

Hookworm Infection

Family: Ancylostomidae

<u>Species</u>	<u>Hosts</u>
■ Ancylostoma caninum	dog, fox
■ Ancylostoma tubaeforme	cat
■ Ancylostoma braziliense	dog, cat
■ Uncinaria stenocephala	dog, cat
■ Bunostomum trigonocephalum	sheep, goat
■ Bunostomum phlebotomum	cattle
■ Gaigeria pachycelis	sheep, goat
■ Ancylostoma duodenale	human
■ Necator americanus	human
■ Globocephalus spp.	pig

Hookworm infections of cats and dogs

- Hookworms lives in the small intestine of cats and dogs.
- Parasite is 1-2 cm long.
- Mouth capsules are well developed
 - *Ancylostoma* also has 2 or 3
 - *Uncinaria* has 2 cutting plates
- Direct developments
(Transport host: mice and rats)
- Eggs are '**Strongyle type**', 60x40 μ m and contain two to eight blastomer.

Life Cycle

- Eggs are passed out with faeces.
- Larvae develop in soil to infective L3 stage.
- Larvae (L3) are either ingested by the host or they enter the host by skin penetration (cutaneous contact).
- Paratenic hosts can also be important.
- The larvae migrate to the host lungs via lymphatic system and bloodstream.
- Where they moult to L4 in the bronchi and trachea, and swallowed and pass to the small intestine where the final moult occurs.
- In the small intestine, the larvae develop into adults.
- Eggs are then expelled with the feces and the cycle continues.

Life Cycle-2

- Alternatively, larvae may migrate in the host to subcutaneous fat, and in females, to the skeletal muscles and mammary glands. Once in these tissues, the larvae become inactive. When infected females begin to nurse offspring, the larvae are activated and passed to the young who become infected. This "trans-mammary route" of infection is of primary importance as younger animals are more susceptible to infection. Older animals often develop resistance to repeated exposures of the parasite.
- Thus, it is much more likely that young animals will be infected with the parasite than the older animals.
- Finally, if a rodent ingested the L3, the larvae will migrate to the tissues and become dormant. If the rodent is eaten by a dog, the larvae will mature to adulthood in the small intestine (via paratenic hosts).
- The prepatent period is two weeks.

Life Cycle-3

- Before 2 weeks of birth larval action start and larvae 20 days after birth are laid out with milk.

	Galactogen (transmammary transmission)	Prepatent time (period)
A. caninum	+	14-20 days
A. tubaeforme	-	22-25 days
A. braziliense	-	10-11 days
U. stenocephala	-	15 days

Larval infection (L3)

Through the skin

Perforating the mucosa

By mouth (orally)

mice, rat or direct L3

swallowing

down to 3 months

up to 3 months

immunity

Esophagus, stomach,
small intestine
Prepatent time: 15-26 days.

heart, lung,
trachea,
small intestine
Prepatent time:
14-20 days.

Larvae become inactive in
skeletal muscles and
intestinal wall (inhibition)

L3 ★

pregnancy

Female hosts
Small intestine
Prepatent time:
4 weeks.

milk (mammary gland via transmammary transmission)
Prepatent time: 16 days
Turn out of larvae by milk approximately, 20 days

A.caninum's life cycle

- ❑ Alternatively, larvae may migrate in the host to subcutaneous fat, and in females, to the skeletal muscles and mammary glands.
- ❑ Once in these tissues, the larvae become inactive.
- ❑ When infected females begin to nurse offspring, the larvae are activated and passed to the young who become infected.
- ❑ This «transmammary route» of infection is of primary importance as younger animals are more susceptible to infection.
- ❑ Older animals often develop resistance to repeated exposures of the parasite.
- ❑ Thus, it is much more likely that young animals will be infected with the parasite than the older animals.
- ❑ Finally, if a rodent ingests the L3 larvae, the larvae will migrate to the tissues and become dormant (inhibisyon),
- ❑ If the rodent is eaten by a dog, the larvae will mature to adulthood in the small intestine.

Pathogenesis

- For dogs, galactogenic infection is important.
(50-100 mortem)
- **Pathogenesis**
 - Haemorrhage, bleeding in the intestinal mucosa
 - Parasite absorbs blood from the last hosts, Because of this reason 6-10% blood is lost.
 - Hypochromic-microcttic anemia
 - Eczema and ulcers occurs during parasite skin perforation, ulcer

Clinical signs

- Diarrhea (dark)
 - Anemia
 - Respiratory distress, increase in respiratory rate
 - Feather (hair) mixed and matte
 - Fatigue, indifference
 - Decrease in weight gain
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- Puppies- Anemia, pale membranes, diarrhea, weight loss, weakness, poor growth, occasionally death.
 - Adults- Usually asymptomatic but any of the above symptoms may be present.

