Parasitology is a fascinating field, especially when exploring the intricate mechanisms by which parasites propagate. In the fast-paced veterinary clinic environment, the study of parasitology too often becomes routine and mundane—we simply perform yet another fecal examination and dutifully record the results.

We invite you to step out of this routine and rediscover the amazing life cycles of these remarkable organisms. Challenge yourself to not only identify a hookworm egg by genus alone, but by species. Explore the complex relationships between parasites and their intermediate and definitive hosts.

This diagnostic manual is designed to be an informative source for the identification and exploration of internal parasites. To be of most benefit to veterinarians and technicians, the manual was designed to be convenient and easy to use. As you’ll see, the parasites described in this manual have been divided into two groups according to the material (i.e., feces or blood) tested for infection. Additional sections are devoted to pseudoparasites, parasite life cycles and practical, time-saving diagnostic procedures. In addition, you will find guidelines for parasite prevention in dogs and cats developed by the Companion Animal Parasite Council, plus a handy index.

All of the information provided here is brief and to the point. Wherever possible, symbols are used to convey key information (see the key at left).

We would like to acknowledge Professor Byron Blagburn, Department of Pathobiology, College of Veterinary Medicine, Auburn University, for providing astute technical assistance and one-of-a-kind illustrative material for this manual.

Novartis is pleased to provide you with this laboratory manual to assist with diagnosis of common parasites in dogs and cats. We hope it will further aid your fecal examinations and parasite identification. Please use this manual to help educate your clients on the risks and prevention of internal parasites. We are honored to work with you toward the most important goal: a happy, healthy pet.

Jason Drake, DVM
Director of Professional Services
Novartis Animal Health US, Inc.

Dr. France Gagné
National Director, Professional Services
Novartis Animal Health Canada Inc.
INTERNAL PARASITES OF DOGS AND CATS

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PARASITES FOUND IN BLOOD

Nematodes
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Dirofilaria immitis 7
Acanthocheilonema (Dipetalonema) reconditum

Note the characteristic smaller size and blunt anterior end of microfilariae of *A. reconditum* (top) and the characteristic tapering anterior end of microfilariae of *D. immitis* (bottom).

**Characteristics of microfilariae of *D. immitis* and *A. reconditum***

<table>
<thead>
<tr>
<th></th>
<th><em>Dirofilaria immitis</em></th>
<th><em>Acanthocheilonema reconditum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>307–322 μm (310 μm average)</td>
<td>246–293 μm (280 μm average)</td>
</tr>
<tr>
<td><strong>Width</strong> (½ of length from anterior end)</td>
<td>6.1–7.2 μm</td>
<td>4.7–5.8 μm</td>
</tr>
<tr>
<td><strong>Shape of head</strong></td>
<td>Tapered</td>
<td>Blunted</td>
</tr>
<tr>
<td><strong>Cellularity of anterior end</strong></td>
<td>Cellular</td>
<td>Clear space</td>
</tr>
<tr>
<td><strong>Condition of tail</strong></td>
<td>Straight</td>
<td>Button hook shaped in some (artifact of formalin fixation)</td>
</tr>
<tr>
<td><strong>Motility in direct smear of anticoagulated whole blood</strong></td>
<td>Stationary</td>
<td>Progressive (tends to move out of field of view)</td>
</tr>
</tbody>
</table>
Adult *D. immitis* in the right ventricle of the heart.

Microfilariae of *D. immitis* as seen on a membrane filtration test. Note: Circulating microfilariae are very rarely observed in the cat.
# Parasites Found in Feces

## Parasites of the Gastrointestinal Tract

- **Cestodes**
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  - Echinococcus spp. 14
  - Taenia spp. 15

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  - Pearsonema (Capillaria) plica 30
PARASITES OF THE GASTROINTESTINAL TRACT – CESTODES

*Dipylidium caninum*

Egg packet of *D. caninum*

*Comparison of adult D. caninum with a canine roundworm.*
**Dipylidium caninum**

Adult *D. caninum*. Note that the segments are longer than they are wide. Dried proglottids (segments) are sometimes brought in for identification by pet owners.

**Dipylidium caninum**

Dried *D. caninum* segments; sometimes found by pet owners.
Comparison of common tapeworms in dogs and cats

