Arteries	Arterial worm
	Fascioloides magna	Liver	Large liver fluke
	Lipoptena spp.	Skin	Keds
	Onchocerca cervipedis	Under skin	Skin worm
	Parelaphostrongylus odocoilei	Muscle	Muscle worm
	Cysticercus of *Taenia krabbei*	Muscle	Measels
Muskrat	*Capillaria hepatica*	Liver	None (eggs in liver)
	Cysticercus of *Taenia taeniaformis*	Liver	Liver cysts
	Giardia sp.	Intestine	Beaver fever
	Mites (numerous kinds)	Hair	Mites
	Trematodes (numerous kinds)	Intestine	Flukes
	Trichuris opaca	Intestine	Whipworm
Opossum	*Brachylaima virginianum*	Intestine	Fluke
	Capillaria spp.	Lungs, intestine	Capillary worm
	Cruzia americana	Intestine	Pinworm
	Physaloptera turgida	Stomach	Stomach worm
	Trypanosoma cruzi	Blood	Blood flagellate

Table 54. Important parasites of selected wildlife species (*continued*)

Host	Genus and Species	Location	Common Name
Porcupine	*Dipetalonema* sp.	Under skin	Skin worm
	Monoecocestus sp.	Small intestine	Tapeworm
	Sarcoptes sp.	Skin	Mange mite
	Trichodectes setosus	Hair	Louse
	Wellcomia evaginata	Large intestine	Pinworm
Rabbits	*Cittotaenia* spp.	Intestine	Tapeworm
	Cysticercus of *Taenia pisiformis*	Peritoneal cavity	Larval tapeworm
	Dirofilaria scapiceps	Under skin	Skin worm
	Graphidium strigosum	Stomach	Stomach worm
	Obeliscoides cuniculi	Stomach	Stomach worm
	Passalurus ambiguous	Large intestine	Pinworm
	Protostrongylus spp.	Lungs	Lungworm
Raccoon	*Baylisascaris procyonis*	Small intestine	Ascarid
	Crenosoma goblei	Lungs	Lungworm
	Gnathostoma procyonis	Stomach	Stomach worm
	Dracunculus insignis	Under the skin	Subcutaneous worm
	Physaloptera spp.	Stomach	Stomach worm
Reptiles	Ascarids (many kinds)	Intestines	Ascarid
	Kalicephalus spp.	Intestines	Hookworm
	Ophionyssus sp.	Skin	Mite
	Pinworms are very common	Intestines	Pinworms
	Strongyloides sp.	Intestine	Threadworm
Rodents	*Capillaria hepatica*	Liver (eggs)	None
Striped skunk	*Baylisascaris columnaris*	Small intestine	Ascarid
	Capillaria hepatica	Liver (eggs)	None
	Physaloptera spp.	Stomach	Stomach worm
	Skrabingylus spp.	Nasal sinus	Sinus worm
White-tailed deer	*Cephenemyia* spp.	Throat	Throat bot
	Fascioloides magna	Liver	Large liver fluke
	Haemonchus contortus	Abomasum	Barber-pole worm
	Linognathus spp. and *Solenopotes* spp.	Skin	Sucking lice
	Lipoptena spp.	Skin	Keds (wingless flies)
	Tricholipleurus spp.	Skin	Biting lice
	Parelaphostrongylus andersoni	Muscle	Muscle worm
	Parelaphostrongylus tenuis	Meninges	Meningeal worm
Wild cats	*Cylicospirura* spp.	Stomach	Stomach nodular worm
	Physaloptera spp.	Stomach	Stomach worm
	Toxoplasma gondii	Intestine/feces	Toxo

Note: Many of the parasites of wild animals are the same as or similar to parasites in related domesticated animals.

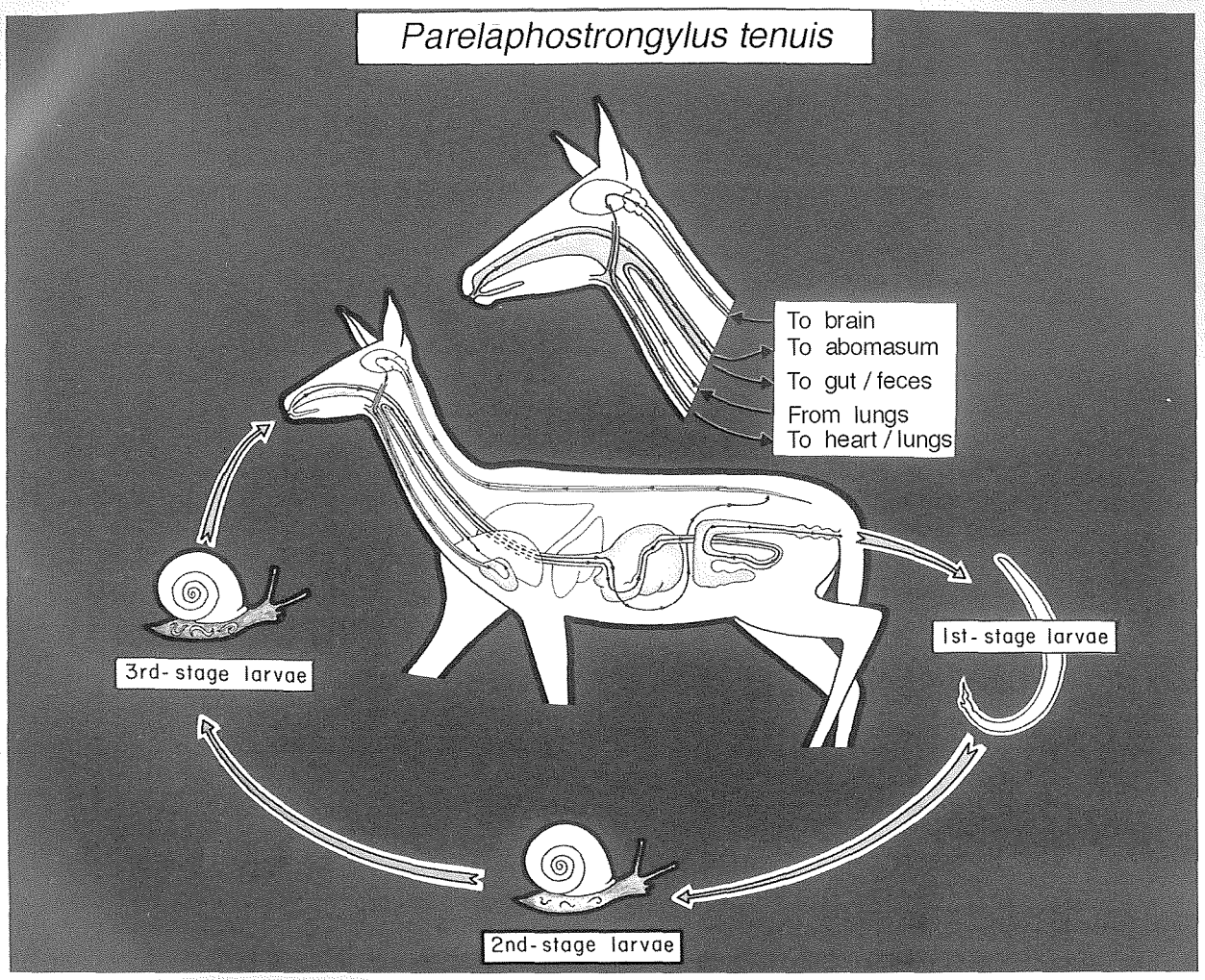


Fig. 226a. *Parelaphostrongylus tenuis.*

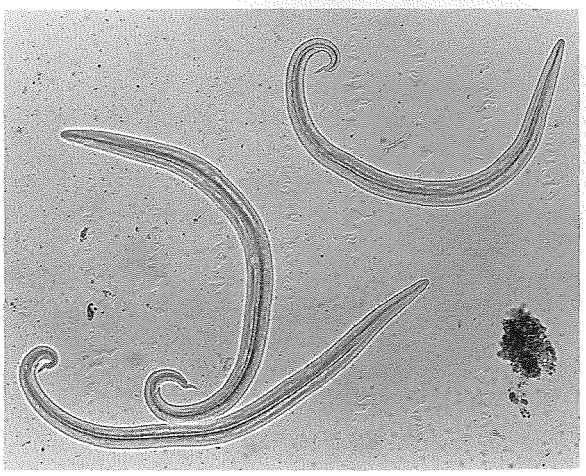


Fig. 226b. *Parelaphostrongylus tenuis* (first-stage larvae in feces).

Parelaphostrongylus tenuis

Common name: Meningeal worm or brain worm (Metastrongyloidea-Protostrongylidae).
Adult size: 10–15 cm. Prepatent period is 90 ± 9 days.
Size of larvae: 300–400 µm, first-stage larvae in feces, with dorsal spine on kinky tail.
Importance: This is one of the most important parasites of wildlife. Adult *P. tenuis* live associated with the meninges on the surface of the brain of white-tailed deer. The parasite is essentially nonpathogenic to white-tailed deer. However, when infective larvae in snails are eaten by hosts such as moose, caribou, elk, mule deer, exotic species of deer, llamas, and domestic sheep and goats, the infection is often lethal because larvae damage the spinal cord and brain and cause severe inflammatory reactions to the CNS, resulting in incoordination, paralysis, and death. Presence of infected white-tailed deer in an ecosystem may severely limit the survival of other susceptible hosts (see bibliography).
Diagnosis: At necropsy the adult worms are found on the brain of white-tailed deer or larvae in the the spinal cord or brain tissue of susceptible hosts. Dorsal-spined larvae can be found in the feces of definitive hosts using the Baermann funnel.
Note: There are closely related nematodes that also pass dorsal-spined larvae in the feces of wild ruminants (see Table 55). There are still several unknown species of these worms, and there is considerable variation in the lengths of the first-stage larvae. The definitive diagnosis is to find and identify the adult parasites in the host. Some of the adults are in the muscles (*P. odocoilei*, *P. andersoni*, *Elaphostrongylus cervi*), the lungs (*Varestrongylus alpenae*, *Muellerius capillaris*), or on the meninges of the brain (*Parelaphostrongylus tenuis*).
Treatment: Ivermectin, 0.2 mg/kg SC has been reported to be effective against early developing larval stages of *P. tenuis*, but is not effective against adult parasites. Prevention: Treatment every three weeks is recommended to prevent infection.

Table 55. Lengths of first-stage dorsal-spined larvae*

Elaphostrongylus cervi	375–490 µm	Mean = 425 µm
Muellerius capillari	240–340 µm	Mean = 280 µm
Parelaphostrongylus andersoni	310–420 µm	Mean = 350 µm
Parelaphostrongylus odocoilei	340–385 µm	Mean = 355 µm
Parelaphostrongylus tenuis	310–380 µm	Mean = 350 µm
Varestrongylus alpenae	260–320 µm	Mean = 300 µm

Note: See Gray et al., 1985, *Can J Zool* 63:1449–1454; Pybus and Shave, 1984, *J Wildl Dis* 20:284–288.
*May not be accurate for diagnosis.

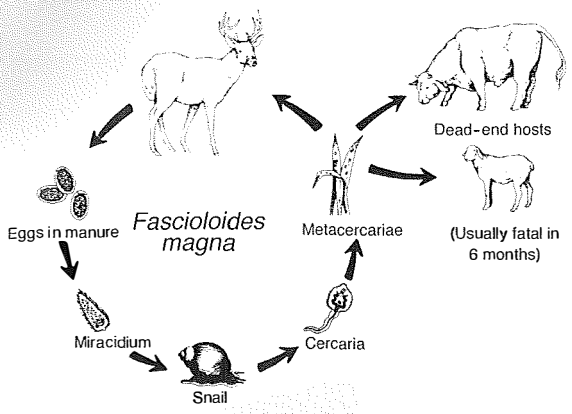


Fig. 227a. Life cycle of *Fascioloides magna*.

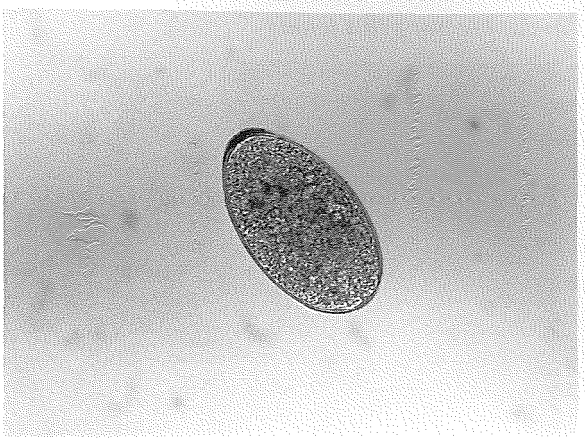


Fig. 227b. *Fascioloides magna* egg.

Fascioloides magna

Common name: Deer liver fluke or large American liver fluke (Fasciolidae).
Adult size: 4–6 cm in the liver parenchyma.
Size of egg: 150 μm × 70 μm , operculated, yellow. Prepatent period is 7 months.
Importance: This fluke is nonpathogenic in deer and elk. It is a fatal infection in domestic sheep and goats. Infected cattle, bison, and llamas do not pass eggs (dead-end hosts). Reduced productivity is associated with infection in cattle.
Diagnosis: In deer and elk, use sedimentation test. In cattle and sheep, use serological tests.
Treatment in deer: Clorsulon, 7–21 mg/kg PO; less than 80% effective
Albendazole, 15 mg/kg PO; 90% effective
Triclabendazole, 20 mg/kg PO; more than 95% effective

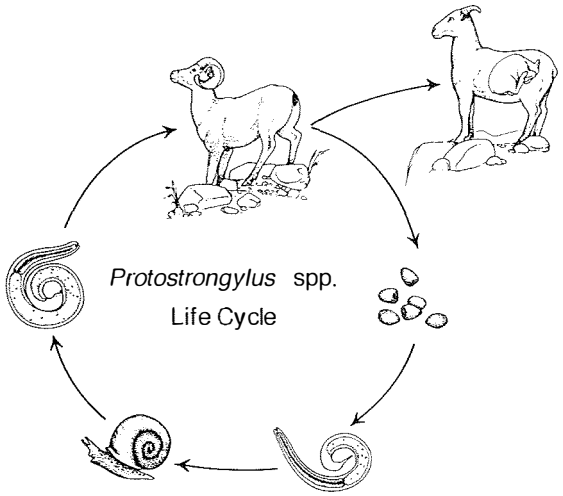


Fig. 228a. *Protostrongylus* spp.

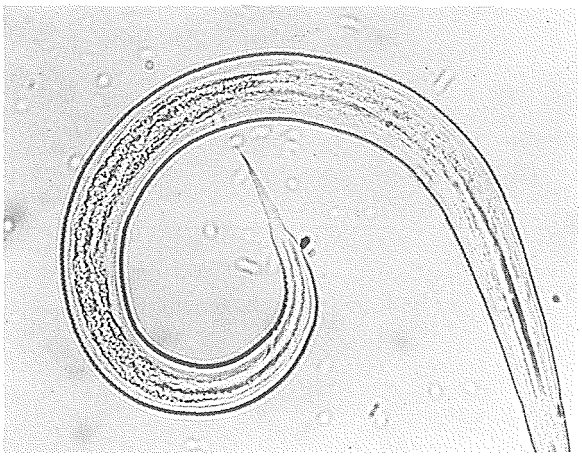


Fig. 228b. *Protostrongylus* sp. larva.

Protostrongylus spp.

Common name: Bighorn sheep lungworm (Metastrongyloidea-Protostrongylidae).
Adult size: 10–20 mm.
Size of larva: 340–400 μm × 20 μm, with straight, pointed tail. Prepatent period is 5 weeks.
Importance: The most important parasite of bighorn sheep. Transmitted transplacentally and may predispose to bacterial pneumonia, especially in lambs. *P. rushi* is in the major air passages. *P. stilesi* is in the alveolar areas.
Diagnosis: Use Baermann funnel and look for first-stage larvae.
Treatment: Fenbendazole, 10 mg/kg PO q 24 h × 3 d
Ivermectin, 0.2 mg/kg SC
Albendazole, 15 mg/kg PO

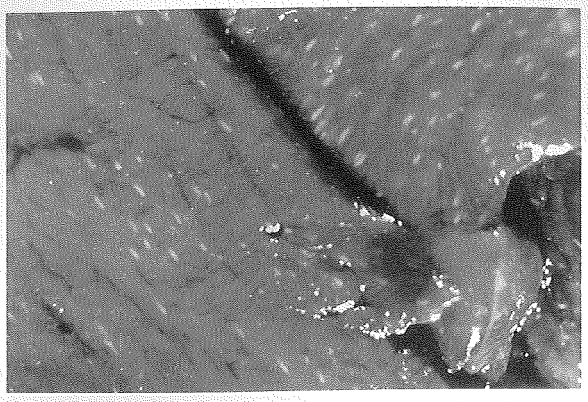


Fig. 229a. *Sarcocystis* sp. cysts in elk heart. The white cysts can be seen without magnification.

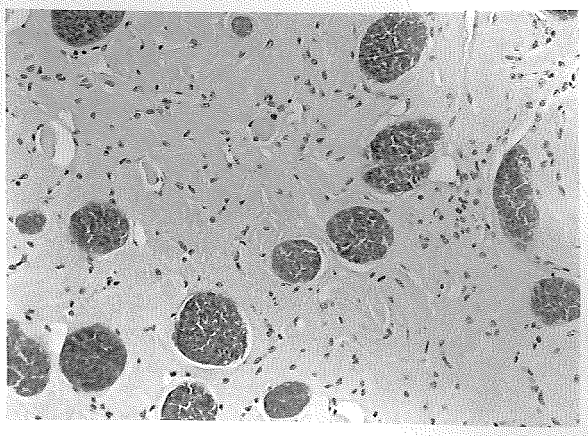


Fig. 229b. Histologic section of *Sarcocystis* sp. in muscle.

Sarcocystis sp.

Common name: Nerve or muscle cysts (Protozoa-Apicomplexa).
Size: Usually microscopic, but some species, especially in ducks, elk, and rabbits, 1 mm or more.
Importance: Usually nonpathogenic, but large numbers may kill the host. Carnivores are the definitive hosts that pass the infective oocysts. These do not infect humans.
Diagnosis: Visual observation; usually by histology.
Treatment: None known; some ionophores such as monensin may ameliorate signs.

