

- GENUS: DIROFILARIA
  - *Dirofilaria immitis* / Common name - Dog heartworm
  - *Dirofilaria repens*

- GENUS: DIPETALONEMA
  - *Dipetalonema reconditum*

# Hosts

- **Definitive Host:** dogs, foxes, wolves, coyotes, occasionally cats, ferrets, sea lions
- Adults are found in the right ventricle and pulmonary arteries, caudal vena cava
- **Accidental hosts:** humans
- **Intermediate Host:** mosquitoes

# Morphology

- Adults are long, white, thread-like worms
  - Females 25 to 30cm long
  - Males 12 to 16 cm long with spirally coiled tail
- Microfilariae
  - Sheathless
  - 218 to 329 $\mu$ m long
  - have a long pointed tail

# Life Cycle

- Female parasites release microfilariae directly into the bloodstream
- Microfilariae are ingested by mosquitoes during feeding
- Inside the mosquito, the microfilariae develop to L2's and finally to L3's.
- Development to L3 in the mosquitoes, takes about 2 weeks. Larvae are present in the mouthparts.
- The L3 is the infective stage for dogs.

# Life Cycle

- The L<sub>3</sub> is deposited in mosquito saliva. A dog infected by microfilariae is bitten by a mosquito
- The average mosquito can only transmit a maximum of 10 infective larvae at one time
- The L<sub>3</sub> larvae migrate to the subcutaneous or subserosal tissues where they develop into an L<sub>4</sub> and L<sub>5</sub> stage.
- Young *D. immitis* pass into the heart via the venous circulation (right side of the heart, the pulmonary arteries and lungs, caudal vena cava). They mate and produce microfilariae.

# Life Cycle

- If the **microfilariae** is not ingested by a mosquito after **2 years**, they die of “old age.”
- The minimum prepatent period is about 6-7 months.
- **Adult** worms can live in the dog for several years (up to **5-7 years**)
- **Microfilariae** can be transmitted across the placenta.

# Canine Symptoms

- Can be asymptomatic according to the number of parasites
- Exercise intolerance, loss of condition
- Lethargy
- Weakness
- Loss of appetite
- Cough
- Dyspnea (difficulty breathing)
- Abnormal lung and heart sounds
- Icterus
- Hepatomegaly (enlargement of the liver)
- Ascites (fluid accumulation in the abdominal cavity)
- Temporary loss of consciousness due to poor blood flow to the brain
- Death

# Feline Symptoms

- Non-specific generic signs of illness can see
- Dyspnea
- Cough
- Vomiting intermittently
- Lethargy
- Lack of appetite and weight loss
- Asthma-like signs
- Difficult or rapid breathing
- When worms are carried to the pulmonary arteries are often misdiagnosed as asthma or allergic bronchitis



# Diagnosis

- Blood Tests
  - Filter test, modified Knott's test and direct blood smear to look for microfilariae (differentiation may be achieved by using histochemical stains for acid-phosphate activity). Samples ideally are taken in the early evening.
    - Doesn't work well for light infections
  - Antigen ELISA test (needs to have females present!)
    - Only works for female worms
    - Need at least 3 for it to be detected
  - Newer tests for antibodies
- X-rays
  - Enlargement of lobes of lungs or right side of heart
- Echocardiography

# Species differences

Species	Length ( $\mu$ )	Anterior end	Tail	Acid-phosphate activity
D. immitis	> 300	tapering	straight	anal and excretory*
D. repens	< 300	round	straight	anal*
D. reconditum	< 300	blunt	button-hook	whole body*

# Interpretation of test results

Adult worm	-	Adult worm	+
Microfilaria	+	Microfilaria	-

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- Placental contamination
- Blood transfusion
- Adults are dead, microfilariae are alive

- Presence of only adult male
- Immature worms
- Occult (female parasite sterile)
- Microfilaricide