<table>
<thead>
<tr>
<th></th>
<th>Dipylidium caninum</th>
<th>Taenia pisiformis*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common name</strong></td>
<td>Cucumber seed tapeworm</td>
<td>Dog - Rabbit tapeworm</td>
</tr>
<tr>
<td><strong>Definitive host</strong></td>
<td>Dog, cat, rarely humans</td>
<td>Dog</td>
</tr>
<tr>
<td><strong>Intermediate host</strong></td>
<td>Fleas, lice</td>
<td>Rabbits</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>Small; 0.2–0.8 meters (0.6–2.6 feet)</td>
<td>Large; 0.6–2 meters (1.9–6.6 feet)</td>
</tr>
<tr>
<td><strong>Structure of head</strong></td>
<td>Small rostellum (attachment device)</td>
<td>Large rostellum</td>
</tr>
<tr>
<td></td>
<td>armed with many small hooks;</td>
<td>surrounded by 4</td>
</tr>
<tr>
<td></td>
<td>rostellum is surrounded by 4 suckers</td>
<td>suckers</td>
</tr>
<tr>
<td>**Structure of mature/</td>
<td>Oblong (resemble cucumber seed),</td>
<td>Mature proglottids</td>
</tr>
<tr>
<td>gravid proglottids</td>
<td>with two sets of reproductive organs</td>
<td>are square to</td>
</tr>
<tr>
<td>(tapeworm segments)</td>
<td>opening into bilateral pores;</td>
<td>rectangular, with</td>
</tr>
<tr>
<td></td>
<td>proglottids are often motile. Dried</td>
<td>a single set of</td>
</tr>
<tr>
<td></td>
<td>proglottids resemble rice grains.</td>
<td>reproductive organs</td>
</tr>
<tr>
<td><strong>Structure of eggs</strong></td>
<td>Individual eggs consist of a hexacanth</td>
<td>Individual eggs</td>
</tr>
<tr>
<td></td>
<td>(6-hooked) embryo within a thin</td>
<td>consist of a</td>
</tr>
<tr>
<td></td>
<td>embryophore (shell); individual eggs</td>
<td>hexacanth embryo</td>
</tr>
<tr>
<td></td>
<td>are contained in packets of 3–30</td>
<td>within a radially</td>
</tr>
<tr>
<td></td>
<td>eggs. Egg packets (200–300 μm) are</td>
<td>striated embryo-</td>
</tr>
<tr>
<td></td>
<td>passed in feces or retained within</td>
<td>phore. Eggs (30–40</td>
</tr>
<tr>
<td></td>
<td>proglottids.</td>
<td>μm) are usually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>passed individually</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in feces. Eggs of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T. pisiformis can</td>
</tr>
<tr>
<td></td>
<td></td>
<td>not be distinguished</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from eggs of other</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taenia spp., or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>from those of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Echinococcus spp.</td>
</tr>
<tr>
<td><strong>Zoonotic potential</strong></td>
<td>Yes, usually small children</td>
<td>No</td>
</tr>
<tr>
<td><strong>Disease potential in</strong></td>
<td>Both Dipylidium and Taenia tapeworms</td>
<td></td>
</tr>
<tr>
<td><strong>dogs or cats</strong></td>
<td>are generally nonpathogenic to dogs or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cats. Rarely, heavy infections can</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cause soft or diarrheic feces,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>restlessness, abdominal pain, dull</td>
<td></td>
</tr>
<tr>
<td></td>
<td>coat, and excessive grooming of the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>perineum due to pruritus. Dipylidium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>can infect humans, particularly small</td>
<td></td>
</tr>
<tr>
<td></td>
<td>children, resulting in similar clinical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>signs.</td>
<td></td>
</tr>
</tbody>
</table>

*A similar tapeworm, Taenia (syn. Hydatigera) taeniaeformis infects cats. It resembles T.pisiformis.
### Selected tapeworms of veterinary importance

<table>
<thead>
<tr>
<th>Tapeworm Species</th>
<th>Definitive Hosts*</th>
<th>Intermediate Hosts</th>
<th>Larval Stage; Site of Larval Tapeworm Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipylidium caninum</td>
<td>Canids, felids,</td>
<td>Flea, louse</td>
<td>Cysticercoid; body cavity of insects</td>
</tr>
<tr>
<td></td>
<td>rarely humans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taenia pisiformis</td>
<td>Canids</td>
<td>Rabbits</td>
<td>Cysticercus; abdominal cavity and liver of rabbits</td>
</tr>
<tr>
<td>Taenia hydatigena</td>
<td>Canids</td>
<td>Livestock</td>
<td>Cysticercus; abdominal cavity and liver of livestock</td>
</tr>
<tr>
<td>Taenia ovis</td>
<td>Canids</td>
<td>Sheep, goats</td>
<td>Cysticercus; musculature of intermediate hosts</td>
</tr>
<tr>
<td>Taenia multiceps</td>
<td>Canids</td>
<td>Sheep, cattle, humans</td>
<td>Coenurus; brain and spinal cord of intermediate hosts</td>
</tr>
<tr>
<td>Taenia serialis</td>
<td>Canids</td>
<td>Rabbits, rodents,</td>
<td>Coenurus; connective tissue of rabbits, rodents and rarely humans</td>
</tr>
<tr>
<td></td>
<td>rarely humans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taenia taeniaeformis</td>
<td>Felids</td>
<td>Rodents</td>
<td>Strobilocercus; liver of rodents</td>
</tr>
<tr>
<td>Mesocestoides spp.</td>
<td>Canids, felids</td>
<td>Coprophilic insect or mite (1st host); mammals, reptiles, frogs, birds (2nd host)</td>
<td>Tetrahyridium in insect or mite and in abdominal cavity and liver of vertebrates</td>
</tr>
<tr>
<td>Echinococcus granulosus</td>
<td>Canids</td>
<td>Livestock, humans</td>
<td>Unilocular hydatid cyst; liver, lungs</td>
</tr>
<tr>
<td>Echinococcus multilocularis</td>
<td>Canids, rarely felids</td>
<td>Rodents, humans, rarely pig, horse</td>
<td>Multilocular hydatid; liver, lungs</td>
</tr>
<tr>
<td>Spirometra mansonioides</td>
<td>Felids, canids, raccoons</td>
<td>Copepods (1st host); many vertebrates except fish (2nd hosts)</td>
<td>Proceroid (body cavity of copepods); plerocercoid (body musculature and subcutaneous fascia of vertebrates)</td>
</tr>
<tr>
<td>Diphyllobothrium latum</td>
<td>Humans, canids, felids, porcids</td>
<td>Copepods (1st host); fish (2nd host); several paratenic hosts</td>
<td>Proceroid (body cavity of copepods); plerocercoid (abdominal cavity, musculature of fish)</td>
</tr>
</tbody>
</table>

*All tapeworms inhabit the small intestine of the definitive host.*
Parasites of the **GASTROINTESTINAL TRACT – CESTODES**

**Echinococcus spp.**

- Eggs of *E. granulosus*
- Adult *E. granulosus*. Although *E. granulosus* occurs only in the dog, other species of *Echinococcus* appear in dogs and cats.
Parasites of the **GASTROINTESTINAL TRACT – CESTODES**

*Taenia* spp.