Fig. 230a. *Psoroptes* sp. (in bighorn sheep).

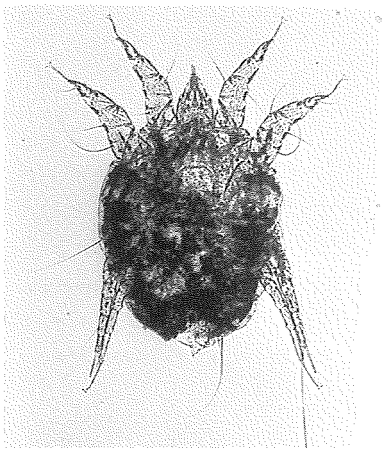


Fig. 230b. *Psoroptes* sp. (long, jointed pedicels).

Psoroptes ovis

Common name: Psoroptic mange mite (Acarina-Psoroptidae).
Adult size: Males, 500 μm; females, 750 μm.
Importance: This mite can cause serious losses in bighorn sheep populations. By 2001, psoroptic mange in bighorns has been reported in many states (Arizona, New Mexico, Wyoming, Montana, Washington, Idaho, Oregon, California) and appears to be spreading. Affected sheep lose their hair and develop crusty lesions in the ears and often over the entire body. Death occurs in severely affected animals. This condition apparently does not spread to cattle or sheep, but mites can grow in ears of rabbits and deer.
Diagnosis: Visual observation of lesions and a skin scraping of the edge of a lesion to isolate mites. *Psoroptes* sp. mites have long, jointed pedicels, which confirm the diagnosis.
Treatment: Ivermectin, 1.0–2.0 mg/kg body weight PO or SC × 7 d. A single injection of ivermectin at a high level may not kill all the mites. Repeated treatments may be necessary.
Ivermectin, topically on lesions

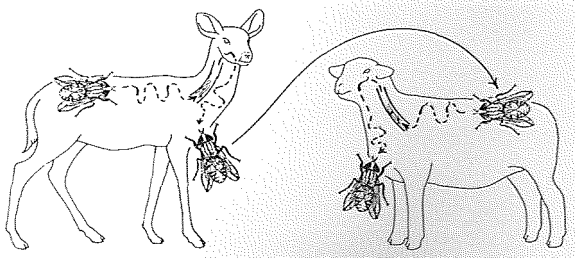


Fig. 231. *Elaeophora schneideri.* Prepatent period is 4–5 months.

Elaeophora schneideri

Common name: Arterial worm (Filarioidea).
Adult size: 5–12 cm, found in arterial system anterior to the heart.
Importance: Found in mule deer; normally not pathogenic. Transmitted by horseflies. In elk, blindness and necrosis of skin on head may result. In sheep, filarial dermatitis, "sorehead," may occur in older sheep. In moose, blindness may occur.
Diagnosis: Take a punch of ear skin, placed in saline; look for live microfilariae.
Treatment: None.

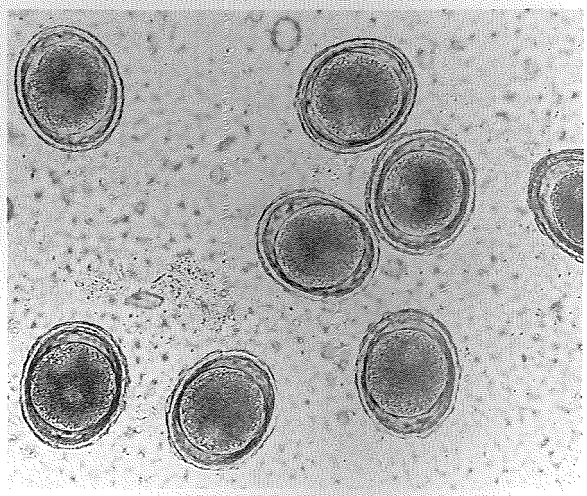


Fig. 232. *Baylisascaris procyonis* (in raccoons). Prepatent period is 5 weeks.

Baylisascaris procyonis

Common name: Raccoon ascarid (Ascaridoidea).
Adult size: 12–23 cm, in small intestine.
Size of egg: 80 μm × 70 μm.
Importance: This ascarid causes visceral larva migrans in humans and CNS disorders in a variety of birds and animals. Humans should use hygienic measures when working with raccoons and raccoon feces. Eggs are not infective when passed in feces and require approximately 30 days or more to become infective.
Diagnosis: Fecal flotation. (Similar to *Toxocara canis* in dogs).
Treatment: Fenbendazole, 20 mg/kg PO q 24 h × 5 d
Mebendazole, 22 mg/kg PO q 24 h × 5 d
Piperazine, 200 mg/kg PO
Pyrantel, 10 mg/kg PO

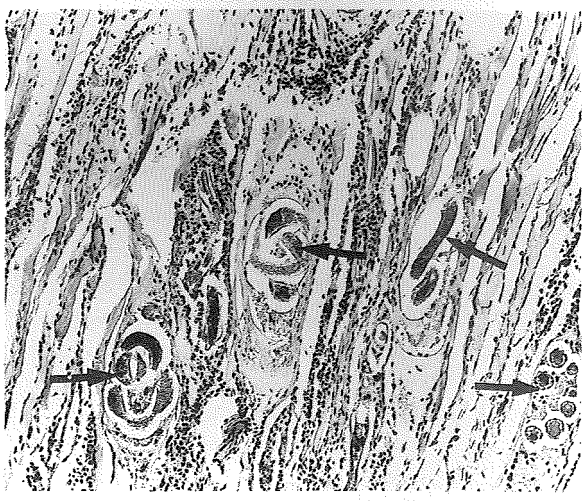


Fig. 233. *Trichinella spiralis* larvae (arrows) in muscle (bear).

Trichinella spiralis

Common name: Trichina worm (Trichuroidea).
Larval cyst size: Up to 3 mm.
Importance: Transmissible to humans via ingestion of meat. Found in many carnivores and other vertebrates (see Fig. 163).
Diagnosis: Larvae are encysted in muscle. For tissue squash, diaphragm is often used, or digest muscle in 1% acid pepsin and look for larvae under a dissecting microscope. Histology is used for diagnosis.
Treatment: None in wildlife.

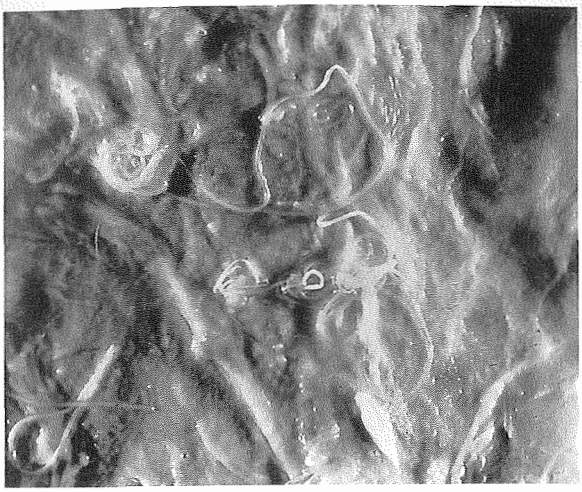


Fig. 234. *Onchocerca cervipedis* (in deer).

Onchocerca cervipedis

Common name: Skin worm (Filarioidea).
Adult size: Up to 20 cm, usually coiled on the surface of the muscles or on the subcutaneous side of the skin.
Importance: Not pathogenic, but seen by hunters. Causes psychosomatic disease in humans.
Diagnosis: Can be seen in subcutaneous fascia (under the skin), especially on front legs of mule deer.
Treatment: None

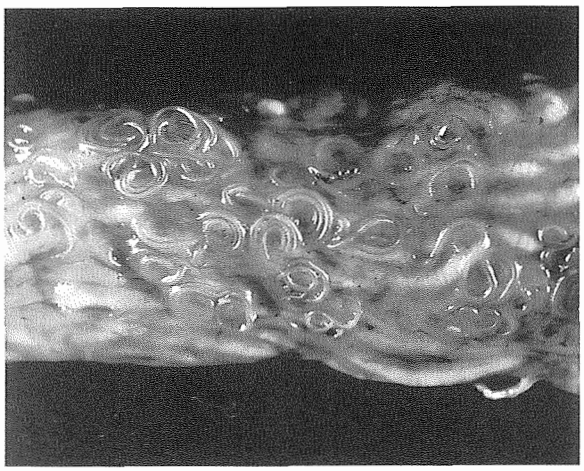


Fig. 235. *Anisakis/Phocanema* (*Pseudoterranova*) spp. (in fish).

Anisakis/Phocanema (Pseudoterranova) spp.

Common name: Cod worm (Ascaridoidea).
Adult size: Several cm, coiled in flesh.
Importance: Adults are in marine mammals; larval stages are common in several kinds of fish. If eaten in raw or poorly cooked fish, the larval stages can cause gastritis, vomiting, and psychosomatic disease in humans.
Diagnosis: Visual observation of fish flesh.
Prevention: Cook or freeze fish.
Treatment: For humans: Piperazine citrate 75 mg/kg q 24 h × 2 d (maximum of 4 g)
Pyrantel pamoate, 11 mg/kg (maximum of 1 g)

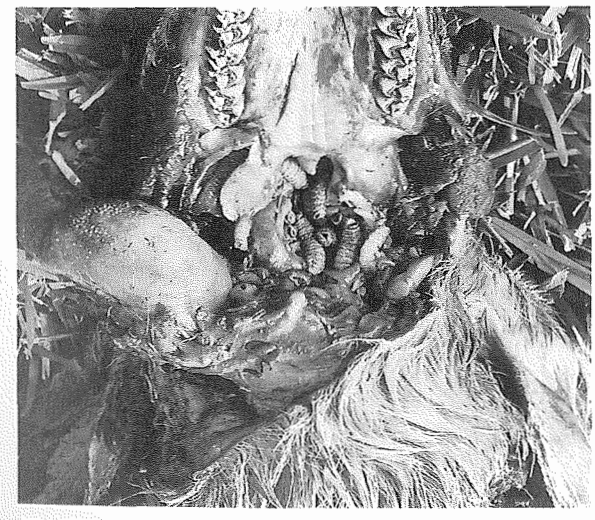


Fig. 236. *Cephenemyia* sp. (in deer). One generation per year.

Cephenemyia sp.

Common name: Deer throat bot (Diptera).
Adult size: 1–3 cm.
Importance: Found in retropharyngeal pouches of throat in species of deer, elk, llamas, and wild ungulates. Usually nonpathogenic, even though 50 or more may be present.
Diagnosis: Visual at necropsy.
Treatment: Ivermectin, 0.2 mg/kg

Fig. 237. *Mesocestoides* sp. (in cougars).

Mesocestoides sp.

Common name: Tapeworm (Pseudophyllidae). Found in felines and canines.
Size of egg: 50 µm × 40 µm, with internal hooks.
Importance: These are acquired from intermediate hosts such as reptiles. Uncommon, but interesting. Usually no pathogenicity associated with adult worms, but larval stages may be pathogenic.
Diagnosis: Eggs in fecal flotation.
Treatment: Praziquantel, 5–50 mg/kg PO.

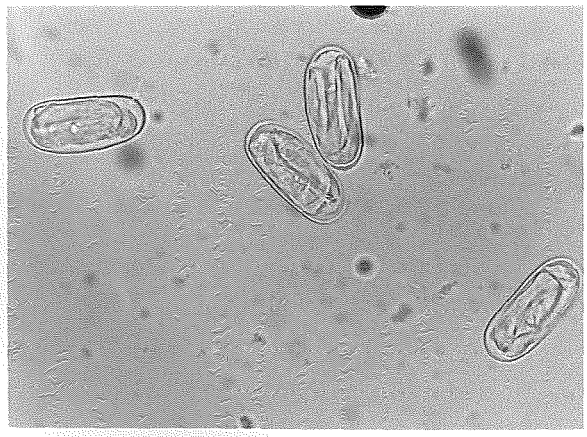


Fig. 238. *Cylicospirura* sp. (in cougars).

Cylicospirura sp.

Common name: Stomach worm (Spiruroidea).
Size of egg: 40 µm × 30 µm.
Importance: Found in most wild felids. Causes large (2–3 cm) nodules in stomach with red worms inside. Pathogenicity is unknown, but ulcers and hemorrhage are sometimes associated with the parasites.
Diagnosis: Eggs in fecal flotation or nodules found in stomach at necropsy.
Treatment: Unknown, but ivermectin or fenbendazole may be effective.

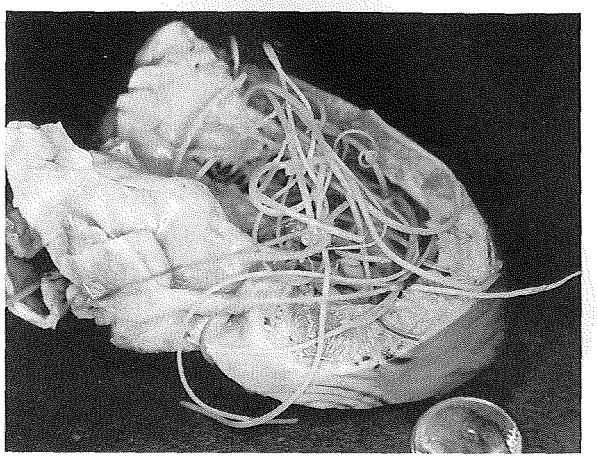


Fig. 239. *Dirofilaria immitis* (in coyotes). Prepatent period is 6 months.

Dirofilaria immitis

Common name: Dog heartworm (Filaroidea). Found in wild canines and occasionally felines.
Size of microfilaria: 310 µm × 7 µm.
Importance: Often fatal to coyotes, red wolves, and wild canids.
Diagnosis: Microfilariae in blood (Knott's test). Serologic tests (ELISA). At necropsy, worms are found in right side of heart.
Treatment: Melarsomine, 2.5 mg/kg IM, twice, 24 h apart
Prevention: Ivermectin, 0.006 mg/kg PO every 30 d (See dog heartworm section.)

Fig. 240. *Elaphostrongylus* spp. (in reindeer).

Elaphostrongylus spp.

Common name: European brain worm (Protostrongylidae).
Larvae size: 425 µm long, first-stage larvae.
Importance: Nonpathogenic in many hosts, but may cause meningitis and CNS disease in moose, caribou, and reindeer. Adult worms are in the epidural space of spinal cord and brain and in muscles. This parasite has serious potential ramifications because of its potential adverse effects in some North American wild ruminants. In North America, it has been found in woodland caribou in Newfoundland.
Diagnosis: Larvae in feces (using Baermann apparatus). Adults found in muscles.
Treatment: None known.

Fig. 241. *Wellcomia evaginata* (in porcupines).

Wellcomia evaginata

Common name: Pinworm (Oxyuridae).
Size of egg: 60 µm × 50 µm.
Importance: Very common in porcupines. Usually nonpathogenic.
Diagnosis: Eggs in fecal flotation.
Treatment: Most anthelmintics are effective.

Fig. 242. *Monoecocestus* sp. (in porcupines). Prepatent period is 70 days.

Monoecocestus sp.

Common name: Tapeworm (Anoplocephalidae).
Size of egg: 85 µm × 55 µm, with spines.
Importance: Very common in porcupines. Pathogenicity is unknown, but is probably relatively nonpathogenic. Note: Isn't it interesting that tapeworm eggs in porcupines have spines?
Diagnosis: Eggs in fecal flotation.
Treatment: Fenbendazole, 50 mg/kg PO q 24 × 3 d
Niclosamide, 157 mg/kg PO
Praziquantel, 2.5–5.0 mg/kg PO or SC

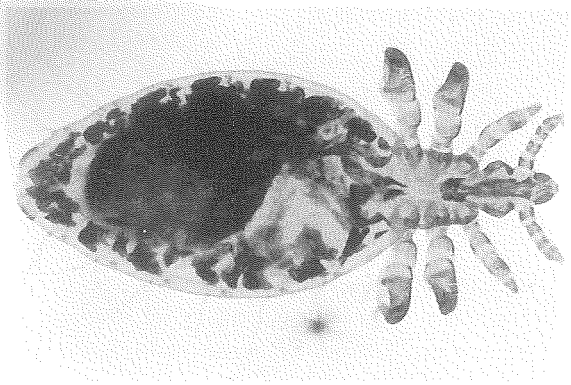


Fig. 243. *Linognathus africanus* (in deer).

Linognathus africanus

Common name: Sucking lice (Anoplura).
Size of adults: 2.5–5.0 mm. Life cycle is about 4 weeks.
Importance: May cause hair loss on face and body, pruritus.
Diagnosis: Visual observation in hair. Using flashlight to perform the examination is helpful.
Treatment: Ivermectin, 0.2 mg/kg IM, SC, or PO
Organophosphate, powders or sprays
Pyrethrin, powders or sprays

Fig. 244. *Lipoptena* sp. (in deer).

Lipoptena sp.

Common name: Deer ked (Diptera). This is a wingless fly.
Size of adults: 3–6 mm.
Importance: Very common on deer and elk. Usually nonpathogenic.
Diagnosis: Visual observation of hair. Keds are often in pairs.
Treatment: Organophosphate, powders or sprays
Pyrethrin, powders or sprays

Fig. 245. *Soboliphyme baturini* eggs (in martens).

Soboliphyme baturini

Common name: Marten stomach worm (Dioctophymoidea).
Size of adults: Up to 38 mm, heavy robust bodies, with a well-developed buccal capsule.
Size of eggs: 94 µm × 45 µm (our measurements).
Importance: Large worms in the stomach of martens, especially in Alaska. Closely related to the giant kidney worm of dogs. The pathogenicity is unknown, but large numbers of worms are found in healthy martens.
Diagnosis: Necropsy or fecal flotation.
Treatment: Unknown.

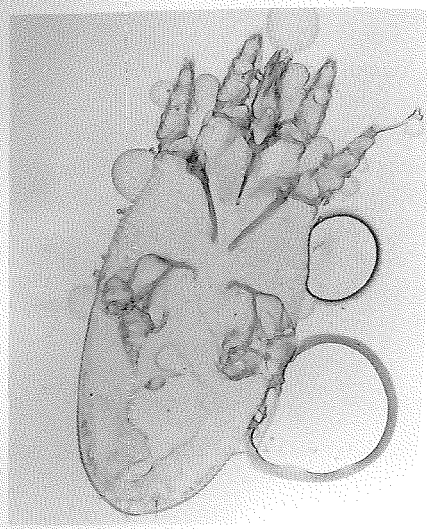


Fig. 246. *Ursicoptes americanus* (mites in bears).