Diagnosis

- Clinical signs
- Fecal examination (Flotation)
 - **Ancylostoma spp.** Eggs, (55-75 X 34-45 μm , elliptical, thin shelled, 2-8 with blastomer, smaller and thinner than **Uncinaria** species.
 - **Uncinaria stenocephala** (63-80 X 32-50 μm , elliptical, thin shelled, with blastomer, larger (according to **Ancylostoma** egg)

Treatment

Active ingredient	host	Dose and route of administration
Fenbendazole	dog cat	50 mg/kg p.o. 3 days 20-25 mg/kg p.o. 5 days
Moxidectin	dog	0.2 mg/kg p.o.
Ivermectin	dog	1 mg/kg p.o., s.c.
Pyrantel pamoate	dog cat	5 mg/kg p.o. 10-20 mg/kg p.o.
Flubendazole	dog, cat	22 mg/kg p.o. 2-3 days
Febantel	dog	15 mg/kg p.o.
Mebendazole	dog, cat	22-25 mg/kg p.o. 3-5 days
Selamectin	dog, cat	6 mg/kg p.o.
Nitroscanat	dog	50 mg/kg p.o.
Doramectin	dog	1 mg/kg s.c.
Milbemycine oxime	dog	0.5 mg/kg p.o.
Ivermectin+Pyrantel pamoate	dog	6 mg+5 mg/kg p.o.

★ Iron minarel and Vitamin B12 can be given for anemia treatment.

Protection and Control

- Preventing newborns from mating parasites; first weekend and every week one time,
Until 3 months; 1st weekend and once every 2 weeks
- On pregnant and lactating dogs; 2 weeks before parturition
= 1 mg/kg Doramectin
- Prevent maturation of the larvae in mother after birth,
Until 3 months postpartum = At the same time as the puppy
- Protection against *Ancylostoma* and *Uncinaria* infections,
For 4 weeks older ↑ = Milbemycine oxime (1 mg/kg p.o.) once a month
- To kill the larvae on the ground 1 % sodyum hipoklorit (sprey application), sodyum borat 2 kg /10 m² (powder application) or disinfection with hot water.

Cutaneous Larva Migrans

- Third stage larvae(L3) of *Ancylostoma* sp., *U.stenocephala* and *B.phlebotomum* are responsible for cutaneous larva migrans.
- Red migration traces due to migration, rash, increasing itching/pruritis at night, papule, vesicle, oedema
- Larvae can migrate up to 1-2 cm per day
- Larvae die within a few weeks or up to 1-2 months.



If necessary albendazole 400mg, ivermectin 0.2mg/kg, and thiabendazole treatment can be done.

Ruminant hookworm infections

- *Bunostomum trigonocephalum*.....sheep, goat
 - *B.phlebotomum*.....cattle
 - *Gaigeria pachyscelis*.....sheep, goat
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- lives in small intestines, they are 1-3 cm in size
 - There are 2 chitinous plaques and teeth in the mouth.
 - Infection is caused by oral ingestion of L3
 - Prepatent time/period is 8-10 weeks
 - Especially in *Gaigeria* infections, even a small number of larvae can cause death.
 - In cattle, there are also prenatal and galaktogenic transmission in these *B.phlebotomum* infections.

Clinical signs and diagnosis

■ Clinical signs

- Anemia
- Mandibular oedema
- Diarrhea
- Dry skin, mixed hairs
- Puriritis in feet of the calf infections and hit the feet on the ground.

■ Diagnosis

- Common diagnostic test is Fecal Flotation.
 - **Eggs are** 75-104 length X 45-57 μm diameter oval (elliptical), thin-cruste, 4-8 dark blasted, side walls are not similar and in stools culture is searched for L3.

Hookworm infection in pigs

- Species
 - *Globocephalus longemucronatus*
 - *G.urosbulatus*
 - *G.samoensis*
 - *G.versteri*
- Small intestine
- The life cycles are not fully known these worms.

Hookworm infection in human

- Types of parasites may vary by region.
- *Ancylostoma duodenale*: more prevalent in eastern mediterranean and black sea regions.
- *Necator americanus*: more prevalent in eastern and central black sea regions.
- Adult parasite, 8-14 mm length, 0.5-1 mm width
- The last host infection of the disease is through the skin and mouth (orally).

Necator

Ancylostoma

- **Clical signs**
 - Pruritis, dermatitis (eczema,vezicul)
 - Pneumonia, caught, aphonia, increase of phlegm
 - Anemia, change in blood table
 - Abdominal pain

Superfamily Trichinelloide

Genus, Trichinella

- *Trichinella spiralis* has an extremely broad host range; almost any species of mammal can become infected this parasite.
- Male, 1-1.5 mm/female, 3-4 mm length
- Adult male, *Trichinella's*, have a single spicule or at least a spicular sheath, which is often spinate.
- **Adult form** lives in small intestine / **larval form** lives in muscle.
- Lifetime of female parasites are 1-4 months
- Larvae in the cyst calcify in 5-6 months.