Eggs of *T. pisiformis*

Note: Cats are host to other *Taenia* spp.

Adult *T. pisiformis*.

Note the difference in segment shape compared to adult *D. caninum*.
Parasites of the **GASTROINTESTINAL TRACT – NEMATODES**

**Ancylostoma caninum**

Egg of *A. caninum*

**Ancylostoma caninum**

Anterior end of adult *A. caninum*. Note the three pairs of ventral teeth.
Parasites of the **GASTROINTESTINAL TRACT – NEMATODES**

*Ancylostoma tubaeforme*

Egg of *A. tubaeforme*
Egg of *U. stenocephala*

Note the differences in size between *U. stenocephala* (upper right) and *A. caninum* (lower left).
### CANINE HOOKWORMS

<table>
<thead>
<tr>
<th></th>
<th>Ancylostoma caninum</th>
<th>Uncinaria stenocephala</th>
<th>Ancylostoma braziliense</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infection</strong></td>
<td>Ingestion of 3rd stage larvae from contaminated environment</td>
<td>Larval penetration of the skin</td>
<td>Transmammary transmission of larvae is an important route of infection for <em>A. caninum</em></td>
</tr>
<tr>
<td><strong>Prepatent Period</strong></td>
<td>14 to 21 days (nursing puppies may shed eggs in 10 to 12 days)</td>
<td>13 to 27 days</td>
<td>13 to 27 days</td>
</tr>
<tr>
<td><strong>Occurrence</strong></td>
<td>Common</td>
<td>Uncommon (1%)³</td>
<td>Uncommon</td>
</tr>
<tr>
<td><strong>Locations</strong></td>
<td>Worldwide</td>
<td>Colder climates (northern US, Canada, Europe)</td>
<td>Warm, coastal areas (also sub and tropical Central &amp; South America &amp; Caribbean)</td>
</tr>
<tr>
<td><strong>Pathogenic</strong></td>
<td>Very pathogenic: anemia</td>
<td>Rarely pathogenic</td>
<td>Cutaneous larva migrans</td>
</tr>
<tr>
<td><strong>Blood per worm per day</strong></td>
<td>adult female: ~40μl; adult male: ~13μl</td>
<td>0.3μl</td>
<td>1 to 2μl</td>
</tr>
<tr>
<td><strong>Mouthparts</strong></td>
<td>3 pairs of teeth</td>
<td>cutting plates</td>
<td>1 pair of large; 1 pair of small</td>
</tr>
</tbody>
</table>

1. www.capcvet.org
Parasites of the **GASTROINTESTINAL TRACT – NEMATODES**

*Physaloptera spp.*

Embryonated eggs of *Physaloptera* spp. (stomach worm)
Parasites of the **GASTROINTESTINAL TRACT – NEMATODES**

**Toxascaris leonina**

Egg of *T. leonina*

**Toxocara canis**

Egg of *T. canis*

**Toxocara cati**

Egg of *T. cati*

Note: The size is about 10 percent smaller than the *T. canis* egg.
Parasites of the **GASTROINTESTINAL TRACT – NEMATODES**

### Baylisascaris procyonis

![Egg of B. procyonis](image1)

### Toxocara canis

![Egg of T. canis](image2)

Note the similarities. Differentiation can be made based on size and color, as the egg of *B. procyonis* is roughly three-quarters the size of *T. canis* and typically appears darker.
Parasites of the **GASTROINTESTINAL TRACT – NEMATODES**

**Trichuris vulpis**

- Egg of *T. vulpis*

- Adults of *T. vulpis*: Note how the whip-like anterior ends are laced through the mucosa.
Parasites of the **GASTROINTESTINAL TRACT – PROTOZOA**

**Giardia spp.**

Motile trophozoite of *Giardia* spp. (iodine stain)

*C certain assemblages may infect humans*

**Giardia spp.**

Cyst of *Giardia* spp. (iodine stain)
Parasites of the **GASTROINTESTINAL TRACT – PROTOZOA**

**Isospora (Cystoisospora) spp.**

Nonsporulated oocysts of *I. canis*

Nonsporulated oocysts of *I. ohioensis*
Isospora (Cystoisospora) spp.

Nonsporulated oocysts of *I. felis*

Nonsporulated oocysts of *I. rivolta*
Parasites of the **GASTROINTESTINAL TRACT – PROTOZOA**

**Toxoplasma gondii**

Nonsporulated oocysts of *T. gondii*

Compare the size of *T. gondii* to *I. felis* in the background.

**Cryptosporidium spp.**

Sporulated oocysts of *Cryptosporidium* spp.
Parasites of the **RESPIRATORY TRACT** – **NEMATODES**

**Aelurostrongylus abstrusus**

Larva of *A. abstrusus*
Note dorsal appendage on tail of larva.

**Eucoleus (Capillaria) aerophilus**

Egg of *E. aerophilus*
Parasites of the **RESPIRATORY TRACT – TREMATODES**

*Paragonimus kellicotti*

Egg of *P. kellicotti*. Note the collar surrounding the operculum.
Parasites of the **URINARY TRACT** – **NEMATODES**

*Pearsonema (Capillaria) feliscati*

Stained egg of *P. feliscati* from urinary sedimentation

*Pearsonema (Capillaria) plica*

Egg of *P. plica* from urinary sedimentation
PSEUDOPARASITES

**Pseudoparasites**

- Alternaria spp. 32
- Free-living nematode 33
- Grain mite egg 34
- Planarian 34
- Pollen granules 35

**Spurious parasite**

- Monocystis lumbrici or Rhyncocystis pilosa spore 36

Pseudoparasites are specimens found in feces or blood that are mistaken for parasites. (For the purpose of this manual, only examples of pseudoparasites found in feces are included.) Pseudoparasites can be differentiated from spurious parasites, which are parasites of a host other than the host under examination. For example, dogs and cats often consume feces of other vertebrate animals or consume invertebrates and will sometimes excrete stages of parasites unique to their prey. *Monocystis lumbrici* is an example of a spurious parasite. While it is a true parasite of earthworms, dogs and cats can ingest earthworms, causing *M. lumbrici* to appear in fecal examinations.
Alternaria spp.