Ursicoptes americanus

Common name: Mange mite of bears.
Size of adults: 265–359 µm × 130–150 µm.
Importance: Can cause clinical mange in captive and free-ranging bears.
Diagnosis: Skin scraping to detect mites.
Treatment: Amitraz (0.025%) dip, every 2 weeks until mites are no longer detected. Ivermectin may be effective.

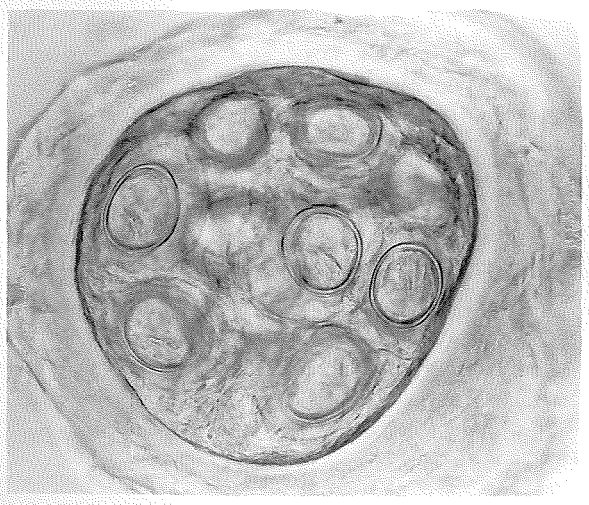


Fig. 247. *Wyominia tetoni* (egg packet, bighorn sheep).

Wyominia tetoni

Common name: Bighorn sheep fringed tapeworm.
Size of egg packets: 174 µm × 145 µm.
Importance: Probably nonpathogenic, but may cause bile duct proliferation and interfere with digestion.
Diagnosis: Fecal flotation, or observe tapeworm segments on the fecal pellets. Adult tapeworms are found in the bile ducts at necropsy.
Treatment: Fenbendazole, 10 mg/kg PO

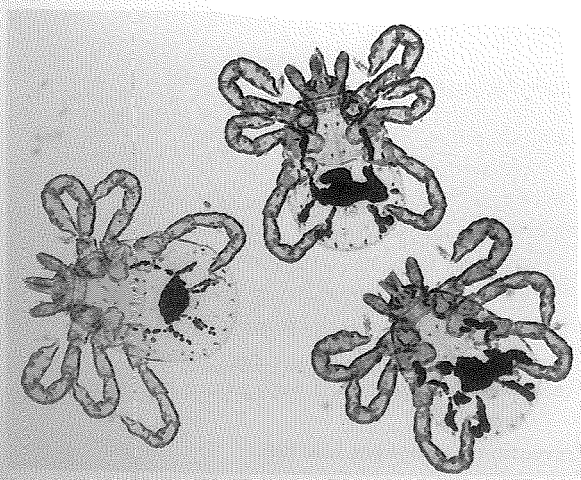


Fig. 248. Larval ticks (*Dermacentor* sp. on rodents).

Dermacentor sp.

Common name: Seed ticks or larval ticks.
Adult size: 700 µm × 500 µm (6 legs).
Importance: May cause infected animals to scratch, may cause anemia, and may be responsible for the transmission of diseases. Found on rodents and many animals.
Diagnosis: Visual observation.
Treatment: Dust with pyrethrins, permethrins, carbamates, or organophosphates.

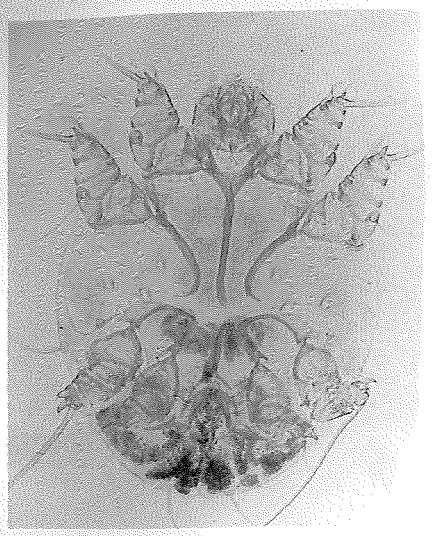


Fig. 249. *Sarcoptes scabiei* (mites) on wild canids.

Sarcoptes scabiei

Common name: Mange mites.
Adult size: 500 µm × 400 µm.
Importance: Causes sarcoptic mange in wild canids. Affected animals experience hair loss and death may occur. Common on foxes, coyotes, and wolves.
Diagnosis: Deep skin scraping; look for mites and eggs.
Treatment: Ivermectin, 0.2 mg/kg SC or PO

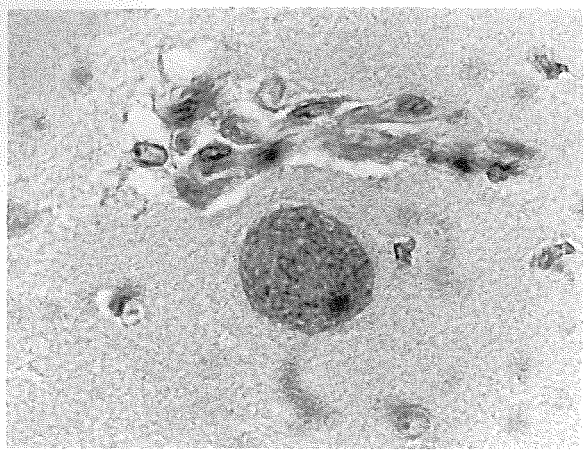


Fig. 250. Pseudocyst of *Toxoplasma gondii* (protozoa) can be found in CNS of any wild bird or mammal.

Toxoplasma gondii

Common name: Toxo.
Size of pseudocysts: 20–35 µm.
Importance: Can be transmitted to humans. Transmission occurs by cannibalism, ingestion of oocysts, or congenitally. Cats are the only definitive hosts, but all birds and mammals are susceptible to infection and disease.
Disease: The disease is characterized by fever, anorexia, lethargy, lymphadenopathy, myalgia, pneumonitis, myocarditis, hepatitis, and encephalitis. Abortion often occurs in ungulates.
Diagnosis: Identify pseudocyts in histological tissue sections, primarily CNS. Trophozoites can often be seen see in amniotic fluid and other fluids.
Treatment: Sulfas and pyrimethamine.
Prevention: Do not eat raw meat, and prevent oral ingestion of oocysts from cat feces.

Fig. 251. Egg of *Diphyllobothrium latum* (tapeworm in bears and humans).

Diphyllobothrium latum

Common name: Broad fish tapeworm (Pseudophyllidea).
Size of egg: 75 µm × 45 µm.
Importance: Transmitted by eating infected fish. May compete for vitamin B_{12}, but usually not pathogenic. Common in bears.
Diagnosis: Eggs in fecal flotation or large tapeworm segments in feces.
Treatment: Praziquantel, 5 mg/kg once PO (same for humans).
Prevention: Do not eat raw fish.

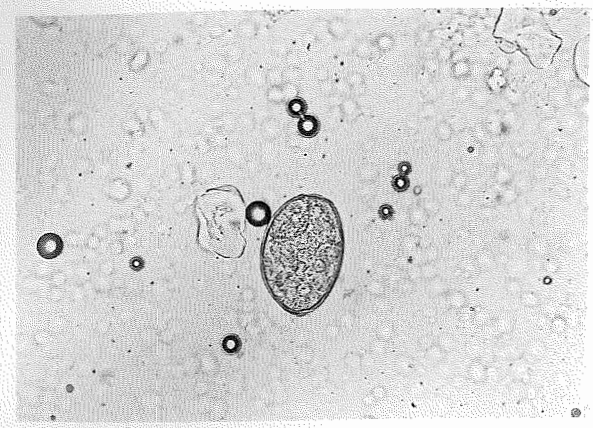


Fig. 252. Eggs of *Prouterina wescotti* (fecal float).

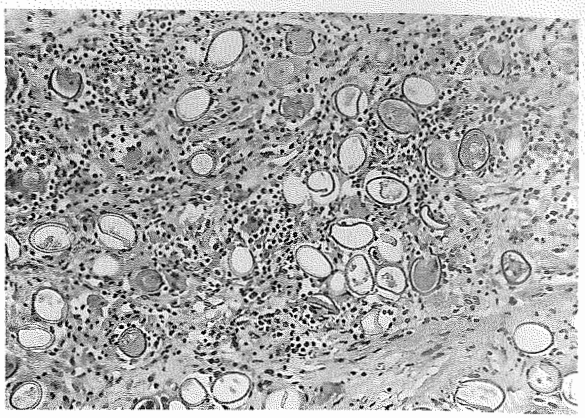


Fig. 253. Numerous trematode eggs (*P. wescotti*) in brain tissue.

Prouterina wescotti

Common Name: Bear brain fluke (Trematoda: Prouterinidae).
Size of egg: 68 µm × 41 µm.
Size of adult: 2–4 mm.
Importance: This parasite has been found in the brain, lungs, and nasal sinuses of one black bear that died of neurologic disease. It is very unusual for trematodes to enter neural tissue. Although the black bear may not be the natural host, severe disease occurred. The complete case history is available (Foreyt et al., *J Wild Dis* 32:225–233, 1996).
Diagnosis: The best diagnosis is to examine nasal sinuses of bears demonstrating neurologic signs and find the 2– to 4-mm trematodes. Eggs may float in sugar flotation. In histologic sections, eggs and adult trematodes can be seen in brain and lungs.
Treatment: None known.

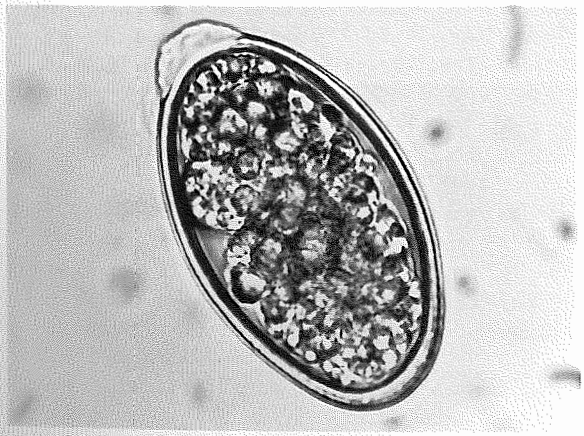


Fig. 254. Eggs of *Gnathostoma* sp. from felids and raccoons. Eggs are 70 µm × 35 µm.

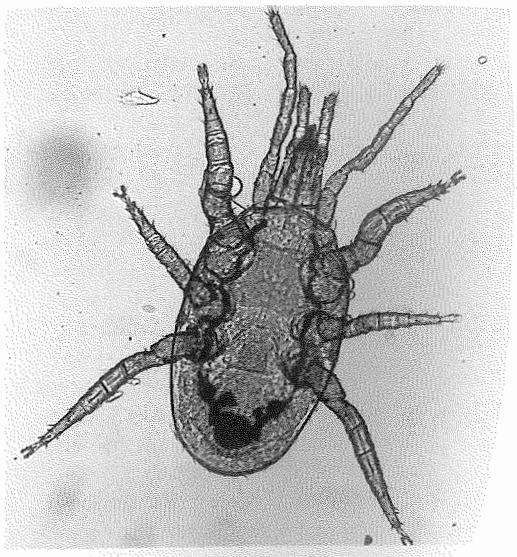


Fig. 255. *Ornithonyssus* sp. (mites) from the foot of an elk. These are probably incidental parasites (1 mm long).

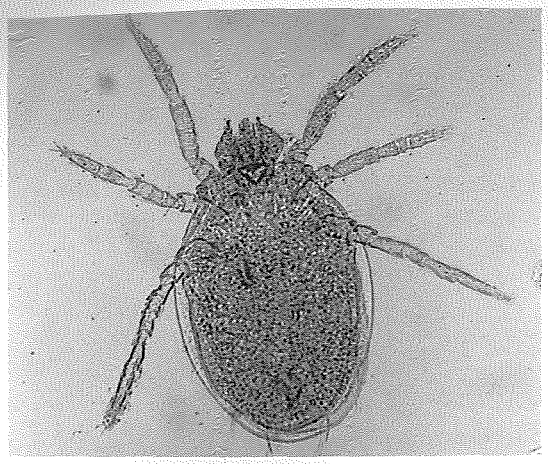


Fig. 256. Larval chiggers (*Trombicula* sp.) found on many kinds of animals. They usually bite and then fall off. They are often orange and 1 mm long.

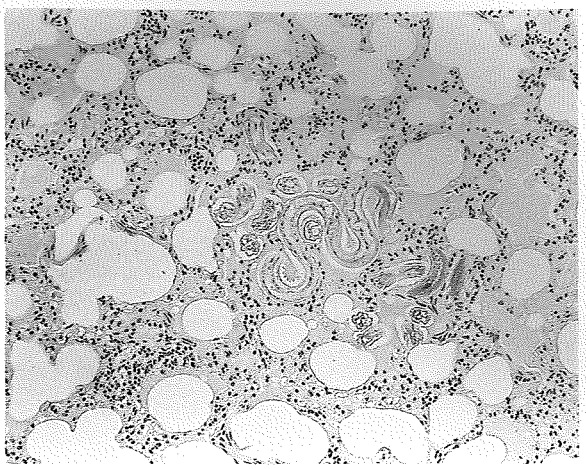


Fig. 257. *Protostrongylus* sp. larvae in the lungs of bighorn sheep (see Fig. 228a and b, for life cycle and diagnosis).

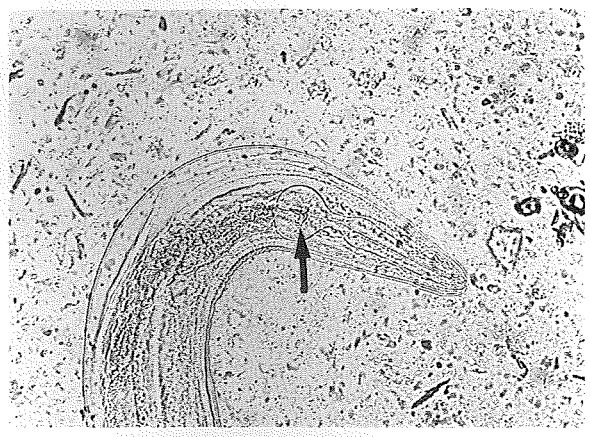


Fig. 258. Anterior end of an adult pinworm (*Passalurus ambiguus*) in the feces of a rabbit (note the bulb-type esophagus, arrow).

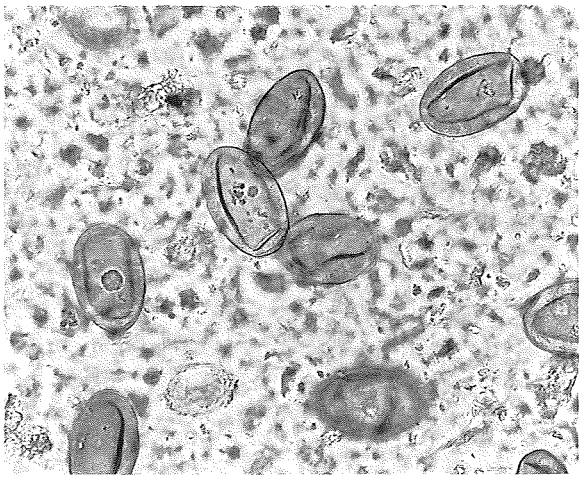


Fig. 259. Eggs of a pancreatic trematode, *Eurytrema* sp., from a cougar. Eggs are 45 µm × 35 µm.

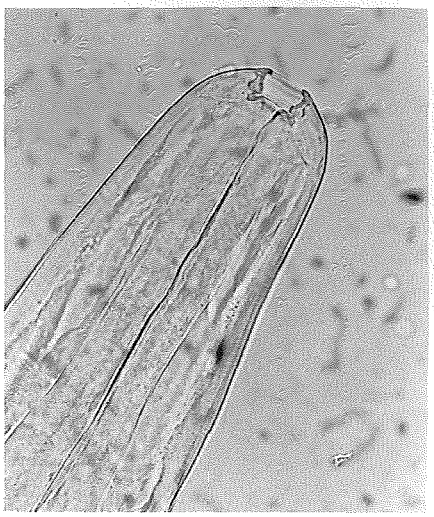


Fig. 260. Anterior end of *Thelazia* sp. (the eyeworm) from under the third eyelid of a bighorn sheep.

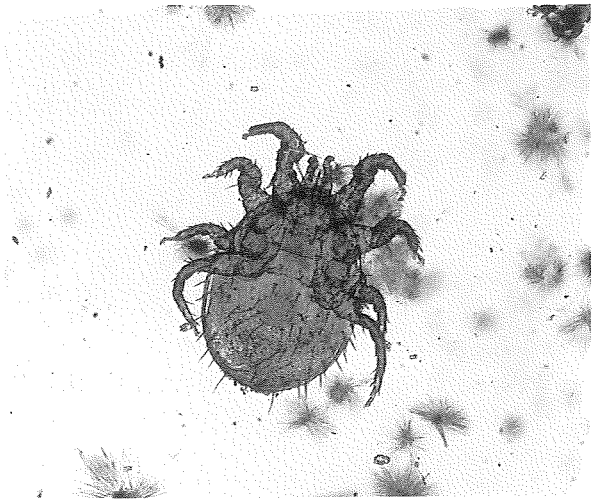


Fig. 261. Typical muskrat mite (very common on muskrats).

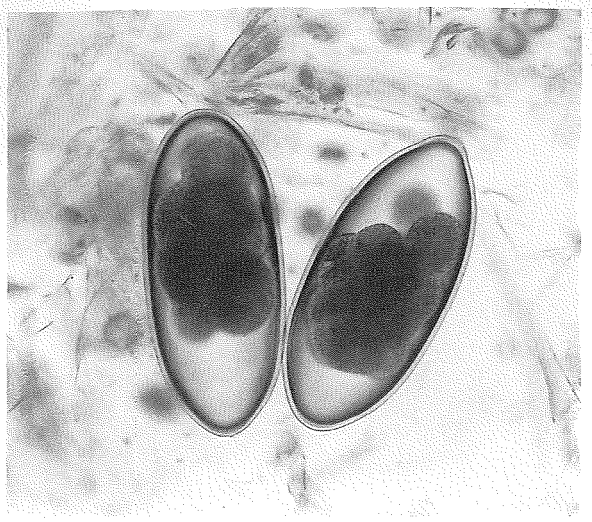


Fig. 262. *Nematodirella* sp. eggs from a musk ox.