○(female parasite sterile..due to treatment or host immunity)\*

# Treatment

- In dogs, heartworm disease can be treated. It is not an easy treatment
- In cats, the treatment is even more difficult. The medicines that treat heartworm disease in dogs have some side effects in cats, making treatment very hard, and sometimes dangerous.
- Adulticide
  - *Melarsomine dihydrochloride* (Immiticide®)
    - Intramuscular injection into lumbar muscles (2.5 mg/kg repeated after 24 hours)
  - *Thiacetarsamide sodium* (Caparsolate®)
    - Intravenous injection. No longer available (2.2 mg/kg twice daily for 2 days)
  - Complications include **thrombosis\*** (clogging) of pulmonary arteries due to dead worms
  - No current treatment for cats
- Microfilaricide
  - Macrocyclic lactone (ML) i.e., milbemycin oxime, selamectin, moxidectin and ivermectin
  - Commonly used in heartworm preventative

# Treatment and Prevention

- Treatment of heartworm disease is risky and there is always a chance of complications.
  - It can be cause emboli, obstruction, allergic reaction or death
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- **Adulticide compounds**
    - Thiacetarsamide sodium 2.2 mg/kg X 3 days i.v.  
(side effects can see ...vomiting, fever and dyspnea)
    - Melarsomine dihydrochloride\* 2.5 mg/kg X 2-3 days i.m. (lumbal kas) for L3, L4 and L5
    - Levamisole 22 mg/kg p.o. twice a day 3-4 weeks

**Against complications of thrombosis**

    - Aspirin 5 mg/kg p.o. every day (it may be contraindicated)
    - Heparin 300 U/kg s.c. every 8 hours
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- **Microfilaricide compounds**
    - Levamisol 11 mg/kg X 6-12 days
    - Ivermectin 0.02 mg/kg p.o. (toxic for Collie, Bobtail dog breed)
    - Milbemycine oxime 0.5 mg/kg
    - Selamectin 0.6-0.12 mg/kg topikal
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- Preventive (monthly preventive medications can be given for two or three months to safely eliminate these immature heartworms). Ivermectin, moxidectin, milbemycine oxime and selamectin can administered 30-day dosing intervals (during the mosquito season, a month before and a month after)
  - When possible, dogs should be reduced outdoor exposure
  - It should be done mosquito control

# Dirofilaria repens



- **Definitive host:** Dog, cat, fox
- They live subcutaneous, intermuscular tissues
- 5-17 cm
- Indirect life cycle
- **Intermediate host:** Mosquitoes (Aedes, Culex, Mansonia)



# Life cycle, Clinical signs and treatment

- ✓ Microfilariae are ingested by female mosquitoes during feeding
- ✓ Development to L3 takes place in mosquito like *D. immitis*
- ✓ Final host is infected with L3 when mosquito suck the blood
- ✓ L3 develop into L4, L5 and adult stage in subcutaneous and intermuscular tissues
- ✓ Usually asymptomatic
- ✓ Itching, subcutaneous nodule
  
- ✓ Treatment: Surgical remove of parasite from skin

# Dipetalonema reconditum

- **Definitive host:** Dog, wild carnivor
- They live subcutaneous tissues, kidney and body cavity
- 1-3 cm
- **Intermediate host:** flea, tick, lice, mosquito
- Indirect life cycle
- Usually asymptomatic. It may cause subcutaneous abscessation and ulceration
- Microfilariae are seen on blood examination
- Therapy isn't usually indicated



# Oxyuris equi

- ❖ Equine (horse) pinworms
- ❖ Common in foals
- ❖ Adult worms are found in caecum and colon
- ❖ Females are greyish white, with very long tapering tails, may reach up to 15 cm.
- ❖ Males have caudal alea and single pin-shaped spicule, are generally less than 1.2 cm long.
- ❖ Life is direct. This is especially stable infection.

- After fertilisation, gravid females migrate to rectum/anal area at night, lays her eggs (up to 50 000 eggs) on perianal skin and attach eggs to exterior anus with a gelatinous, sticky material (sticky !!!!).
- Development to infective L3 within the eggs is fast (4-5 days). Horse rubbed off against food/water troughs and contaminate the environment. Eggs on fodder, grass, bedding etc. are ingested by horse.  
**Eggs are especially dispersed by tail rubbing.**
- Egg containing L3 is ingested, L3 move into the LI and migrate into mucosal crypts (L4/5-10 mm), then emerge and feed on the mucosa before maturing. Adults inhabit the lumen and feed on the contents.
- Prepatent period 4-5 months. Life span 6 months