These conidia are common environmental fungal contaminants.
These pseudoparasites are often recovered from feces collected from the ground. Note the bulbed esophagus.

Free-living nematode
Dogs and cats ingest these eggs by eating mite-infested food. Eggs are often recovered during fecal flotation.

Grain mite egg

This free-living flatworm is not a parasite but crawls into water dishes kept outside. It can then be ingested and is sometimes regurgitated by dogs and cats.

Planarian
Pollen granules

Pine pollen

Pollen granules

Tree pollen
These spurious parasites often infect earthworms; dogs and cats may ingest earthworms. In fecal floatations, the spore is similar in appearance to eggs of *T. vulpis*, although much smaller.
Feline
Aelurostrongylus abstrusus 38
Ancylostoma tubaeforme 39
Dirofilaria immitis 40
Taenia spp. 41
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Toxocara cati 43
Uncinaria stenocephala 44

Canine
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Baylisascaris procyonis 46
Dipylidium caninum 47
Dirofilaria immitis 48
Echinococcus granulosus 49
Echinococcus multilocularis 50
Taenia spp. 51
Toxascaris leonina 52
Toxocara canis 53
Trichuris vulpis 54
Uncinaria stenocephala 55
**AELUROSTRONGYLUS ABSTRUSUS**

Prepatent period: 7-9 weeks
Patent period: several years

- Adult worms in lung produce eggs.
- Larvae hatch from eggs.
- Larvae move to intestine via tracheal migration.
- Larvae ingested by intermediate hosts (snails and slugs).
- Larvae are passed in feces.
- Tissues of transport host or intermediate host ingested by cat.
**ANCYLOSTOMA TUBAEFORME**

Prepatent period: 2-3 weeks  
Patent period: can be prolonged depending on immune status

*A. tubaeforme*: The principal routes of transmission are through ingestion and skin penetration. Paratenic transmission occurs rarely, if at all.

- Larvae migrate via lungs to the intestine and mature to adult
- Adult worms lay eggs in small intestine
- Infective larvae penetrate skin or ingested by cat directly or with transport host
- Eggs embryonate and hatch; larvae undergo two molts to infective third-stage larvae
- Nonembryonated eggs pass in feces
- Larvae can be ingested by transport host
- Humans can be infected by larvae penetrating the skin
- Larvae migrate in the skin
- Larvae migrate via lungs to the intestine and mature to adult
- Adult worms lay eggs in small intestine
- Infective larvae penetrate skin or ingested by cat directly or with transport host
- Eggs embryonate and hatch; larvae undergo two molts to infective third-stage larvae
- Nonembryonated eggs pass in feces
- Larvae can be ingested by transport host
- Humans can be infected by larvae penetrating the skin
- Larvae migrate in the skin
**Dirofilaria immitis**

- **Prepatent period:** 6-8 months
- **Patent period:** usually short

Mosquito bites cat and transmits infective L3

Microfilariae develop in mosquito to infective L3 stage. Development in the mosquito is temperature-dependent; infected larvae can develop in 8 days at 30°C

Larvae mature into adults in the pulmonary arteries and the right heart; female adults release microfilariae in the blood

Mosquito ingests microfilariae with blood meal
**TAENIA spp.**

Prepatent period: 4-11 weeks  
Patent period: several years  
Cats mainly: *Taenia taeniaeformis*

- Tissues of intermediate host ingested by cat
- Adult worms in small intestine
- Eggs ingested by intermediate host (mouse, squirrel, etc)
- Eggs released from segments or are free in feces
- Posterior segments of adult worms or eggs are passed in feces
**TOXASCARIS LEONINA**

Prepatent period: 13 weeks
Patent period: 4-6 weeks

- Tissues of transport host or embryonated eggs ingested by cat
- Embryonated eggs ingested by transport host
- Eggs embryonate
- Larvae undergo two molts to infective third-stage larvae within the egg
- Embryonated eggs survive for long periods in contaminated environments
- Larvae mature in small intestine, adult worms lay eggs
- Nonembryonated eggs pass in feces
**TOXOCARA CATI**

Prepatent period: 3-6 weeks
Patent period: 4-6 months

**Transmission to offspring:**
Transmammary

Tissues of transport host or embryonated eggs ingested by cat

Embryonated eggs ingested by transport host

Eggs embryonate

Embryonated eggs survive for long periods in contaminated environments

Larvae undergo two molts to infective third-stage larvae within the egg

Larvae migrate via liver and lung to intestine and mature to adults

Adult worms lay eggs in the small intestine

Transmission to offspring: Transmammary

Nonembryonated eggs pass in feces

Humans can be infected by ingesting embryonated eggs

Larvae migrate to internal organs (i.e. muscles, eyes and central nervous system)

Embryonated eggs survive for long periods in contaminated environments

Humans can be infected by ingesting embryonated eggs

Larvae migrate to internal organs (i.e. muscles, eyes and central nervous system)
**UNCINARIA STENOCEPHALA**

Prepatent period: 3-4 weeks  
Patent period: can be prolonged depending on immune status