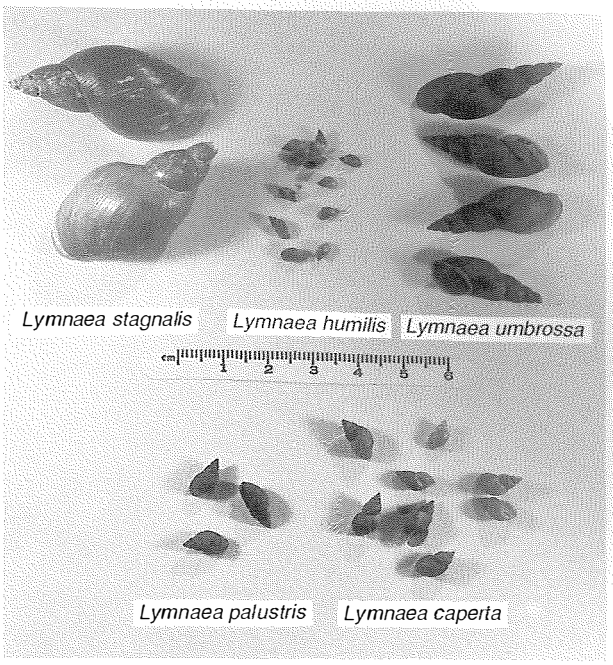


Fig. 263. Several *Lymnaea* spp. that are intermediate hosts for liver flukes (*Fascioloides magna*).

Bibliography

Beynon PH (ed.): *Manual of Raptors, Pigeons and Waterfowl*. Ames, Iowa, Iowa State University Press, 1996, 364 pp.

Chapman JA, Feldhamer GA: *Wild Mammals of North America, Biology, Management, Economics*. Baltimore, Maryland, Johns Hopkins University Press, 1982.

Davidson WR (ed): *Diseases and Parasites of White-tailed Deer*. Miscellaneous Publication No. 7, Tall Timbers Research Station, Tallahassee, Florida, 1981.

Davidson WR, Nettles VF: *Field Manual of Wildlife Diseases in the Southeastern United States*. Southeastern Cooperative Wildlife Disease Study, The University of Georgia, Athens, Georgia, 1988.

Davis JW, Anderson RC (eds): *Parasitic Diseases of Wild Animals*. Ames, Iowa, Iowa State University Press, 1971.

Davis JW, Anderson RC, Karstad LH, Trainer DO (eds): *Infectious and Parasitic Diseases of Wild Birds*. Ames, Iowa, Iowa State University Press, 1971.

Dieterich RA (ed): *Alaskan Wildlife Diseases*. Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska, 1981.

Forrester DJ: Parasites and Diseases of Wild Mammals in Florida. Gainesville, Florida, University Press of Florida, 1992, 459 pp.

Fowler M (ed): *Zoo and Wild Animal Medicine*. 2nd edition. Philadelphia, W.B. Saunders Co., 1986.

Fowler ME, Cubas ZS (eds.): *Biology, Medicine and Surgery of South American Wild Animals*. Ames, Iowa, Iowa State University Press, 2001, 572 pp.

Friend M (ed): *Field Guide to Wildlife Diseases*. Resource Publication 167, U.S. Department of the Interior, Fish & Wildlife Science, Washington, D.C., 1987.

Heidenreich M: *Birds of Prey: Medicine and Management*. Ames, Iowa, Iowa State University Press, 294 pp., 1997.

Levine ND: *Veterinary Protozoology*. Ames, Iowa, Iowa State University Press, 1985 414 pp.

Petrak ML (ed): *Diseases of Cage and Aviary Birds*. Philadelphia, Lea & Febiger, 1982.

Samuel WM, Pybus M (eds.): Parasitic Diseases of Wild Mammals, 2nd edition. Ames, Iowa, Iowa State University Press, 2001, 568 pp.

Stocker L. *Practical Wildlife Care*. Ames, Iowa, Iowa State University Press, 2000, 296 pp.

Thorne ET (ed): *Diseases of Wildlife in Wyoming*. Wyoming Game and Fish Department, Cheyenne, Wyoming, 1982.

Wallach JD, Boever WJ: *Diseases of Exotic Animals – Medical and Surgical Management*. Philadelphia, W.B. Saunders Co., 1983.

Williams ES, Barker IK (eds.): *Infectious Diseases of Wild Mammals*. 3rd edition. Ames, Iowa, Iowa State University Press, 2001, 576 pp.

Wobeser G: *Diseases of Wild Waterfowl*. New York, Plenum Press, New York, 1981.

Section 13

PARASITES OF MARINE MAMMALS

Marine Mammals

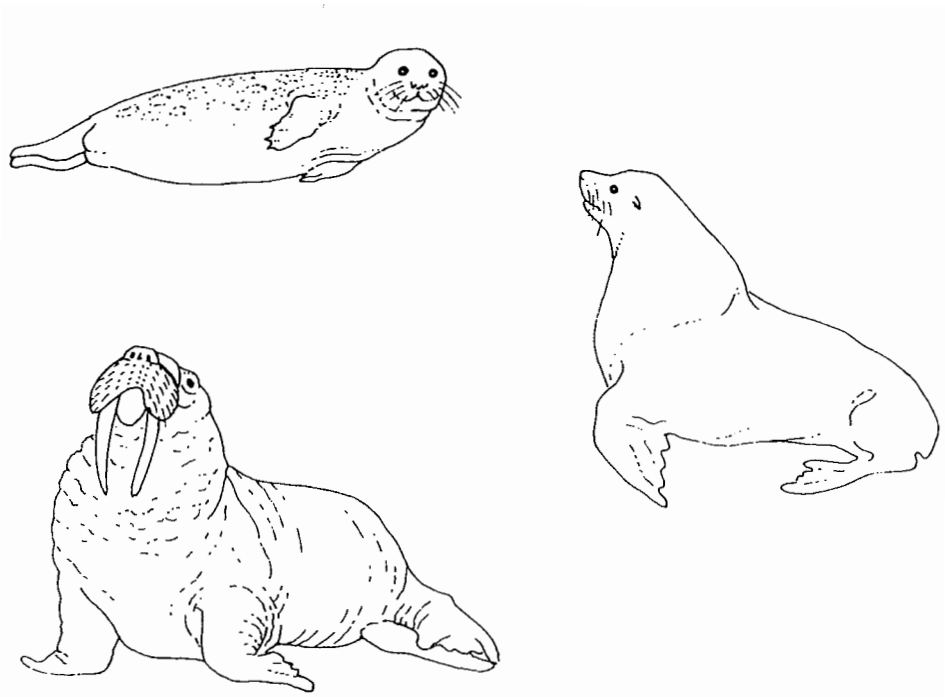


Fig. 264. Marine mammals (Pinnipedia): seals, sea lions, walruses.

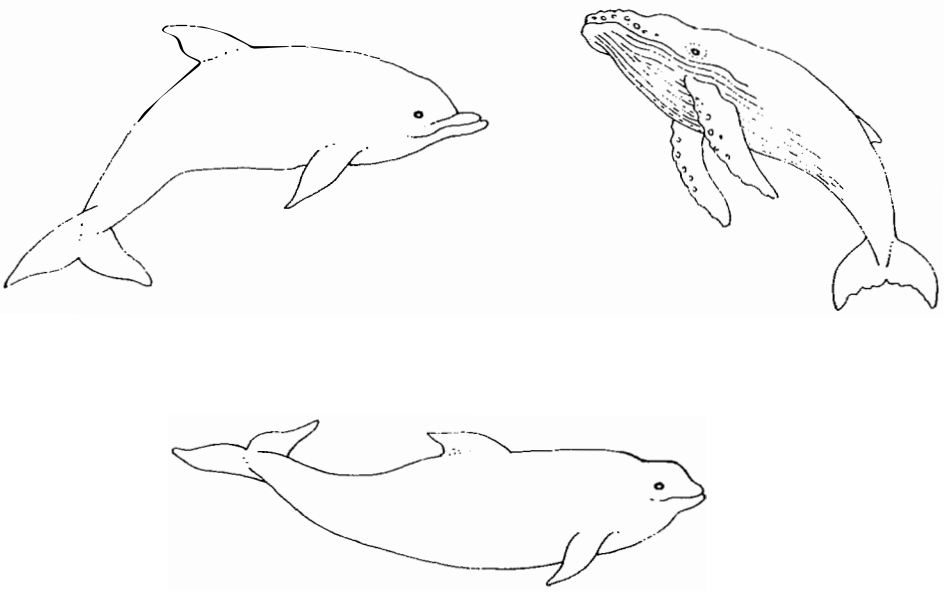


Fig. 265. Marine mammals (Cetacea): whales, dolphins, porpoises.

Major Parasites

Table 56. Major parasites of pinnipedia (seals, sea lions, and walruses)

Parasite	Location
Trematodes	
Cryptocotyle	Intestine
Zalophotrema	Liver
Pricetrema	Intestine
Cestodes	
Diphyllobothrium	Intestine
Phyllobothrium	Tissue
Nematodes	
Anisakis	Stomach
Ascaris	Intestine
Contracaecum	Stomach
Dipetalonema	Heart
Dirofilaria	Heart
Ostostrongylus	Lung
Parafilaroides	Lung
Porrocaecum	Stomach
Terranova	Stomach
Uncinaria	Intestine
Acanthocephala	
Corynosoma	Intestine
Ectoparasites	
Antarctophthirus (louse)	Skin
Echinophthirius (louse)	Skin
Halarachne (nasal mite)	Nasal sinuses
Lepidophthirus (louse)	Skin

Table 57. Major parasites of cetacea (whales, dolphins, and porpoises)

Parasite	Location
Trematodes	
Braunina	Stomach and intestine
Campula	Liver
Fasciola	Liver
Hadwenius	Intestine
Leveasiella	Intestine
Nasitrema	Air sinus and brain
Odhneriella	Liver
Pholeter	Stomach
Cestodes	
Diphyllobothrium	Stomach and intestine
Phyllobothrium	Blubber
Strobilocephalus	Intestine
Tetraabothrius	Intestine
Trigonocotyle	Intestine
Nematodes	
Anisakis	Stomach and intestine
Contracaecum	Stomach and intestine
Crassicauda	Kidney, muscle, and urogenital system
Halocercus	Lung
Pharurus	Air sinus, lung, and heart
Phocanema	Stomach
Pseudalius	Lung and heart
Stenurus	Bronchi
Terranova	Stomach
Acanthocephala	
Corynosoma	Stomach and intestine
Ectoparasites	
Cyamus (louse)	Skin

Drugs

Table 58. Anthelmintics for marine mammals

Pinnipeds
- Internal parasites
  - Melarsomine (adult heartworm), 2.4 mg/kg, twice, 24 hours apart
  - Diethylcarbamazine citrate (heartworm preventative), 5 mg/kg daily administration
  - Ivermectin (heartworm prevention), 0.006 mg/kg every 30 days
  - Droncit (tapeworms and flukes), 10 mg/kg PO
  - Fenbendazole, 50 mg/kg PO
  - Ivermectin, 0.2 mg/kg PO
  - Levamisole, 10 mg/kg PO
  - Mebendazole, 15 mg/kg PO q 24 h × 2
- External parasites
  - Benzyl benzoate (20%) and benzene hexachloride (0.9%) applied with sponge (mites)
  - Ivermectin, 0.2 m/kg PO

Cetaceans
- Internal parasites
  - Droncit (tapeworms and flukes), 10 mg/kg PO
  - Fenbendazole, 50 mg/kg PO
  - Ivermectin, 0.2 mg/kg PO
  - Levamisole, 10 mg/kg PO
  - Niclosamide (tapeworms), 110 mg/kg PO
  - Piperazine, 55 mg/kg PO

Internal Parasites

Fig. 266. *Otostrongylus* sp., larva 300 µm × 20 µm.

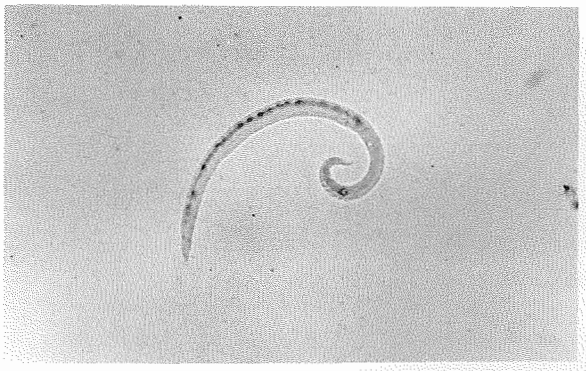


Fig. 267. *Parafilaroides* sp., larva 250 µm × 20 µm.

Table 59. Comparison of first stage of larvae of *Otostrongylus* sp. and *Parafilaroides* sp.

	Otostrongylus sp.	*Parafilaroides* sp.
First-stage larvae (length and width)	270–420 × 19–24 µm	240–265 × 5–15 µm
Males (length and width)	105 mm × 1.3 mm	6–18 mm × 90–120 µm
Females (length and width)	140–160 mm × 2 mm	16–21 mm × 170 µm
Location found in host	Bronchi, trachea, heart	Lung parenchyma
Pathogenicity	Less severe (pneumonia)	Severe (bronchiolar obstruction)

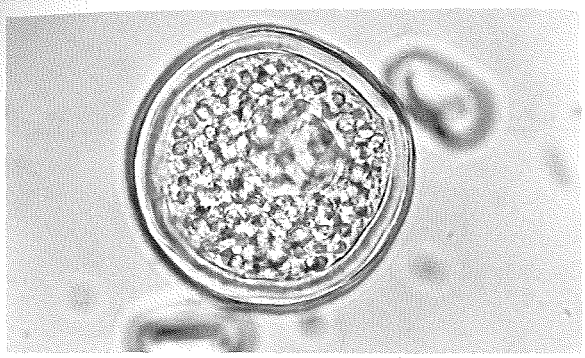


Fig. 268. Typical nematode egg (ascarid).

Nematodes (roundworms) of marine mammals are common. The ascarid group primarily consists of *Contracaecum, Anisakis, Phocanema,* and *Terranvova.* Ascarids are very common. The larval stages of these are often seen in fish, and some can infect humans when the larvae in fish are ingested. Marine mammals are usually infected by eating infected fish.

The adult parasites are usually large and live in the stomach or intestines. Adult worms are 3–10 cm.

Most dewormers listed in Table 58 are effective for treatment.

Prevention for humans is to cook fish well before eating. Pyrantel is used to treat humans.

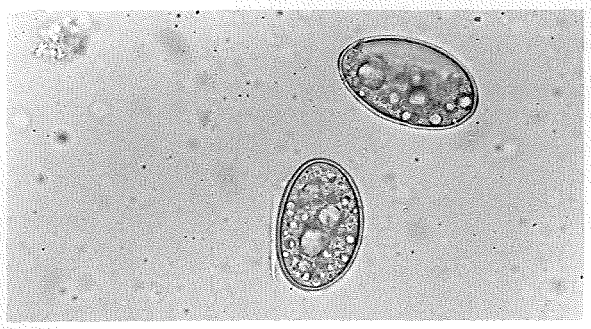


Fig. 269. Typical trematode eggs.

Trematodes (flukes) are also common in marine mammals. Examples are listed in Tables 56 and 57. Eggs are usually operculated at one end.

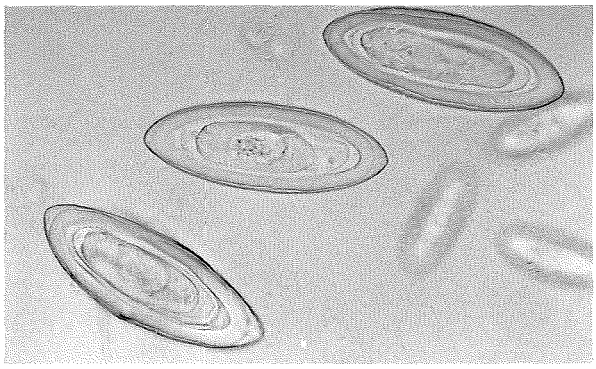


Fig. 270. Typical acanthocephala eggs.

Acanthocephala are spiny-headed worms and are found commonly in the intestines of marine mammals. Their spiny heads are firmly imbedded in intestinal mucosa. Acanthocephalans often appear yellow or orange at necropsy.

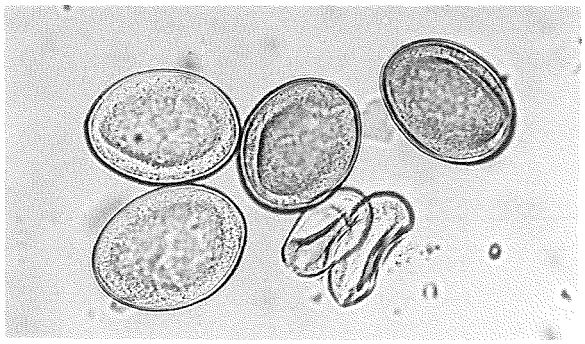


Fig. 271. Typical tapeworm eggs.

Tapeworms (cestodes) are common in marine mammals. The broad fish tapeworm (*Diphyllobothrium* sp.) is especially common in those animals that eat fish. Pseudophyllidean tapeworms like *Diphyllobothrium* spp. are the most common type of tapeworm in marine mammals and have operculated eggs. Tapeworms are often nonpathogenic and can be treated with praziquantel.