## Life Cycle

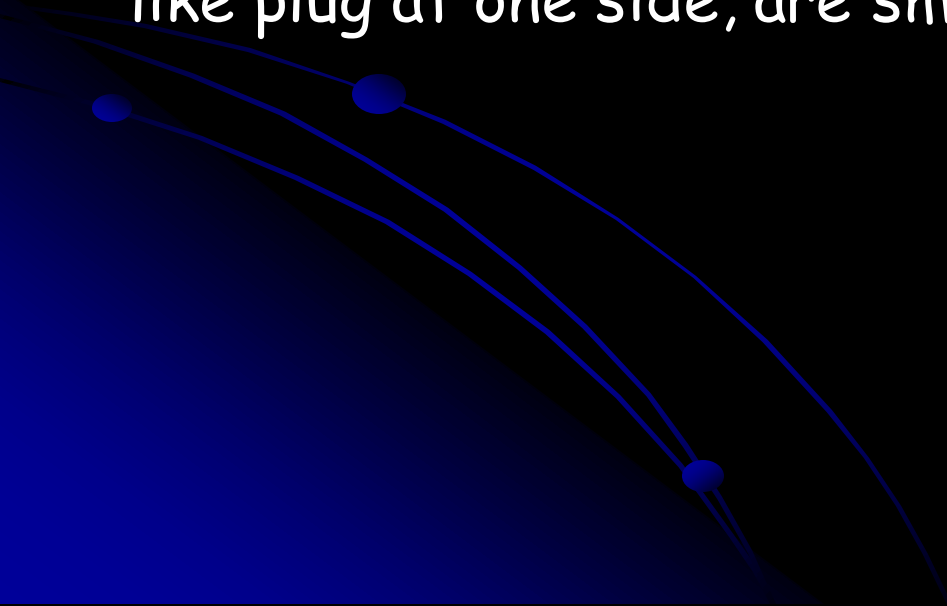
# Patogenesis

- Worms do not encyst in the intestinal wall. They migrate through the large intestine (mucosal crypts of the caecum and colon). The development to **L4** takes place within 10 days. L4 emerge and **feed on the mucosa** (most pathogenic effect) before maturing to adult stages that inhabit the lumen and feed on intestinal contents.
- The more important effect is **anal pruritis** caused by **adult females** during egg-laying.
- They cause less damage to the horse than other internal parasites.
- Maintain good stable hygiene to prevent eggs remaining on the areas where they have been dispersed by tail rubbing.

# Clinical signs

- Adult worms in the intestine rarely cause any clinical signs.
- Females often deposit their eggs around the anus, which cause irritation. Due to pruritis caused by migrating female *O.equi*. The intense pruritis around the anus leads to restless, elevation of tail, impaired feeding, loss of condition
- Horses will rub their tails and hind ends against solid objects. Rubbing causes broken hairs, hairless parts, bare patches around the tail, inflammation and "rat-tailed" appearance

# Diagnosis

- Clinical signs
  - The long-tailed females are seen in the feces
  - Fecal examination may not reveal a pinworm infection. Samples collected around the perineal region may contain dried eggs. Piece of cellophane tape is placed sticky side down to the skin. Eggs (80-95 X 40-45  $\mu\text{m}$ ) will stick to the tape and it can be viewed under a microscope.
  - Eggs may be larvated, are elongated and slightly flattened with an operculum like plug at one side, are smooth-thick shelled, these are rarely seen in feces.
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# Treatment

Compound	Efficacy stage	Dosage
Ivermectin*	Adult, L4, L3	0.2 mg/kg p.o.
Moxidectin	Adult, L4	0.4 mg/kg p.o.
Mebendazole	Adult, L4	10 mg/kg p.o.
Oxibendazole	Adult, L4	10 mg/kg p.o.
Pyrantel embonate	Adult, L4	19 mg/kg p.o.
Thiabendazole	Adult, L4	50 mg/kg p.o.
Cambendazole	Adult, L4	20 mg/kg p.o.
Febantel	Adult, L4	5-6 mg/kg p.o.
Albendazole	Adult	5.5-10 mg/kg p.o.
Mebendazole	Adult, L4	10 mg/kg p.o.
Fenbendazole	Adult, L4	7.5-10 mg/kg p.o.