1. **Eggs embryonate and hatch**: Larvae undergo two molts to infective third-stage larvae.
2. **Infective larvae ingested by cat**.
3. **Larvae migrate via lungs to the intestine and mature to adult**.
4. **Adult worms lay eggs in small intestine**.
5. **Nonembryonated eggs pass in feces**.
**ANCYLOSTOMA CANINUM**

Prepatent period: 2-3 weeks
Patent period: 7 months to 2 years, can be prolonged depending on immune status

Larvae migrate via lungs to the intestine and mature to adult

Adult worms lay eggs in small intestine

Transmission to offspring: Transmammary

Nonembryonated eggs pass in faeces

Infective larvae penetrate skin or ingested by dog directly or with transport host

Humans can be infected by larvae penetrating the skin

Larvae can be ingested by transport host

Eggs embryonate and hatch; larvae undergo two molts to infective third-stage larvae

Larvae migrate in the skin

Nonembryonated eggs pass in feces

Infective larvae penetrate skin or foot pads or ingested by dog directly or with transport host
**Baylisascaris procyonis**

Prepatent period: 8 weeks
Patent period: 4-6 months

Larvae develop to adults in the small intestine, adult worms lay eggs

Tissues of transport host or embryonated eggs ingested by dog

Embryonated eggs ingested by transport host

Embryonated eggs survive for long periods in contaminated environments

Humans can be infected by ingesting embryonated eggs

Nonembryonated eggs pass in feces

Eggs embryonate

Larvae undergo two molts to infective third-stage larvae within the egg

BAYLISASCARIS PROCYONIS
**DIPYLIDUM CANINUM**

Prepatent period: 2-3 weeks  
Patent period: several months  

*On occasion: dog biting lice *Trichodectes canis*

- Infected adult flea ingested by dog
- Eggs ingested by larval flea*
- Infectious larvae develops as larval flea develops into adult
- Posterior (gravid) segments or individual egg packets are passed in feces  
- Segments and egg packets in feces and on fur in perineal area  
- Adult worms in small intestine
**DIROFILARIA IMMITIS**

**Prepatent period:** 6 months  
**Patent period:** several years

**Effects of immature heartworms:**

Disease associated with *Dirofilaria immitis* may not be limited to mature adult worms. Advancement of L₄ to immature adult heartworm (L₅) begins at 50 days post infection. By day 58 approximately half of the L₄ have become immature adults, and by day 70 all L₄ are now immature adults. These small worms (approx. 1.5 cm) are carried by the flow of blood to the pulmonary arteries. Inflammatory events associated with these and maturing later stages include peri-arteritis, interstitial edema and inflammatory interstitial disease. These immature worms in the pulmonary vessels are not detectable by veterinarians with available heartworm tests.

**Effects of adult heartworms:**

Presence of adult worms in the right heart and pulmonary arteries results in the more commonly observed disease syndrome. The physical presence of adult worms can lead to inflammation and proliferation of the arterial walls (villous endarteritis). Death of adult worms and resulting embolic worm fragments can trigger a cascade of inflammatory events leading to thrombosis and decreased blood flow to the lungs. In severe, long-standing infections, ventricular hypertrophy and classical right heart failure are observed.

Note: Infective larvae reach the heart and lungs about 3 months after being transmitted to the animal by a bite from a carrier mosquito. A positive blood test will be achieved after 6–6.5 months, when infective larvae have matured into adult heartworms.
**ECHINOCOCCUS GRANULOSUS**

Prepatent period: 45 days  
Patent period: several months

- Tissues of intermediate host ingested by dog or cat
- Eggs ingested by intermediate host (sheep, cattle, and horses)
- Hydatids forming in the liver or the lungs of the intermediate host
- Eggs in feces
- Posterior segments of adult worms pass in feces
- Eggs are released from segments
- Humans can be infected through eggs (directly from animals or through contaminated food)
- Hydatids forming in the liver may result in death

**Internal Parasites** of dogs and cats

**Adult worms in small intestine**
**ECHINOCOCCUS MULTILOCULARIS**

Prepatent period: 28 days
Patent period: several months

**Parasite Life Cycles**

- **Intermediate host ingested by dog or cat**
- **Eggs ingested by intermediate host**
- **Hydatids forming in the liver of the intermediate host**
- **Eggs in feces**
- **Posterior segments of adult worms pass in feces**
- **Eggs are released from segments**
- **Adult worms in small intestine**
- **Humans can be infected through eggs (directly from animals or through contaminated food)**
- **Hydatids forming in the liver of the intermediate host may result in death**

**Humans can be infected**

- Through eggs (directly from animals or through contaminated food)
- **Intermediate host ingested by dog or cat**
- **Eggs ingested by intermediate host**
- **Hydatids forming in the liver of the intermediate host**
- **Eggs in feces**
- **Posterior segments of adult worms pass in feces**
- **Eggs are released from segments**
- **Adult worms in small intestine**
- **Humans can be infected through eggs (directly from animals or through contaminated food)**
- **Hydatids forming in the liver may result in death**
**TAENIA spp.**

Prepatent period: 4-10 weeks  
Patent period: 1 month to several years
**TOXASCARIS LEONINA**

Prepatent period: 8 weeks  
Patent period: 4-6 months

- Larvae mature in small intestine, adult worms lay eggs
- Tissues of transport host or embryonated eggs ingested by dog
- Embryonated eggs ingested by transport host
- Embryonated eggs survive for long periods in contaminated environments
- Eggs embryonate
- Larvae undergo two molts to infective third-stage larvae within the egg
- Nonembryonated eggs pass in feces

**Prepatent period:** 8 weeks  
**Patent period:** 4-6 months
**TOXOCARA CANIS**

Prepatent period: 21 days after transplacental infection  
27-35 days after lactogenic infection  
3-4 weeks after egg infection  
Patent period: 4-6 months
**TRICHURIS VULPIS**