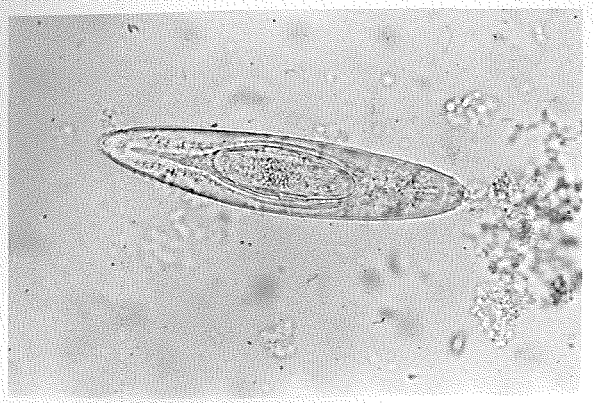


Fig. 272. *Bolbosoma* sp. (acanthocephala), 160 µm × 28 µm. Photo by M. Dailey. Used with permission.

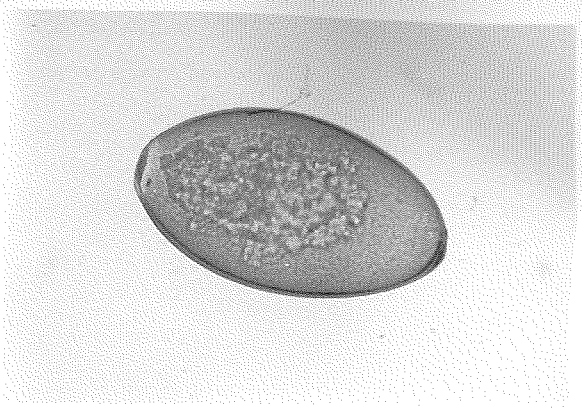


Fig. 273. *Braunina cordiformis* (trematode), 165 µm × 97 µm. Photo by M. Dailey. Used with permission.

Fig. 274. *Zalophotrema hepaticum* (trematode), 73 µm × 48 µm. Photo by M. Dailey. Used with permission.

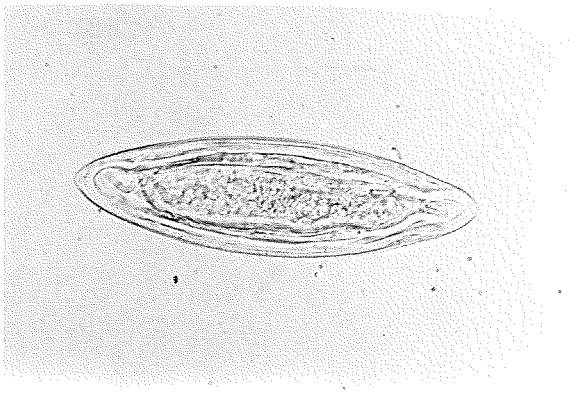


Fig. 275. *Corynosoma* sp. (acanthocephala), 79 µm × 24 µm. Photo by M. Dailey. Used with permission.

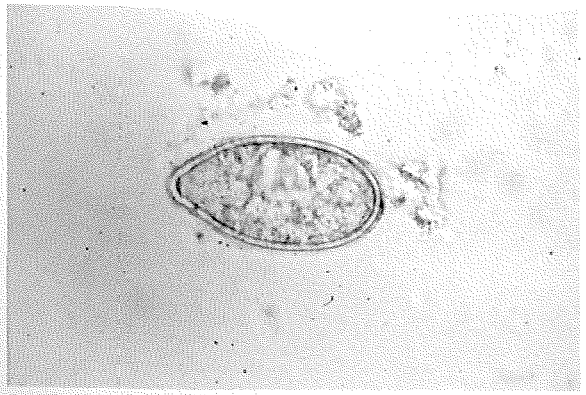


Fig. 276. *Pricetrema zalophi* (trematode), 33 µm × 18 µm. Photo by M. Dailey. Used with permission.

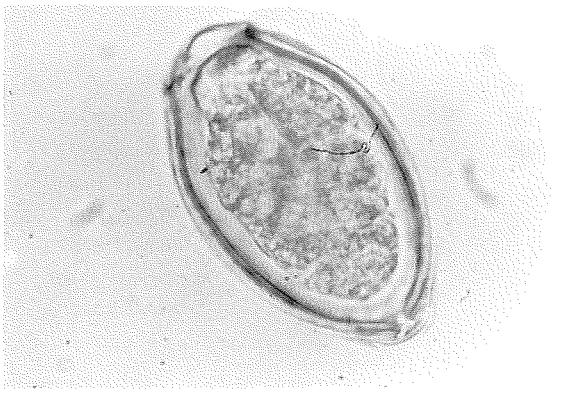


Fig. 277. *Synthesium* sp. (trematode), 56 µm × 33 µm. Photo by M. Dailey. Used with permission.

Fig. 278. *Anisakis* sp. (nematode-ascarid), 50 µm × 40 µm. Photo by M. Dailey. Used with permission.

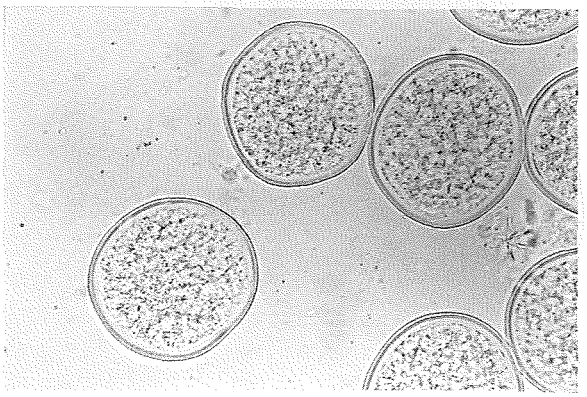


Fig. 279. *Contracaecum* sp. (nematode-ascarid), 50 µm × 50 µm. Photo by M. Dailey. Used with permission.

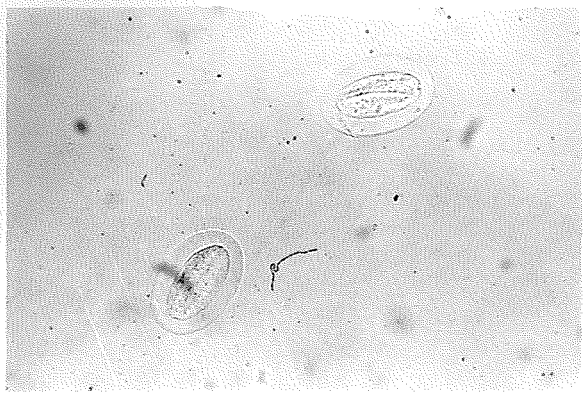


Fig. 280. *Crassicauda* sp. (nematode). Eggs are larvated, 55 µm × 37 µm. Photo by M. Dailey. Used with permission.

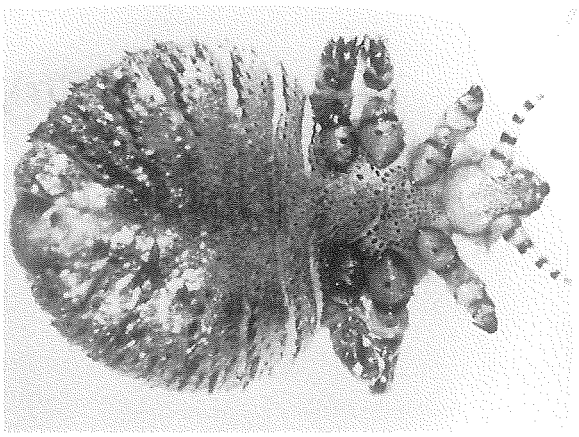


Fig. 281. *Antarctophthirus* sp. (louse), 3 mm.

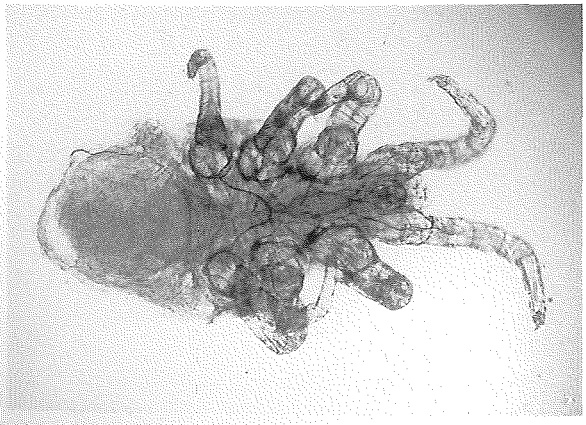


Fig. 282. *Orthohalarachne diminuta.* Mites are in the bronchioles and trachea. Photo by M. Dailey. Used with permission.

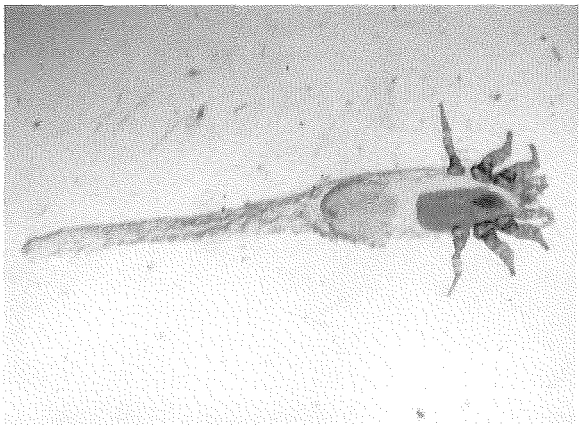


Fig. 283. *Orthohalarachne attenuata.* Mites are in the nasopharynx. Photo by M. Dailey. Used with permission.

Fig. 284. *Nasitrema* sp. (trematode) egg. Photo by M. Dailey. Used with permission.

Nasitrema sp.

Common name: Trematode.
Hosts: Various cetaceans, especially dolphins.
Size of egg: 82 µm × 48 µm.
Importance: Located in the air sinus, they may cause strandings by infecting the tympanic cavity and damaging the eighth cranial nerve (Morimitsu et al. 1986, 1992).
Treatment: Praziquantel, 10 mg/kg PO

Fig. 285. *Otostrongylus* sp. (lungworm larva) nematode. Photo from M. Dailey. Used with permission.

Otostrongylus sp.

Name: Lungworm
Hosts: Pinnipeds
Size of larvae: 260 µm × 20 µm
Importance: Located in the lungs, the worms may compromise respiration and may predispose to pneumonia.
Treatment: Ivermectin, 0.2 mg/kg PO
Fenbendazole, 50 mg/kg PO

Fig. 286. *Uncinaria lucasi* (nematode) eggs.

Uncinaria lucasi

Name: Hookworm (nematode).
Hosts: Northern fur seal primarily.
Size of eggs: 135 µm × 85 µm
Importance: Hookworms are located in the small intestine in pups, blubber and fat in adults. Transmitted transmammarily and often causes mortality in pups (Lyons, 1994).
Treatment: Ivermectin, 0.2 mg/kg PO
Fenbendazole, 50 mg/kg PO

Bibliography

Brown RJ, Smith AW, Keyes MC: Sarcocystis in the northern fur seal. J Wildl Dis 10:53,1974.

Brown RJ, Smith AW, Keyes MC, et al.: Lesions associated with fatal hookworm infections in the northern fur seal. AVMA 165:804, 1974.

Conlogue GJ, Ogden JA, Foreyt WJ: Pediculosis and severe heartworm infection in a harbor seal. Vet Med/Small Anim Clin 75:1184–1187, 1980.

Dailey MD, Brownell RL: A checklist of marine parasites. In Ridgway SH (ed): Mammals of the Sea. Charles C. Thomas, 1972, pp. 528–566.

Dailey MD: Diseases of Mammalia: Cetacea. In Kinne O (ed): Diseases of Marine Animals, Volume IV, Part 2. Hamburg, Federal Republic of Germany, Biologische Anstalt Helgoland, 1985, pp. 815–841.

Dailey MD: Parasitology – Basic Considerations (Cetacea, Pinnipedia and Sirenia). In Fowler ME (ed): Zoo and Wild Animal Medicine. Philadelphia, W.B. Saunders and Co., 1986, pp. 781–789.

Eley TJ: Dipetalonema spirocauda in Alaskan marine mammals. J Wildl Dis 17:65, 1981.

Forrester DJ: Parasites and Diseases of Wild Mammals in Florida. Gainesville, University Press of Florida, 1992, 459 pp.

Gosselin JF, Measures, L. Redescription of Filaroides (Parafilaroides) gymnurus (Railliet, 1899) (Nematoda: Metastrongyloidea), with comments on other species in pinnipeds. Can J Zool 75:359–370, 1997.

Howard EB, Britt JO Jr., Matsumoto GK: Parasitic diseases. In Howard EB (ed): Pathobiology of Marine Mammal Diseases, Volume I. Boca Raton, Florida, CRC Press, Inc., 1983, pp. 119–232.

Hsu CK, Melby EC, Altman NH, et al.: Coccidiosis in harbor seals. JAVMA 164:700, 1974.

Inskeep W, Gardiner CH, Harris RK, Dubey JP, Goldston RT: Toxoplasmosis in Atlantic bottle-nosed dolphins (Tursops truncatus). J Wildl Dis 26:377–382, 1990.

Johnston DG, Ridgway SH: Parasitism in some marine mammals. JAVMA 155:1064 1969.

Kim KC, Haas VL, Keyes MC: Populations, microhabitat preference, and effects of infestation of two species of Orthohalarchne (Halarachnidae:Acarine) in the northern fur seal. J Wildl Dis 16:45, 1980.

Kinne O: Diseases caused by parasites. In Kinne O (ed): Diseases of Marine Mammals. Hamburg, Federal Republic of Germany, Biologische Anstalt Helgoland, 1985, pp. 717–750.

Lauckner G: Diseases of Mammalia: Pinnipedia. In Kinne O (ed): Diseases of Marine Animals, Volume IV, Part 2. Hamburg, Federal Republic of Germany, Biologische Anstalt Helgoland, 1985, pp. 713–754.

Lyons ET: Vertical transmission of nematodes: Emphasis on Uncinaria lucasi in northern fur seals and Strongyloides westeri in equids. J Helminthol Soc Wash 61:169–178, 1994.

Measures L, Gosselin JF. Helminth parasites of ringed seal Phoca hispida from northern Quebec, Canada. J Helminthol Soc Wash 61:240–244, 1994.

Morimitsu T, et al.: Parasitic octavus neuropathy as a cause of mass stranding of Odontoceti. J Wildl Dis 72:469–472, 1986.

Morimitsu T, et al.: Histopathology of eighth cranial nerve of mass stranded dolphins at Goto Islands, Japan. J Wildl Dis 28:656–658, 1992.

Onderka DK: Prevalence and pathology of nematode infections in the lungs of ringed seals (Phoca hispida) of the western Arctic of Canada. J Wildl Dis 25:218–224, 1989.

Perry ML: A new species of Dipetalonema from the California sea lion and a report of microfilariae from a Stellar sea lion (Nematoda:Filarioidea). J Parasit 53:1076, 1967.

Stroud RK, Dailey MD: Parasites and associated pathology observed in pinnipeds stranded along the Oregon coast. J Wildl Dis 14:292, 1978.

Taylor AER, Brown DH, Heyneman D, et al.: Biology of filarid nematode Dipetalonema spirocauda (Leidy, 1858) from the heart of captive harbor seals and sea lions, together with pathology of the hosts. J Parasit 47:971, 1961.

Woodward JC, Zam SG, Caldwell DK, et al.: Some parasitic diseases of dolphins. Pathol Vet 6:257, 1969.

Section 14

PARASITES OF REPTILES

Common Reptiles

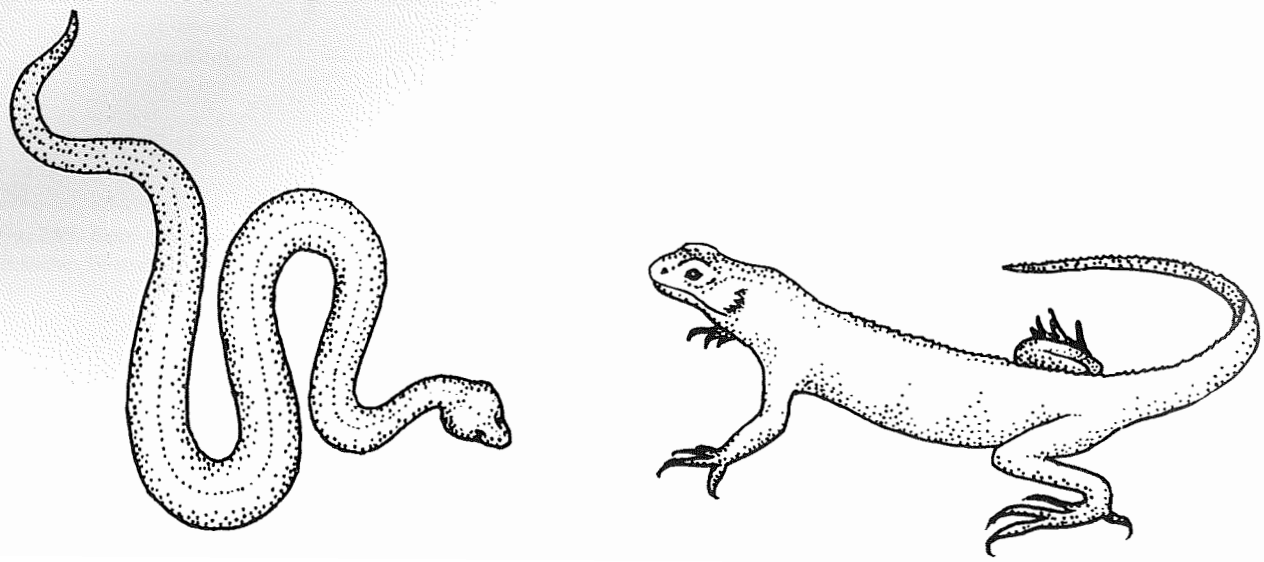


Fig. 287. Reptiles (snakes and lizards).

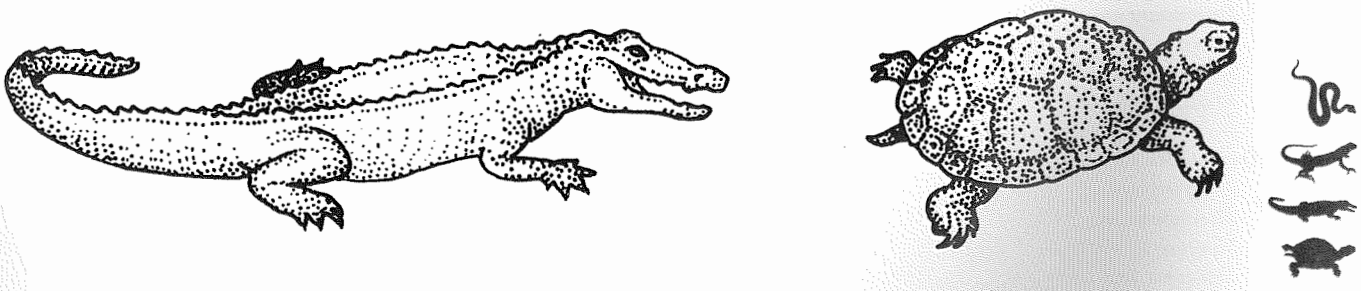


Fig. 288. Reptiles (turtles/tortoises/alligators/crocodiles).