# Prevention and Control

- ❖ The treatment of Oxyuris is best carried out at three levels; **treating worms present in the intestine, treating eggs present on the skin and treating the environment to prevent re-infection or spread to other horses.**
- ❖ Anthelmintic commonly prescribed for entire horses in stable. **One dose is give immediately all animals, then wait one month for another dose.** The second dose is kill any adult worms that may have hatched, in the mean time.
- ❖ **Perianal skin, underside of the tail and hindquarters** should be **cleaned with a wet sponge every day to remove the eggs adhering to the skin** (before their development to L3).
- ❖ Removal of eggs and larvae from the environment is achieved by first of **all removing all bedding** from the stable of the infected horse followed by power washing the **floor and walls**. After this, a heavy duty disinfectant is applied to the walls and floor. New bedding should then be introduced and kept to a minimum. **Grooming equipment** must not be shared at all between horses. The **brush** should then be steeped in strong disinfectant and if possible steam cleaned to ensure it has been decontaminated of any Oxyuris eggs before it is used again.

# Enterobius vermicularis

- Human pinworms
- Large intestine (caecum, appendix, ascending colon)
- Adult is small, white, round worm with cylindrical body and transversely striated.
- Both sexes have 3 lips. Have cervical alae at the anterior part of body wall.
- Female has thin, sharply pointed posterior end, pin-like tail (8-13 mm). Male has a curved posterior end (2-5 mm).
- Prepatent period 2 months. Life span 7 weeks



# Life Cycle

- Infective eggs are ingested. Larvae hatch from eggs in SI (ileum), larvae migrate to LI (caecum, colon) and mature (larvae molt twice before becoming adults).
- Adults mate in colon, and the males die after mating. Gravid females migrate at night to perianal skin, deposit eggs, which become infective in few hours.
- Can lay up to 15 000 eggs/day
- Eggs remain viable in moist environment for up to 3 weeks. Once eggs are deposited near anus. They can contaminate other surfaces such as:  
fingernails, hands, clothing and bed linens, then on to food, water, furniture, toys, bathroom and pets

# Transmission

- Eggs are translucent and are covered in a material that allows them to stick to environmental object.

- **Person-to-person transmission** can also occurs through handling of contaminated clothes, bed linens, carpeting etc. Some small number of eggs may become **airborne** and **inhaled**. These would be swallowed and follow the same development as ingested eggs
- **Self-infection (oto)** occurs by transferring infective eggs to the mouth with hands that have scratched the perianal area
- **Retroinfection**-larvae migrate back up to the rectum to the gastrointestinal tract but the frequency with which this happens is unknown.

# Symptoms

- Asymptomatic
- Symptomatic
  - Familial disease
  - **Perianal pruritis** (main feature, especially at night)
  - Itching leads to secondary bacterial skin infection in perianal region
  - **Restless sleep, grinding of teeth**
  - **Abdominal pain and nausea** are associated with high population
  - **Vulvovaginitis** (Infection can migrate to the vagina and cause vaginal discharge)

# Diagnosis

- Itching around perianal region is indicative of infection.  
Inspection of peri-anal region (to detect worms). Worms are visible in the anal region, especially 2-3 hours after sleep
  - Look like tiny pieces of white thread
  - Eggs are rarely seen in fecal samples
- Diagnosed by **Cellophane -tape method** (to detect eggs). Test should be done immediately after person wakes up in the morning before washing, going to the bathroom or getting dressed since eggs may be removed during these processes.
- The eggs
  - Small size (50-60X20-32  $\mu\text{m}$ ),
  - Have a thick shell that is flattened on one side,
  - Membrane makes the eggs «itchy»,
  - May contain an embryo or fully-developed larvae

# Treatment

- **Mebendazole** or **albendazole** commonly prescribed for entire family. All the family members, including asymptomatic reservoirs should be treated simultaneously
  - **One dose is given immediately, then wait 2 weeks for another dose.** The second dose is kill any adult worms that may have hatched, in the mean time.
    - Mebendazole...100 mg/kg
    - Albendazole....400 mg/kg
- the same treatment should be repeated after 2 weeks

# Prevention and Control

- Personal cleanliness and hygiene (wash hands after using the bathroom and before preparing food)
- Short nail, frequent handwashing
- Wash bedding and underclothing frequently, especially those of any affected family members.