Prepatent period: 8 weeks  
Patent period: up to 18 months
**UNCINARIA STENOCEPHALA**

- **Prepatent period:** 3-4 weeks
- **Patent period:** can be prolonged depending on immune status

**Life cycle diagram:**
- Infective larvae ingested by dog
- Larvae migrate via lungs to the intestine and mature to adult
- Adult worms lay eggs in small intestine
- Nonembryonated eggs pass in feces
- Eggs embryonate and hatch; larvae undergo two molts to infective third-stage larvae

**Notes:**
- Nonembryonated eggs pass in faeces
• Intestinal parasites are present in all regions of the United States
• How prevalent are the most common canine and feline parasites?
2009 US Canine Parasite Prevalence Survey (n=4,015)

Are you seeing parasite prevalence similar to the national prevalence demonstrated below?

<table>
<thead>
<tr>
<th>Parasite</th>
<th>National Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hookworm</td>
<td>33.3%</td>
</tr>
<tr>
<td>A. caninum</td>
<td></td>
</tr>
<tr>
<td>Roundworm</td>
<td>13.2%</td>
</tr>
<tr>
<td>T. canis</td>
<td></td>
</tr>
<tr>
<td>Whipworm</td>
<td>19.4%</td>
</tr>
<tr>
<td>T. vulpis</td>
<td></td>
</tr>
</tbody>
</table>

Note that the National Prevalence of whipworms is greater than that of roundworms.

Intestinal parasites are prevalent in all regions of the United States.

1 Blagburn BL: World Association for the Advancement of Veterinary Parasitology, Calgary, CANADA, August 9-13, 2009. Sponsored by Bayer Animal Health
2009 US Feline Parasite Prevalence Survey (N=1,808)
Are you seeing parasite prevalence similar to the national prevalence demonstrated below?

<table>
<thead>
<tr>
<th>Parasite</th>
<th>National Prevalence¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundworm</td>
<td>21.6%</td>
</tr>
<tr>
<td>Toxacara cati</td>
<td></td>
</tr>
<tr>
<td>Hookworm</td>
<td>8.6%</td>
</tr>
<tr>
<td>Ancylostoma tubaeforme</td>
<td></td>
</tr>
</tbody>
</table>

¹ Blagburn BL: World Association for the Advancement of Veterinary Parasitology, Calgary, CANADA, August 9-13, 2009. Sponsored by Bayer Animal Health
Do not underestimate the importance of accurately conducting fecal examinations. Internal parasites that can be detected by fecal examination remain prevalent in U.S. dogs and cats; some of these are important zoonotic agents.

The following descriptions will help you choose the most appropriate diagnostic procedure. You will also find guidelines and techniques to help achieve the greatest success while conducting these procedures.
The direct smear technique is most appropriate when:

• You suspect protozoa that can be demonstrated as active motile stages (e.g., *Giardia* or trichomonads).
• You suspect a parasite that passes motile larval stages in feces.
• Flotation solution might distort the parasite stages you wish to detect.

*Notes:*
Many larvae also can be recovered in a flotation procedure.
The direct smear procedure is convenient and fast, but has low sensitivity due to the small amount of feces used and the amount of debris on the slide.

**Direct smear procedure:**
1. Apply a small amount of fresh feces to water or saline solution on a slide and mix thoroughly.
2. Add a coverslip.
3. Examine the entire slide. Thickness of the smear should allow reading newsprint placed beneath it.

*Note:*
Iodine can be added to the direct smear at the coverslip margin to stain motile protozoa, cysts or larvae—or for flotation techniques, the coverslip can be added to a drop of iodine already placed on the slide.
**Sedimentation**

**Sample preparation for sedimentation**
Simple straining procedures can separate large debris from parasites and from smaller debris.

1. Mix feces thoroughly with water in a clean disposable cup.
2. Pour the mixture through a metal strainer (preferred) or gauze sponges into a second clean cup.
3. Add the strained mixture to a tube.

**The sedimentation procedure is most appropriate when:**
- Parasite stages are too heavy to float in standard flotation solutions (e.g., heavy operculated fluke eggs or larvae of lungworms).
- Flotation solutions may distort the parasite stages you wish to detect.

**Notes:**
Centrifuging sedimentation samples can increase test speed and improve performance.
Some larvae can be recovered in a flotation procedure.
A sedimentation preparation can be difficult to read due to large amounts of debris on the slide.

**Sedimentation procedure:**
1. Centrifuge or let preparation stand until sediment forms.
2. Remove most of the liquid above the sediment.
3. Place a drop of the sediment on a slide, then add a coverslip and examine.
Simple flotation

**Flotation solution guidelines**
- Desired specific gravity of a fecal flotation solution is 1.18–1.20, measured with a hydrometer.
- Common parasite eggs have specific gravities between 1.06 and 1.20.
- Remember that simple flotation may underestimate or misdiagnose low parasite burdens.

**Notes:**
Simple flotation improves sensitivity over direct smear when a small amount of feces is being tested.
Simple flotation provides less sensitivity than flotation using centrifugation.

**Sample preparation for flotation**
Simple straining procedures can separate large debris from parasites and from smaller debris.
1. Mix feces thoroughly with flotation solution in a clean disposable cup. Try to use at least 1 gram of fresh feces (a cube about ⅛ inch on each side; a fecal loop sample is about 0.1 gram).
2. Pour the mixture through a metal strainer (preferred) or gauze sponges into a second clean cup.
3. Add the strained mixture to a tube.

**Simple flotation is most appropriate when:**
- You want better sensitivity than can be provided in a direct smear.
- A centrifuge is not available or feasible.