Major Parasites

Table 60. Parasites of reptiles (snakes and lizards)

Parasites	Location
Protozoa	
Entamoeba invadens	Intestine
Eimeria/Isospora spp. (coccidia)	Intestine/extra-intestinal
Cryptosporidium sp.	Intestine
Blood protozoa (*Haemoproteus*, *Hepatozoan*, *Plasmodium*	Blood or tissues
Flagellates: *Trichomonas*, *Leishmania Trypanosoma*	Blood or tissues
Ciliates: *Balantidium* sp.	Intestine
	Lungs/intestine
Trematodes (renifers)	
Lechriochis sp.	Lungs
Dasymetra sp.	Oral cavity
Ochetostoma sp.	Oral cavity
Stomatrema sp.	Oral cavity
Zeugorchis sp.	Stomach
Styphylodora sp.	Urinary tract
Spirorchis/Learedius sp.	Circulatory system
Cestodes	
Pseudophyllideans: *Bothridium*, *Bothriocephalus*, *Spirometra*	Intestine
Sparganum larvae (pleurocercoids)	Muscles/SQ
Mesocestoides larvae (tetrathyridia)	Anywhere
Proteocephalus, *Acanthotaenia*, *Crepidobothrium*, *Ophiotaenia*	Intestine
Nematodes	
Ascarids: *Ophidascaris*, *Polydelphis*, *Hexametra*	Intestine/stomach
Hookworms: *Kalicephalus*	Intestine
Filarial worms: *Oswaldofilaria*, *Foleyella*, *Macdonaldius*	Lungs/SQ/ circulatory system
Capillaria sp.	Intestine
Strongyloides/Rhabdias	Intestine
Pinworms (oxyurids) : several species	Intestine
Spirurids: *Abbreviata*, *Eustrongyloides* larvae, *Physaloptera* spp.	SQ/lungs
Acanthocephala	
Sphaerechinorhynchus sp.	Intestine
Mites	
Ophionyssus natricis	Skin
Entonyssus, *Ophiopneumicola*	Lungs
Ticks	Skin
Amblyomma, *Aponomma*, *Hyalomma*, *Ornithodoros*	
Fly larvae	
Sarcophaga	SQ
Pentastomes (several species)	Lungs

Table 61. Parasites of reptiles (turtles and alligators)

Turtles/Tortoises	Location
Nematodes	
Angusticaecum sp.	Intestine
Camallanus sp.	Intestine
Spironoura sp.	Colon
Spiroxys sp.	Colon
Kalicephalus sp.	Intestine
Proatractis sp.	Colon
Trematodes	
Dictyangium sp.	Stomach
Heronimus sp.	Lungs
Neopolystoma sp.	Urinary bladder
Telorchis sp.	Intestine
Acanthocephala	
Neoechinorhynchus sp.	Intestine
Protozoa	
Entamoeba invadens	Intestine
Eimeria spp.	Intestine
Balantidium sp.	Intestine

Alligators/Crocodiles	Location
Nematodes	
Brevimulticaecum sp.	Stomach
Dujardinascaris sp.	Intestine/stomach
Trematodes	
Acanthostomum sp.	Intestine
Archaeodiplostomum sp.	Intestine
Crocodilicola sp.	Intestine
Polycotyle sp.	Intestine
Pseudocrocodilicola sp.	Intestine
Pentastomes	
Sebekia sp.	Lungs
Leeches	
Placobdella spp.	Mouth/skin

Fecal Eggs and Oocysts

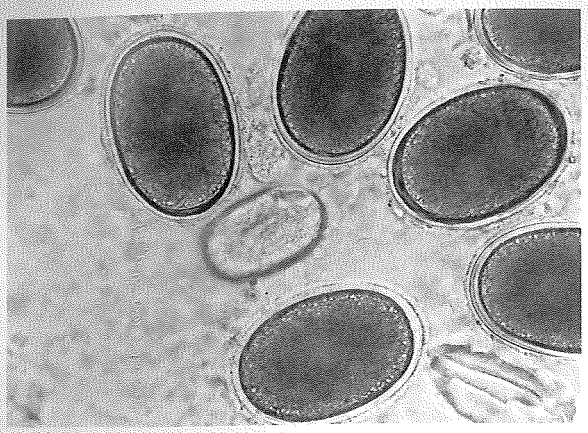


Fig. 289. Eggs of ascarids (*Ophidascaris* sp.) from a rattlesnake. Nematode eggs are 90 µm × 70 µm.

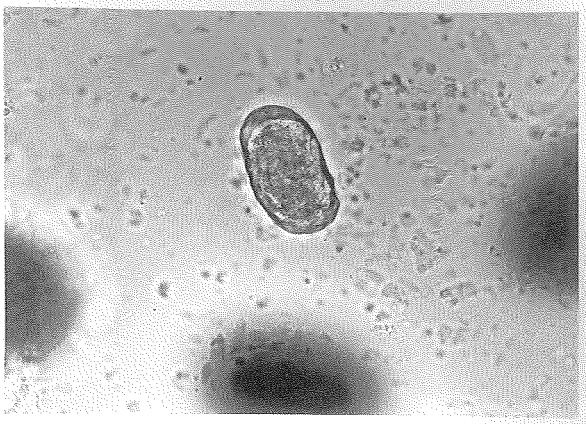


Fig. 290. Eggs of hookworms (*Kalicephalus* sp.) from a rattlesnake. Nematode eggs are 80 µm × 40 µm.

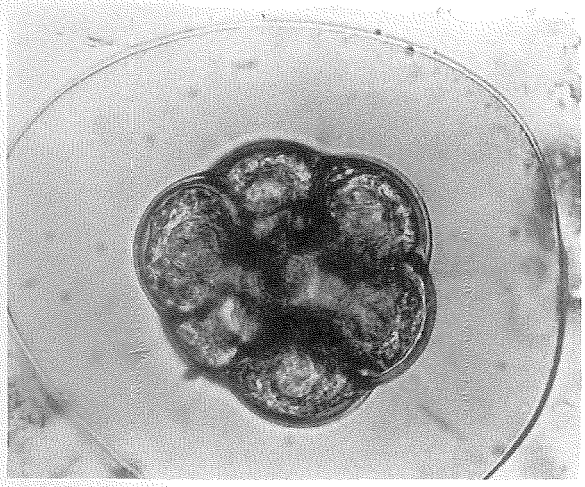


Fig. 291. Eggs of *Kapsultaenia* sp. (tapeworm). Eggs are 90 µm × 70 µm. Photo by S. Barnard. Used with permission.

Fig. 292. Eggs of a pinworm (probably *Pharyngodon* sp.) (nematode), 87 µm × 42 µm. Photo by S. Barnard. Used with permission.

Fig. 293. Eggs of a trematode (*Ocetosoma* sp.). Eggs are 40 µm × 22 µm. Photo by S. Barnard. Used with permission.

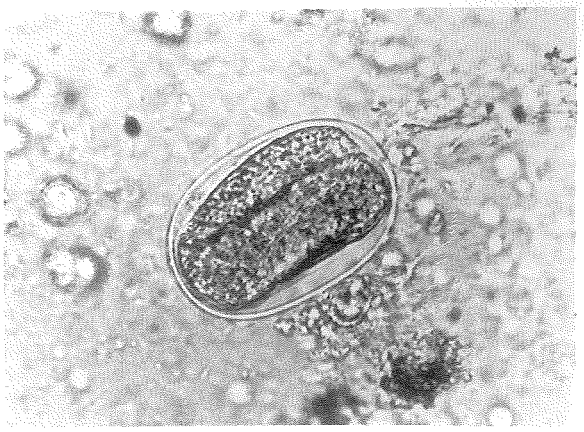


Fig. 294. Eggs of *Strongyloides* sp., a nematode. Eggs are 72 µm × 35 µm. Photo by S. Barnard. Used with permission.

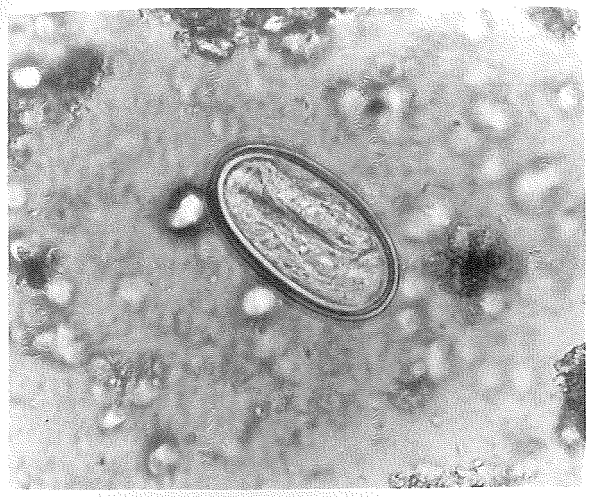


Fig. 295. Eggs of *Physaloptera* sp., a nematode. Eggs are 80 µm × 40 µm. Photo by S. Barnard. Used with permission.

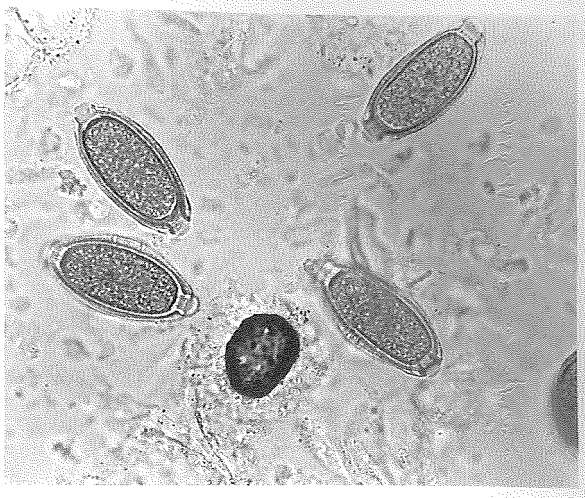


Fig. 296. Eggs of *Capillaria* sp., a nematode from a rattlesnake. Eggs are 80 µm × 40 µm.

Fig. 297. Eggs of *Oswaldcruzia* sp., a hookworm (nematode). Eggs are 78 µm × 45 µm. Photo by S. Barnard. Used with permission.

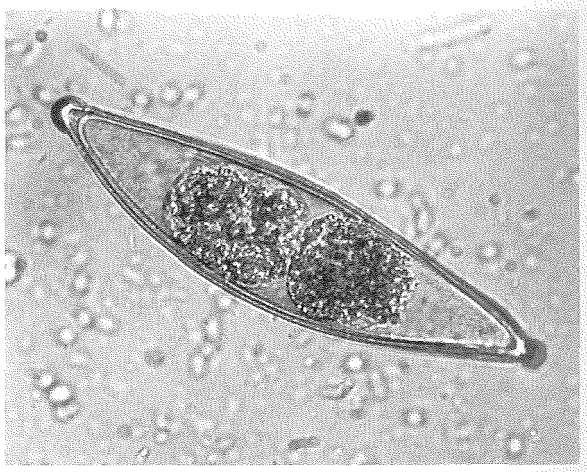


Fig. 298. Eggs of *Pharyngdon* sp., a pinworm (nematode) common in lizards. Eggs are 142 µm × 35 µm. Photo by S. Barnard. Used with permission.

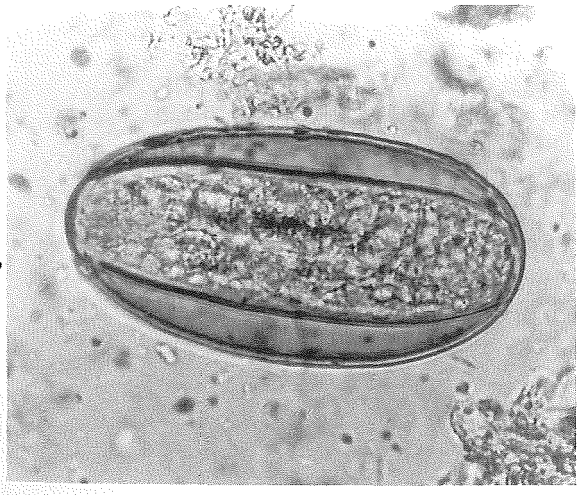


Fig. 299. Eggs of *Tachygonetria* sp., a pinworm (nematode) common in turtles/tortoises. Eggs are 105 µm × 55 µm. Photo by S. Barnard. Used with permission.

Fig. 300. Eggs of *Oochoristica* sp., a tapeworm from a lizard. Eggs are 40 µm × 32 µm. Photo by S. Barnard. Used with permission.

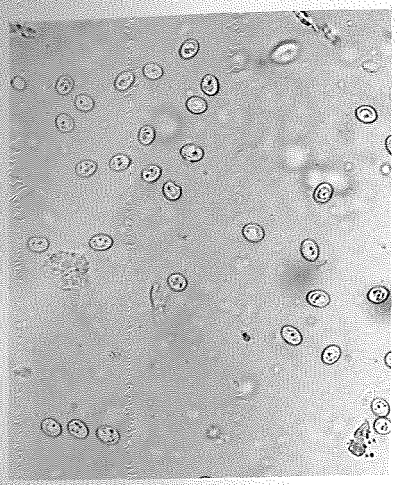


Fig. 301. Oocysts of *Cryptosporidium* sp. Oocysts are 5–7 µm in diameter.

Fig. 302. Cysts of *Balantidium* sp. from a rattlesnake. Cysts are usually between 50 and 100 µm.

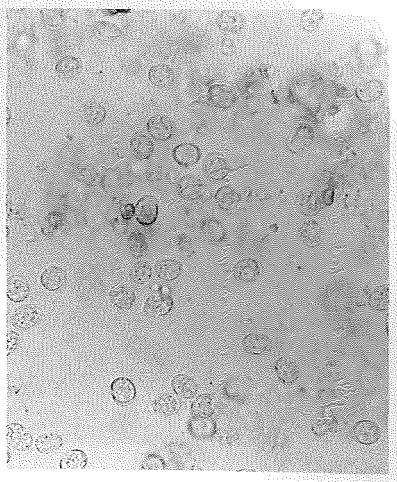


Fig. 303. *Eimeria* sp. (coccidia) from a rattlesnake. Oocysts are 20 µm × 18 µm.

Drugs

Table 62. Drugs for reptiles*

Parasite	Drug	Dosage (mg/kg of body weight)
Nematodes	Dichlorvos (Task)	12.5
	Fenbendazole (Panacur)	50
	Ivermectin (Ivomec), NO TURTLES	0.2
	Levamisole HCL (Tramisol)	10
	Mebendazole (Telmin)	25
	Pyrantel pamoate (Strongid T)	25
Cestodes	Bunamidine (Scolaban)	50
	Dichlophen (several names)	200
	Niclosamide (Yomesan)	150
	Praziquantel (Droncit)	7.5
Trematodes	None are reliable Experimentally, Praziquantel or Albendazole can be tried.	
Protozoa	Dimetridazole (Emtryl)	10 (for flagellates, 5 days)
	Metronidazole (Flagyl)	125–275 (for amoebae, 8 days)
	Sulfadimethoxine (Albon)	45–90 (for coccidia)
	Sulfamethazine	40–75 (for coccidia)
External parasites	DriDi (a silica dessicant)	Topical application
	Dichlorovos "no pest strip"	Hang in cage for a few hours
	Ivermectin (Ivomec)	0.2 SQ, IM, or PO

*Use one-half dose for turtles.

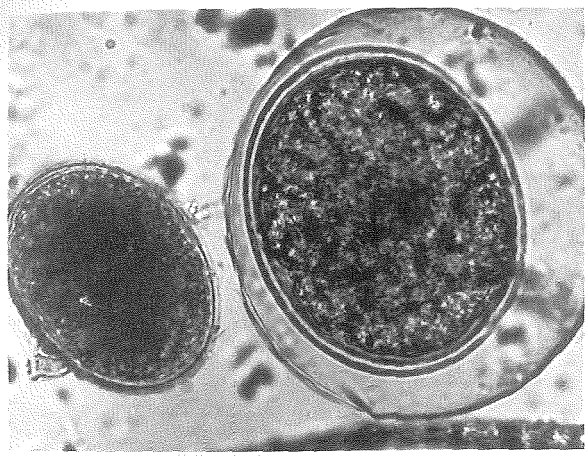


Fig. 304. An unknown pentastome (weird parasite). Eggs are 95 µm × 78 µm. Photo by S. Barnard. Used with permission.

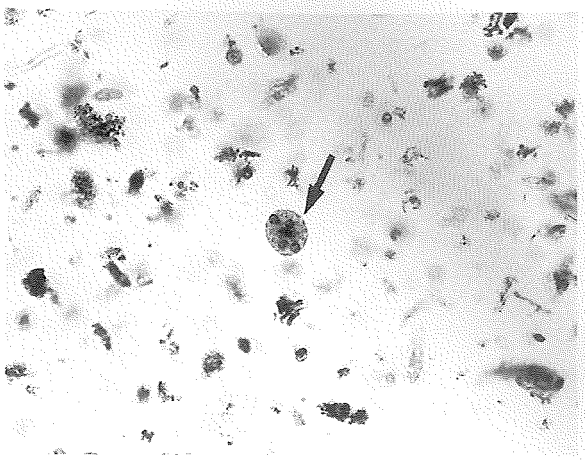


Fig. 305. *Entomoeba* sp. (arrow) from a rattlesnake.

Internal Parasites

Entomoeba sp.