**Simple flotation procedure:**
1. Mix feces and flotation solution (see sidebar at left) and pour into a tube.
2. Add flotation solution to form a meniscus.
3. Add coverslip and wait 15 minutes.
4. Remove coverslip, place on slide and examine.
Comparison of Common Fecal Flotation Techniques for the Recovery of Parasite Eggs and Oocysts
M. W. Dryden, P.A. Payne, R. Ridley, and V. Smith

A variety of procedures are available to detect parasite eggs or oocysts in feces. This study compared the efficacy of simple flotation, a commercial assay, and various centrifugation techniques and three common flotation solutions. Results indicate that centrifugation consistently recovered more eggs than other methods. Proper technique is critical, including ensuring that the specific gravity of the flotation solution is correct and allowing the sample to stand for a sufficient amount of time before examining the coverslip. Because of the zoonotic health risks of many companion animal parasites, veterinarians and their staff should better utilize fecal examinations in their routine diagnostic plan.

Veterinary Therapeutics Vol. 6, No. 1, Spring 2005

Intestinal parasites can be difficult to diagnose.

In a recent study\(^1\) comparing direct smear, Ovassay, and centrifugation techniques, the results showed a wide disparity in how often each test failed to detect the eggs:

<table>
<thead>
<tr>
<th>Technique</th>
<th>Whipworm false negatives</th>
<th>Roundworm false negatives</th>
<th>Hookworm false negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct smear</td>
<td>92.61%</td>
<td>85.38%</td>
<td>72.82%</td>
</tr>
<tr>
<td>Ovassay</td>
<td>32.02%</td>
<td>25.88%</td>
<td>4.85%</td>
</tr>
<tr>
<td>Centrifugation</td>
<td>4.93%</td>
<td>10.53%</td>
<td>0.97%</td>
</tr>
</tbody>
</table>

Note the reduction of whipworm false negatives when comparing direct smear to centrifugation.
Centrifugal flotation

**Flotation solution guidelines**
- Desired specific gravity of a fecal flotation solution is 1.18–1.20, measured with a hydrometer.
- Common parasite eggs have specific gravities between 1.06 and 1.20.

**Sample preparation for flotation**
Simple straining procedures can separate large debris from parasites and from smaller debris.

1. Mix feces thoroughly with flotation solution in a clean disposable cup. Try to use at least 1 gram of fresh feces (a cube about 1⁄2 inch on each side; a fecal loop sample is about 0.1 gram).
2. Pour the mixture through a metal strainer (preferred) or gauze sponges into a second clean cup.
3. Add the strained mixture to a tube.

**Centrifugal flotation is most appropriate when:**
- Sensitivity is the most important criteria in selecting a fecal examination procedure.

**Notes:**
Increased test sensitivity will improve accuracy in recovering fecal stages from animals with low parasite burdens.

Centrifugal flotation is the most sensitive fecal concentration procedure available to the veterinarian.

**Centrifugal flotation procedure with a swinging bucket centrifuge:**
1. Mix feces and flotation solution (see sidebar at left) and pour into a centrifuge tube.
2. Place sample in centrifuge tube holder.
3. Add flotation solution to form a meniscus and place a coverslip on the tube.
4. Spin at 1,200 rpm for 10 minutes.
5. Stop centrifuge, remove coverslip, place on slide and examine.

**Centrifugal flotation procedure with a fixed-angle centrifuge:**
1. Mix feces and flotation solution (see sidebar at left) and pour into a centrifuge tube, filling to within 1⁄2 to 1 inch of the top.
2. Place sample in centrifuge tube holder.
3. Spin at 1,200 rpm for 5 minutes.
4. Stop centrifuge, place sample upright in a tube holder and add flotation solution to form a meniscus.
5. Add a coverslip and let stand for 10 minutes.
6. Remove coverslip and place on slide and examine.
## Common fecal flotation solutions

<table>
<thead>
<tr>
<th>Flotation</th>
<th>Specific Gravity</th>
<th>Preparation (hot water)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>1.00 (standard for comparison)</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>1.20</td>
<td>approx. 400 g/liter</td>
<td>Inexpensive; forms crystals on slide.</td>
</tr>
<tr>
<td>Sodium nitrate</td>
<td>1.18–1.20</td>
<td>approx. 400 g/liter</td>
<td>Good all-purpose solution; forms crystals on slide.</td>
</tr>
<tr>
<td>Zinc sulfate</td>
<td>1.18–1.20</td>
<td>approx. 371 g/liter</td>
<td>Good all-purpose solution; excellent for protozoa. Best general-purpose specific gravity = 1.18–1.20; forms crystals on slide.</td>
</tr>
<tr>
<td></td>
<td>1.29</td>
<td>approx. 700 g/liter</td>
<td>Will levitate heavy debris and parasites. Forms crystals more rapidly.</td>
</tr>
<tr>
<td>Magnesium sulfate</td>
<td>1.27</td>
<td>approx. 500 g/liter</td>
<td>Good all-purpose solution. Will levitate heavy debris and parasites.</td>
</tr>
<tr>
<td>Sheather’s sucrose</td>
<td>1.27</td>
<td>approx. 1,278 g/liter</td>
<td>Excellent all-purpose solution; Add 6 ml phenol or formaldehyde to inhibit microbial growth; sticky solution attracts flies and other pests; this viscosity requires longer incubation time in simple flotation. Does not crystallize or distort specimens if samples are held.</td>
</tr>
</tbody>
</table>
Specific gravities of selected parasites of companion animals*