Common name: *Entomoeba* sp. (a protozoan—amoeba).
Size of trophozoite: 9–38 µm × 8–30 µm.
Size of cyst: 9–24 µm in diameter, with one to four nuclei.
Transmission: Ingestion of cysts from affected feces
Importance: Can cause anorexia, weight loss, blood and mucus in feces, vomiting, and intestinal ulceration. It is most pathogenic in snakes and carnivorous lizards. Death often occurs 2 to 10 weeks after infection.
Prevention: Cysts can survive more than 2 weeks in the environment. Keep cages clean and quarantine sick animals. Do not mix lizards or snakes with turtles or crocodilians.
Treatment: Metronidazole, 125–250 mg/kg q 24 h × 3 d. Do not exceed 400 mg per day.
Paromomycin, 40 mg/kg P●

Bibliography

Ayala SC. Checklist, host index, and annotated bibliography of *Plasmodium* from reptiles. *J Protozool*, 25:87–100, 1978.

Barnard SM, SJ Upton: *A Veterinary Guide to the Parasites of Reptiles.* Volume 1, *Protozoa.* Malabar, Florida, Krieger Publishing Company, 1994.

Brownstein DG, Standberg, JD, Montaili, RJ, Bush, M, Fortner J: *Cryptosporidium* in snakes with hypertrophic gastritis. *Vet Pathol* 14:606, 1972.

Cooper JE: Disease in East African snakes associated with *Kalicephalus* worms (Nematoda: Diaphocephalidae). *Vet Rec* 89:385, 1971.

Flynn, RJ: Parasites of Laboratory Animals. Ames, Iowa, Iowa State University Press, 1973.

Fowler M (ed): *Zoo and Wild Animal Medicine.* 2nd edition. Philadelphia, W. B. Saunders Co., 1986.

Frank W: Endoparasites. In Cooper, JE, Jackson, OF (eds): *Diseases of the Reptilia*, Volume 1. London, Academic Press, 1981, pp. 291–358.

Gardiner CH, Fayer R, Dubey JP: *An Atlas of Protozoan Parasites of Animal Tissues.* U.S. Dep. Agriculture Handbook No. 651, Washington, DC 83 pp, 1988.

Klein TA, Young DG, Greiner EC, Telford SR, Butler JF: Development and experimental transmission of *Schellackia golvani* and *Schellackia occidentalis* by ingestion of infected blood-feeding arthropods. *Int J Parasitol*, 18:259–267, 1988.

Lichtenfels JR and Lavies B: Mortality in red-sided garter snakes, *Thamnophis sirtalis parietalis*, due to larval nematode *Eustrongylides* sp. *Lab Anim Sci* 26:465, 1976.

Marcus LC: *Veterinary Biology and Medicine of Captive Amphibians and Reptiles.* Philadelphia, Lea and Febiger, 1981.

Telford SR: Parasitic diseases of reptiles. *J. Am Vet Med Assoc*, 159:1644–162, 1971.

Telford SR: Haemoparasites of reptiles. In Hoff GL, Frye FL, Jacobsen ER (eds): *Diseases of Amphibians and Reptiles.* New York, Plenum Press, 1984, pp. 385–517.

Zwart P, Truyens EHA: Hexamitiasis in tortoises. *Vet Parasitol*, 1:175–183, 1975.

Section 15

PARASITES OF HUMANS

Location of Major Parasites

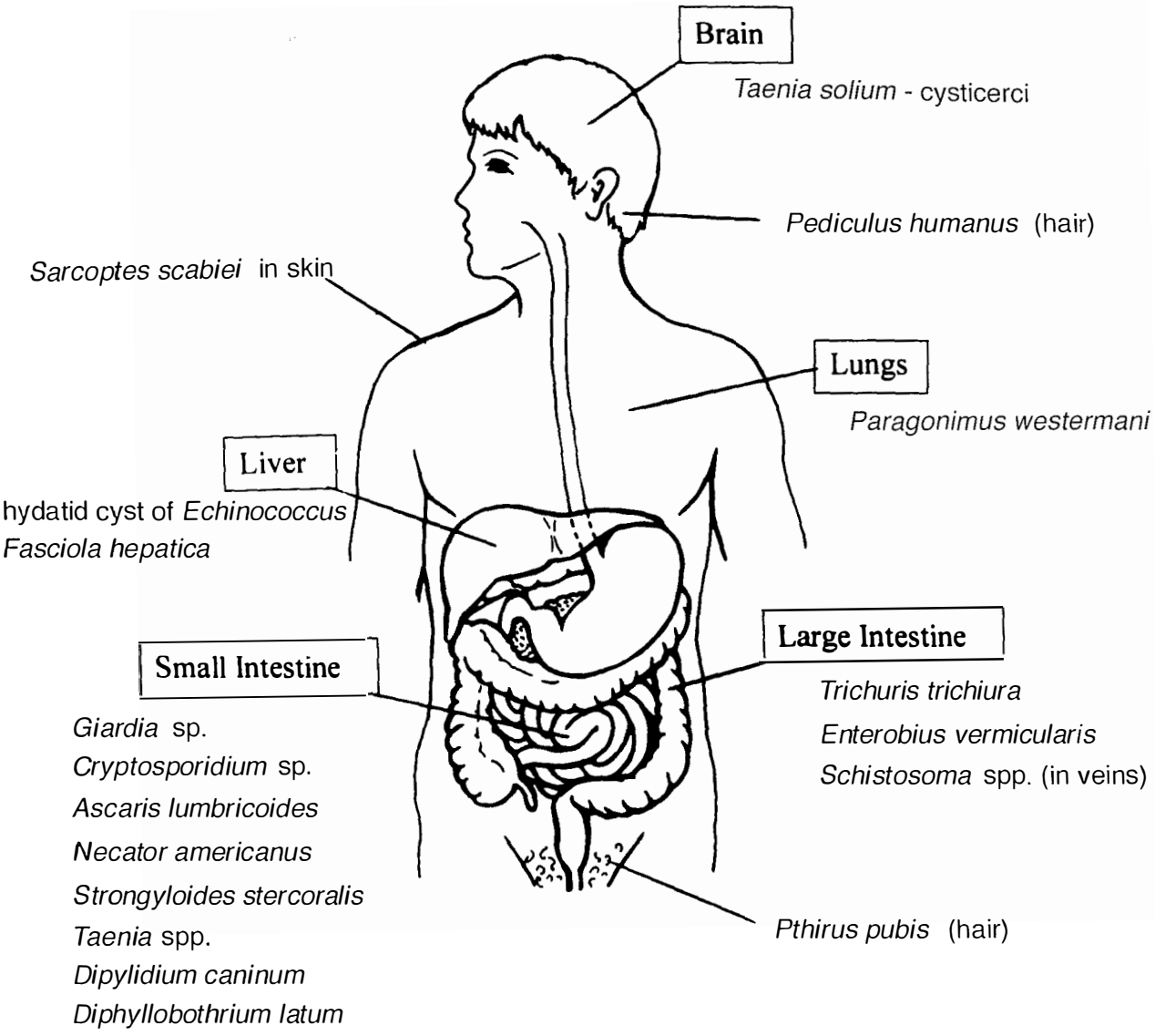


Fig. 306. Location of the common parasites of humans.

Common Parasites

Table 63. Common human parasites

Organism	Parasite or Disease	Treatment	Dose
Protozoa			
Giardia	Giardiasis	Furazolione	100 mg q 6 h × 7–10 d
		Metronidazole	250 mg q 8 h × 5 d
		Paromomycin	8–35 mg/kg q 8 h × 7 d
		Secnidazole	2 g once or 30 mg/kg once
		Tinidazole	2 g once or 30 mg/kg once
Cryptosporidium	Cryptosporidiosis	Paromomycin	25–35 mg/kg q 8 h × 7 d
		Supportive therapy	Fluids and electrolytes
Nematodes			
Ascaris	Roundworm	Albendazole	400 mg once
		Ivermectin	12 mg once
		Mebendazole	100 mg q 12 h × 3 d
		Pyrantel pamoate	11 mg/kg once (maximum 1 g)
		Piperazine	75 mg/kg (maximum 3.5 g)
Enterobius	Pinworm	Albendazole	400 mg once, repeat in 2 weeks
		Mebendazole	100 mg once, repeat in 2 weeks
		Pyrantel pamoate	11 mg/kg once (maximum 1 g), repeat in 2 weeks
Necator	Hookworm	Albendazole	400 mg once
		Pyrantel pamoate	11 mg/kg (max 1 g) q 24 h × 3 d
		Mebendazole	100 mg q 12 h × 3 d
Strongyloides	Threadworm	Ivermectin	0.2 mg/kg q 24 h × 2 d
		Albendazole	400 mg q 12 h × 3 d
Trichuris	Whipworm	Albendazole	400 mg once
		Mebendazole	100 mg q 12 h × 3 d
Cestodes			
Taenia saginata	Beef tapeworm	Praziquantel	5–10 mg/kg once
Taenia solium	Pork tapeworm	Praziquantel	5–10 mg/kg once
Taenia solium (cysts)	Cysticercosis	Praziquantel	50 mg/kg q 24 h × 14 d
		Albendazole	5 mg/kg q 8h × 28–30 d
		Surgery	
Dipylidium	Flea tapeworm	Praziquantel	5–10 mg/kg once
Echinococcus	Hydatid cyst	Albendazole	400 mg q 12 h × 28 d
		Mebendazole	40 mg/kg daily for months
		Surgery	
Diphyllobothrium	Fish tapeworm	Praziquantel	5–10 mg/kg once

Table 63. Common human parasites (*continued*)

Organism	Parasite or Disease	Treatment	Dose
Trematodes			
Fasciola	Liver fluke	Bithionol	30–50 mg/kg q 48 h × 10–15 d
		Praziquantel	25 mg/kg q 8 h × 1 d
Paragonimus	Lung fluke	Bithionol	30–50 mg/kg q 4 8 h × 14 d
		Praziquantel	25 mg/kg q 8 h × 2 d
Schistosoma	Blood fluke	Oxamniquine	15 mg/kg once
		Praziquantel	40–60 mg/kg q 8 h × 1 d
Duck flukes	Swimmer's itch	Corticosteroid cream	Topical
Arthropods			
Sarcoptes	Scabies	Ivermectin	0.2 mg/kg
Pediculus	Body and head louse	Permethrins	0.2%
		Ivermectin	0.2 mg/kg
Pthirus	Pubic louse	Permethrins	0.2 %

Internal Parasites

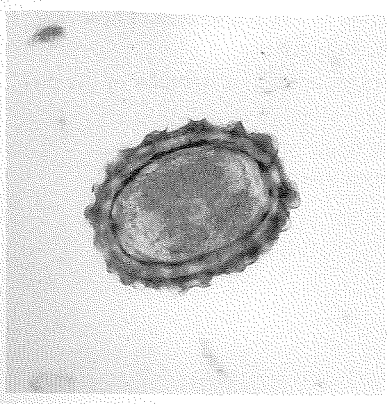


Fig. 307. *Ascaris lumbricoides* (roundworms). Eggs are 80 µm long.

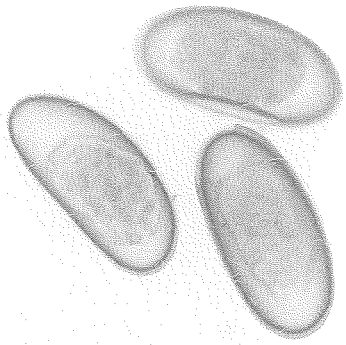


Fig. 308. *Enterobius vermicularis* (pinworms). Eggs are 75 µm long.

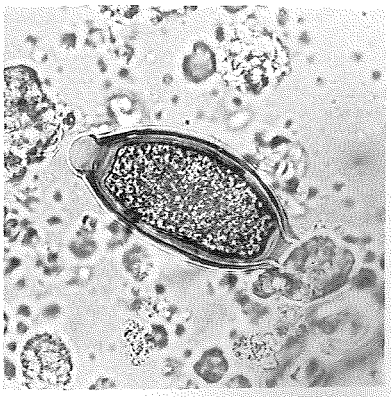


Fig. 309. *Trichuris trichuriata* (whipworms). Eggs are 80 µm long.

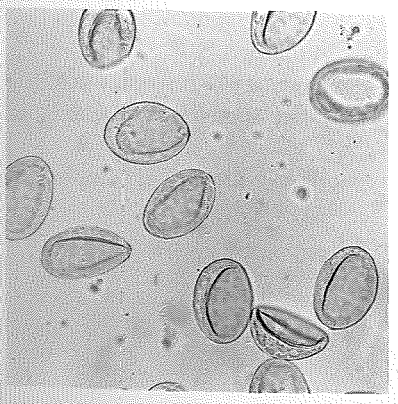


Fig. 310. *Diphyllobothrium latum* (fish tapeworms). Eggs are 80 µm long.

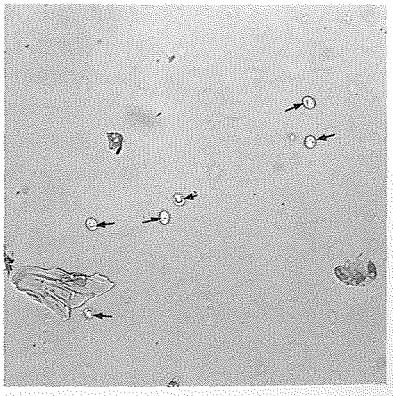


Fig. 311. *Cryptosporidium parvum* (protozoan). Oocysts are approximately 5 µm long (arrows).

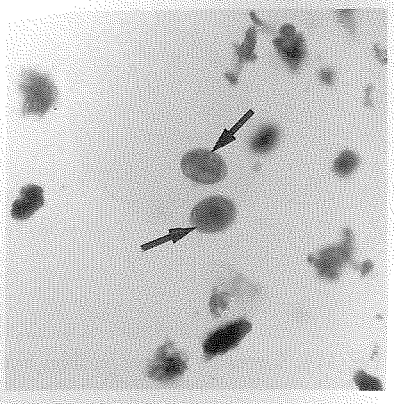


Fig. 312. *Giardia lamblia* (flagellated protozoan) Cysts are approximately 12–15 µm long (arrows).

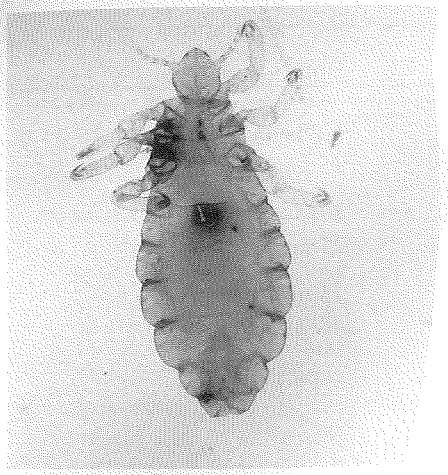


Fig. 313. *Pediculus hominis* (head louse).

External Parasites

Pediculus hominis

Common name: Human head lice.
Adult size: 2–3 mm on the head in the hair. Eggs (nits) are attached to the hairs.
Importance: These are sucking lice and suck blood. They cause itching of the scalp. These lice are host specific in humans.
Diagnosis: Find the eggs, adults, or nymphs on the head.
Treatment: See Table 63.
Permethrin shampoos are the standard treatment, but many lice are resistant.

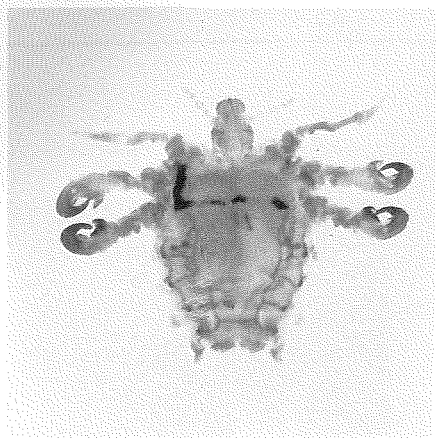


Fig. 314. *Pthirus pubis* (pubic louse).

Pthirus pubis

Common name: Pubic lice.
Adult size: 1 mm, with large claws, in pubic hair. Eggs (nits) are attached to pubic hairs.
Importance: These are sucking lice and suck blood. They cause itching of the pubic area. These lice are host specific in humans.
Diagnosis: Find the eggs, adults, or nymphs in the pubic area.
Treatment: See Table 63.
Permethrin shampoos are commonly used.

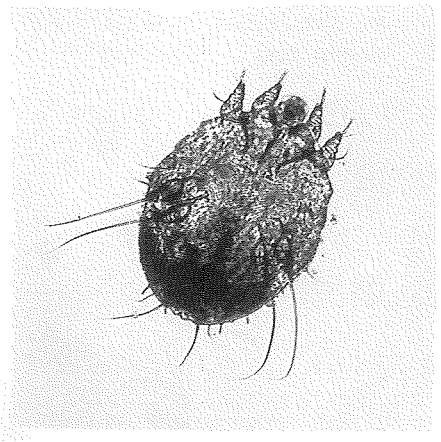


Fig. 315. *Sarcoptes scabiei* (scabies mite).

Sarcoptes scabiei

Common name: Scabies mites.
Adult size: 400–600 um. Adults, nymphs, larvae (6 legs), and eggs are in the skin
Importance: Cause severe itching ("Norwegian itch"). Human scabies mites are relatively host specific in humans.
Diagnosis: Skin scraping. Find eggs, larvae, nymphs, or adults.
Treatment: See Table 63
Ivermectin is often effective.

Bibliography

Bell TA. Treatment of *Pediculus humanus* var. capitis infestation in Cowlitz County, Washington, with ivermectin and the LiceMeister comb. *Pediatr Infect Dis J* 17:923–924, 1998.

Burkhart KM, Burkhart CN, Burkhart CG: Update on therapy: ivermectin is available for use against lice. *Infect Med* 14:689, 1997.

Campbell WC: Ivermectin, an antiparasitic agent. *Med Res Rev* 13:61–79, 1993.

Coleman R: The use of ivermectin in the treatment of scabies. *Ir Med J* 89:167, 1996.

Downs AM, Stafford KA, Coles GC: Susceptibility of British head lice, *Pediculus capitis*, to imidacloprid and fipronil. *Med Vet Entomol* 14:105–107, 2000.

Glaziou P, Cartel JL, Alzieu P, et al.: Comparison of ivermectin and benzyl benzoate for treatment of scabies. *Trop Med Parasitol* 44:331–332, 1993.