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Common Name</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ancylostoma</em> spp.</td>
<td>hookworm</td>
<td>1.06</td>
</tr>
<tr>
<td><em>Physaloptera</em> spp.</td>
<td>stomach worm</td>
<td>1.24</td>
</tr>
<tr>
<td><em>Taenia</em> spp.</td>
<td>taeniid tapeworm</td>
<td>1.23</td>
</tr>
<tr>
<td><em>Toxocara canis</em></td>
<td>canine roundworm</td>
<td>1.09</td>
</tr>
<tr>
<td><em>Toxocara cati</em></td>
<td>feline roundworm</td>
<td>1.10</td>
</tr>
<tr>
<td><em>Trichuris vulpis</em></td>
<td>canine whipworm</td>
<td>1.15</td>
</tr>
</tbody>
</table>

*Modified from Payne PA and Dryden MW. DVM Best Practices, March 2003, pp. 8–11.
The Companion Animal Parasite Counsel (CAPC) is an independent counsel of U.S. veterinary, governmental, and association thought leaders brought together to create guidelines for optimal control of internal and external parasites. These guidelines have been developed to protect the health of pets, enhance the safety of the public, and preserve the bond between pets and people. Veterinarians and pet owners must take measures to protect pets from parasitic infections. Veterinarians, pet owners, and physicians should work together to reduce the risks associated with zoonotic transmission of parasitic diseases. Important preventive measures include:

- Practicing good personal hygiene;
- Controlling pet parasite infections through internal and external parasite treatment and control;
- Minimizing exposure of children to potentially contaminated environments;
- Cleaning up pet feces regularly to reduce environmental contamination with infective parasite stages;
- And understanding and communicating parasitic infection risks and effective control measures.

For more information on CAPC, go to www.capcvet.org.
Administer year-round treatment with broad-spectrum heartworm anthelmintics that have activity against parasites with zoonotic potential.

Administer preventive flea and/or tick products as soon after birth as possible (consistent with label claims) for the life of the pet.

- Conduct annual physical examination with complete history.
- Conduct periodic (annual is ideal) heartworm infection testing in dogs and periodic testing in cats.
- Feed pets cooked or prepared food (not raw meat) and provide fresh, potable water.
- Conduct fecal examinations two to four times during the first year of life and one to two times per year in adults, depending on patient health and lifestyle factors.
- Administer anthelmintic treatment of puppies at 2, 4, 6 and 8 weeks of age, followed by administration of a monthly preventive.
- Administer biweekly anthelmintic treatment of kittens between 3 and 9 weeks of age, followed by administration of a monthly preventive.
- Treat nursing bitches and queens along with their offspring.
- Tailor parasite prevention programs to geographic, seasonal and lifestyle factors.
In the absence of optimal year-round heartworm preventive/intestinal parasite combination products, use the following protocol:

- Deworm puppies and kittens at 2, 4, 6 and 8 weeks of age and then again monthly until 6 months of age.
- In kittens, begin biweekly anthelmintic treatment between 3 and 9 weeks of age and then treat monthly until 6 months of age.
- Conduct fecal examinations two to four times a year in adult pets, depending on patient health and lifestyle factors, and treat with appropriate parasiticides.
- Test for heartworm status yearly in dogs and/or before starting preventive medications.

For additional resources please visit the following websites:

- www.students.novartis.us
- www.growingupwithpets.com
- www.ah.novartis.com
- www.heartwormsociety.org
- www.capcvet.org
- www.cdc.gov
<table>
<thead>
<tr>
<th>Parasites</th>
<th>Identification</th>
<th>Life Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthocheilonema (Dipetalonema) reconditum</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Aelurostrongylus abstrusus</td>
<td>28</td>
<td>38</td>
</tr>
<tr>
<td>Ancylostoma caninum</td>
<td>16</td>
<td>45</td>
</tr>
<tr>
<td>Ancylostoma tubaeforme</td>
<td>17</td>
<td>39</td>
</tr>
<tr>
<td>Baylisascaris procyonis</td>
<td>22</td>
<td>46</td>
</tr>
<tr>
<td>Cryptosporidium spp.</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Dipylidium caninum</td>
<td>10</td>
<td>47</td>
</tr>
<tr>
<td>Dirofilaria immitis</td>
<td>7</td>
<td>40,48</td>
</tr>
<tr>
<td>Echinococcus granulosus</td>
<td>14</td>
<td>49</td>
</tr>
<tr>
<td>Echinococcus multilocularis</td>
<td>14</td>
<td>50</td>
</tr>
<tr>
<td>Eucoleus (Capillaria) aerophila</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Giardia spp.</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Isospora (Cystoisospora) spp.</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Paragonimus kellicotti</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Pearsonema (Capillaria) feliscati</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Pearsonema (Capillaria) plica</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Physaloptera spp.</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Taenia spp.</td>
<td>15</td>
<td>41,51</td>
</tr>
<tr>
<td>Toxascaris leonina</td>
<td>21</td>
<td>42,52</td>
</tr>
<tr>
<td>Toxocara canis</td>
<td>21</td>
<td>53</td>
</tr>
<tr>
<td>Toxocara cati</td>
<td>21</td>
<td>43</td>
</tr>
<tr>
<td>Toxoplasma gondii</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Trichuris vulpis</td>
<td>23</td>
<td>54</td>
</tr>
<tr>
<td>Uncinaria stenocephala</td>
<td>18</td>
<td>44,55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pseudoparasites</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternaria spp.</td>
<td>32</td>
</tr>
<tr>
<td>Free-living nematode</td>
<td>33</td>
</tr>
<tr>
<td>Grain mite egg</td>
<td>34</td>
</tr>
<tr>
<td>Planarium</td>
<td>34</td>
</tr>
<tr>
<td>Pollen granules</td>
<td>35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spurious Parasite</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocystis lumbrici or Rhynocystis pilosa spore</td>
<td>36</td>
</tr>
</tbody>
</table>