Glaziou P, Nyguyen LN, Moulia-Pelat JP, et al.: Efficacy of ivermectin for the treatment of head lice (*Pediculosis capitis*). *Trop Med Parasitol* 45:253–254, 1994.

Goddard J: *Physicians Guide to Arthropods of Medical Importance*. 3rd edition. Boca Raton, Florida, CRC Press, 1999, 440 pp.

Huffam SE, Currie BJ: Ivermectin for *Sarcoptes scabiei* hyperinfestation. *Int J Infect Dis* 2:152–154, 1998.

Meinking TL, Taplin D, Hermida JL, et al.: The treatment of scabies with ivermectin. *N Engl J Med* 333:26–30, 1995.

Ottesen EA, Campbell WC: Ivermectin in human medicine. *J Antimicrob Chemother* 34:195–203, 1994.

Rahman WA: Comparative trials using albendazole and mebendazole in the treatment of helminths in schoolchildren on Penang, Malaysia. *Southeast Asian J Trop Med Public Health* 27:765–767, 1996.

Youssef MYM, Sadaka HAH, Eissa MM, et al.: Topical application of ivermectin for human ectoparasites. *Am J Trop Med Hyg* 53:652–653, 1995.

Section 16

COMMON ARTIFACTS IN FECES

Artifacts

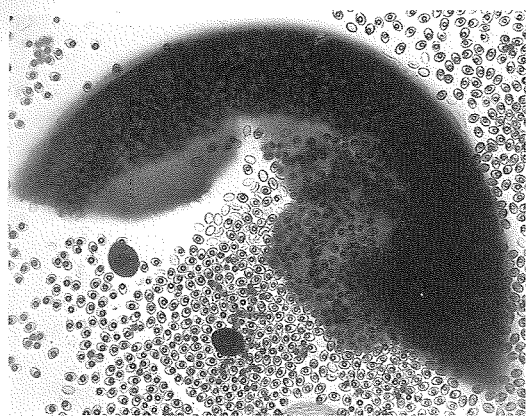


Fig. 316. Microscopic seeds and seed head.

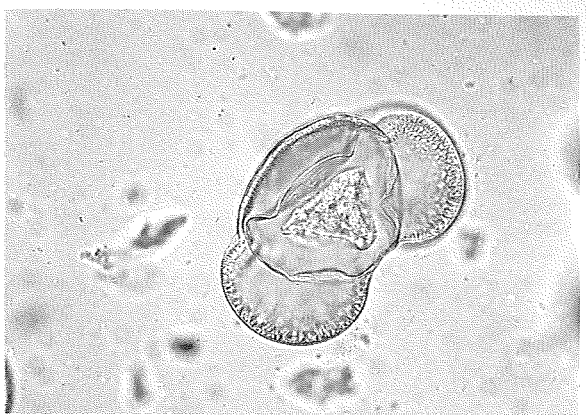


Fig. 317. Pine pollen.

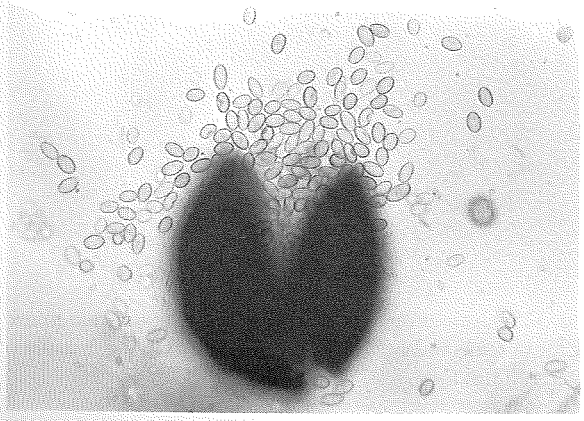


Fig. 318. Microscopic seeds and seed head.

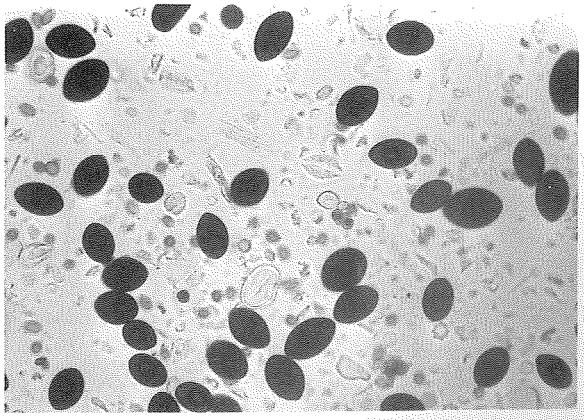


Fig. 319. Microscopic seeds and plant material.

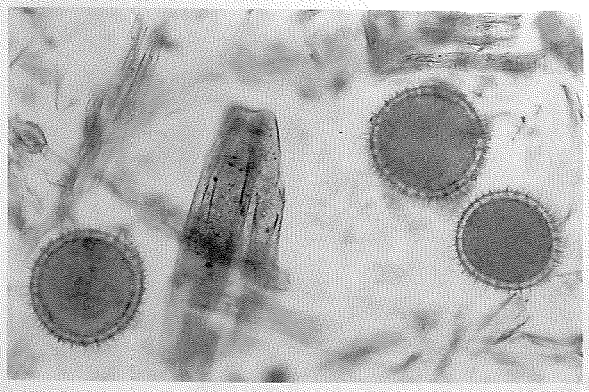


Fig. 320. Pollen.

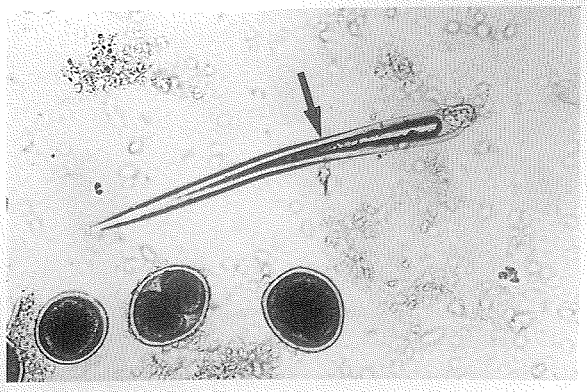


Fig. 321. Plant root hair at arrow (often confused with larvae). Ascarid eggs are also in the photo.

Spurious Parasites

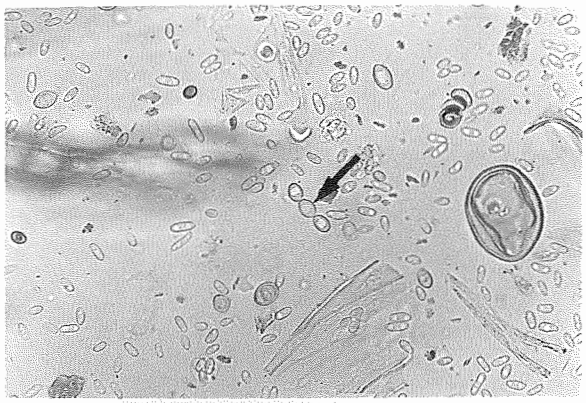


Fig. 322. Yeast (in chains, arrow) are often confused with coccidia.

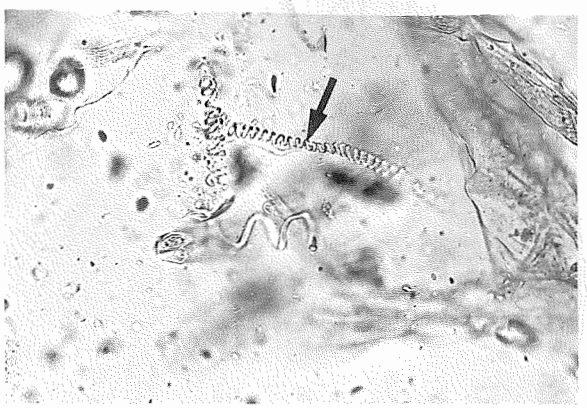


Fig. 323. *Spyrogyra* (an algae), "bedspring artifact" (arrow).

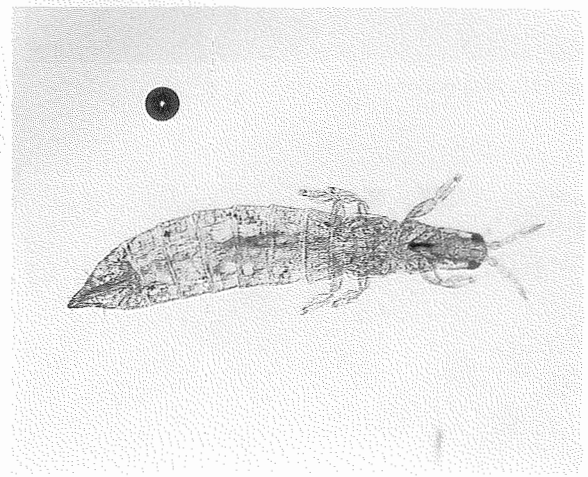


Fig. 324. Thrips (free-living insects) found occasionally in dog feces when collected from the ground.

Fig. 325. Grain mite eggs with mite inside egg. Grain mites occur in feed, and eggs pass in feces. Eggs are big, usually over 100 µm long.

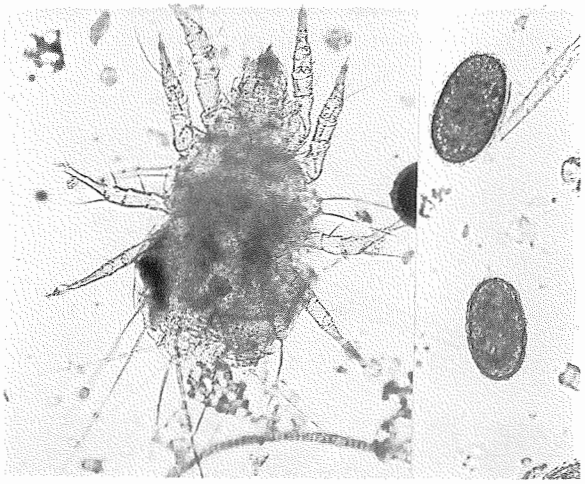


Fig. 326. An incidental mite (*Acarus* sp.) and *Acarus* sp. eggs in feces. Eggs are approximately 100–130 µm long.

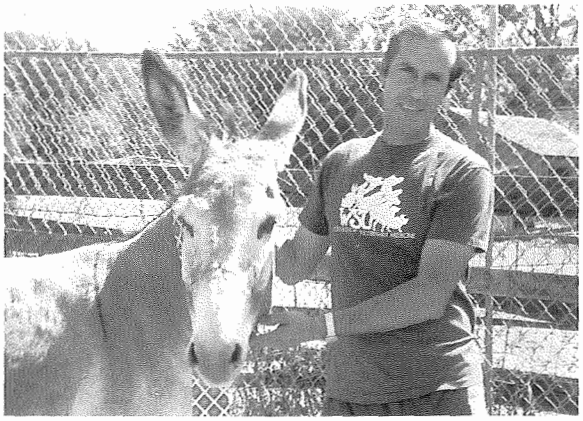


Fig. 327. *Ascaris foreyti*, 1,778 mm long.

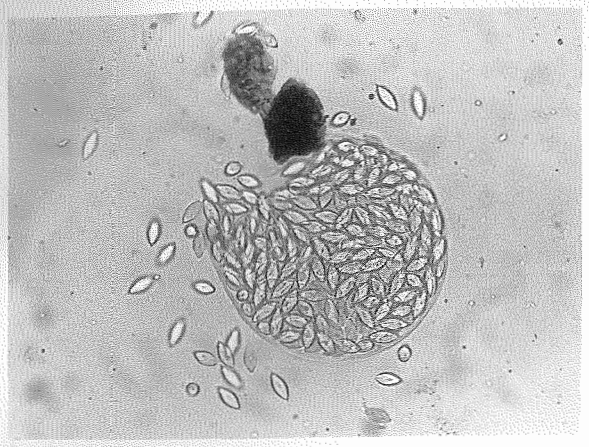


Fig. 328. Microscopic seed head.

Microscopic seeds from these microscopic seed heads often look like parasite eggs. These seeds resemble tiny *Trichuris* eggs to some degree.

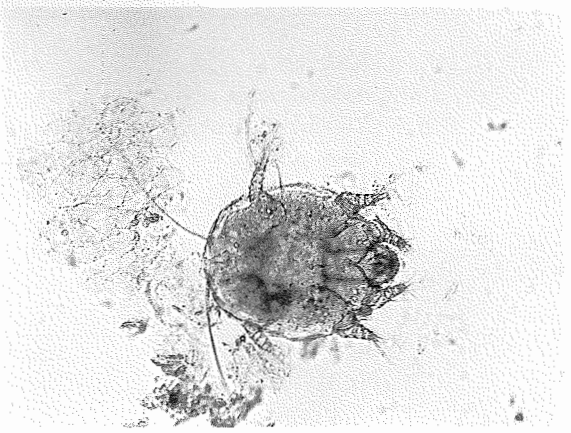


Fig. 329. A spurious mite in dog feces.

Mites and mite eggs are often seen in feces. Some of these mites are environmental mites that are ingested and pass out in feces. Some mites are the result of animals licking themselves, and some mites are spurious parasites that are the result of ingesting prey species that have mites. This mite is *Cnemidocoptes*, a bird mite in dog feces. Apparently, this dog ate an infected bird.

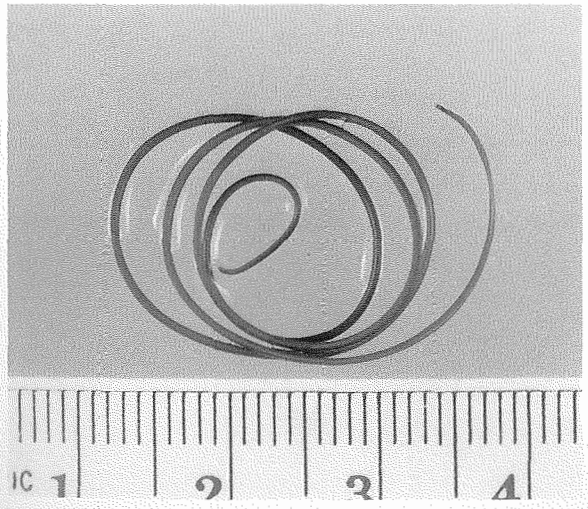


Fig. 330 The horsehair worm.

The "horsehair worm" (*Gordius*) is often found in livestock waterers, freshwater springs, and in water from springs, toilets, kitchen sinks, etc. These are not parasites of vertebrates. These are long worms, often 6–10 inches long.

Section 17
TABLES

Table 64. Metric / English conversion factors and measures of concentration

Metric / English Conversion Factors				
1 kg	=	1,000 g	=	2.2 lb
1 g	=	1,000 mg	=	0.035 oz
1 l	=	1,000 ml or cc	=	1.058 qt
1 ml or cc	=	0.034 fluid oz		
1 ml	=	1,000 µl		
1 l of water weighs 1 kg				
English / Metric Conversion Factors				
1 lb	=	453.6 g	=	0.454 kg
1 oz	=	28.35 g		
1 pt of water weighs approximately 1 lb				
1 gal of water weighs approximately 8.34 lb				
1 gal	=	4 qt	=	3.785 l
1 qt	=	2 pt	=	0.946 l
1 pt	=	0.473 l		
1 fluid oz	=	29.6 ml or cc		
Measures of Concentration				
1 ppm	=	1 µl/l		
	=	1 µl/kg		
	=	0.0001%		
	=	0.013 oz in 100 gal of water		
1 percent	=	10,000 ppm		
	=	10 g/l		
	=	1.33 oz by weight/gal of water		
	=	8.34 lb/100 gal		
0.1%	=	1,000 ppm	=	1,000 ml/l
0.01%	=	100 ppm	=	100 ml/l
0.001%	=	10 ppm	=	10 ml/l
0.0001%	=	1 ppm	=	1 ml/l

cc, cubic centimeter; g, gram; gal, gallon; kg, kilogram; l, liter; lb, pound; mg, milligram; ml, milliliter; oz, ounce; ppm, parts per million; pt, pint; qt, quart; µl, microliter.

Table 65. Temperature, length, and volume conversion chart

Temperature		Length			Volume	
°C	°F	cm	mm	inch	liters	quarts
100	212	2.54	25.4	1	1	1.1
90	194	5.08	50.8	2	2	2.1
80	176	10.16	101.6	4	3	3.2
70	158	20.32	203.2	8	4	4.2
60	140	30.48	304.8	12	5	5.3
50	122	40.64	406.4	16	6	6.3
40	104	50.80	508.0	20	7	7.4
35	95	60.96	609.6	24	8	8.5
30	86	71.12	711.12	28	9	9.5
25	77	81.28	812.8	32		
20	68	91.44	914.4	36		
15	59					
10	50					
5	41					
0	32					
−5	23					
−10	14					
−15	5					
−20	−4					
−25	−13					
−30	−22					
−40	−40					

Table 66. Abbreviations used in text

BID	Twice a day
BW	Body weight
CBC	Complete blood count
CNS	Central nervous system
d	Day
ELISA	Enzyme-linked immunosorbent assay
h	Hour
IM	Intramuscular(ly)
IV	Intravenous(ly)
PO	By mouth
ppm	Parts per million
q	Every
SC	Subcutaneously
SD	Standard deviation

INDEX

Numbers in bold italic represent species description. When a comma precedes spp., more than one species form is given.

Veterinary Parasitology Reference Manual is a practical, thorough, bench top reference for basic diagnostic veterinary parasitology. The manual provides pertinent information on parasite life cycles, importance, location in the host, zoonotic potential, current literature, diagnosis, and treatment. It also includes step-by-step instructions for the most common diagnostic procedures used in routine veterinary practice.

Sections are organized by animal host species, including dogs; cats; cattle, sheep, and goats; llamas; horses; pigs; birds; ratites (ostriches, emus, and cassowaries); and laboratory animals, as well as wildlife, reptiles, marine mammals, and humans. There is a section in which common artifacts found in fecal samples are presented, and the last section includes conversion tables and a list of abbreviations.

Features of the Fifth Edition include:

- Updated and enhanced references
- Information on new drugs
- Improved section on parasites of marine mammals
- Sections on parasites of laboratory animals and humans
- Over 500 photographs and figures

Readers will find this to be an easily accessible and accurate resource for information about parasites in a variety of animals—wild, domestic, common, and exotic.

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