T. spiralis, identification

- The thin adults of *Trichinella spiralis* are found embedded in the mucosa of the small intestine of swine, carnivorans, and man.
- The other species are all very similar morphology.
- The genus *Trichinella* contains nine species and three genotypes.
- Six of the nine species and the three unnamed genotypes (T6, T8, and T9) are similar in that they infect only mammals;
- These *Trichinella* species are: *T. spiralis*, *T. nativa*, *T. nelsoni*, *T. britovi*, *T. muralli*, and *T. patagoniensis*.
- The other three species infect mammals and other host types: mammals and birds (*T. pseudospiralis*), and mammals and reptiles (*T. papuae* and *T. zimbabwensis*).

Life cycle/development

- The life cycle for this species begins after ingestion of the first stage juvenile (L1) from the intermediate host.
- Both sexes reach maturity about 2 days after the infected meat is eaten. At 5 days after infection, the viviparous females are giving birth to prelarvae,
- Which enter the lymphatics system and later the bloodstream to be transported to the muscles.
- They are transported all over the body and take up residence in voluntary muscle by entering individual muscle cells.
- The larvae grow within the muscle and a covering is created around them causing a cyst.
- After the cyst is formed the worm cannot migrate any further.
- The only way this species can continue its life cycle is to be ingested by another host.
- When the new host eats the muscle tissue containing the cyst the digestive juices break down the capsule and release the worm.

Life cycle/development-2

- ❑ There are three different ecological types of life cycles, **1**-the urban cycle, **2**-the sylvatic cycle, and **3**-the marine cycle.
- ❑ **In the urban cycle**, rats and pigs serve as hosts and reservoirs of the parasite
- ❑ Humans can become infected with the worm by eating pork that is not cooked thoroughly.
- ❑ **In the sylvatic cycle**, predators and scavengers are hosts to *T.spiralis*.
- ❑ **In the marine cycle**, seals, walruses, whales, and polar bears are all hosts.
- ❑ The female is viviparous.
- ❑ She lays her living larvae within the small intestine beginning the fifth or sixth day after infection.

Pathogenesis and clinical signs

- There is a slight infection in pets.
- Diarrhea in severe infections
- If larvae in the muscle, acute myositis, fever, eosinophilia
- In humans; >1200 larvae → died
 - **Mature period (in intestine):** abdominal pain, diarrhea, vomiting
 - **Larval migration period (after 1-2 weeks=muscle tissue):** head/muscle pain, vertigo, muscle weakness, photophobia, face-to-eye circumference and peripheral edema, fever, conjunctivitis, ascites, eosinophilia, paralysis of respiratory muscles
 - **Cystic period (muscle):** Decrease in symptoms, muscle pain, weakness
Rarely myocarditis, some important symptoms related to pneumonia and encephalitis.

Diagnosis, treatment, and control

- **Diagnosis; Animal;** serology: ELISA
intramuscular trichinoscopy or digestive techniques
- **Human;** Eozinophilia, increase of creatin phosphokinase, intramuscular biopsy (larvae), serology (ELISA IgG)
- **Treatment;** Applications of cambendazole, ivermectin, mebendazole, thiabendazol both mature and larvae. And steroid applications.
- **Control;**
 - Pork carcass examination in slaughterhouses
 - Mouse fight on pig stables.
 - Well cooking of pork and other products.
 - Don't feeding pigs with slaughterhouse surplus.

Habronemosis

- Habronemiasis, otherwise as «summer sores» is fairly common among horses.
- The parasites behind habronemiasis are stomach worms.
- Adult parasites are about 1-2.5 cm long.
- The three nematodes most commonly named *Habronema muscae*, *Habronema majus* and *Draschia megastoma*.

Species:


- *Habronema musca*.....under the mucus layer
- *Habronema microstoma (majus)*.....under the mucus layer
- *Draschia megastoma*.....stomach mucosa in fibrous nodules
- Life cycle is indirect.
- Intermediate host: maggots (houseflies) (*Musca domestica*, *Stomoxys calcitrans*)

Biology

- larvae hatch from the tiny eggs.
- soon after they are laid, and larvae or eggs may be present in the feces.
- If larvae (L1) ingested by maggots (*Musca domestica* for *D. megastoma*, and *H. muscae*, *Stomoxys calcitrans* for *H. microstoma*),
- They develop to infective third-stage larvae in a little more than 1 week.
- The infective larvae migrate to the head of the fly and collect within labium.
- When a fly alights on a warm, moist surface such as the muzzle, the ocular conjunctiva, or cutaneous wounds of a horse, the larvae change hosts.
- Those larvae that are swallowed presumably complete their life histories.

- The three big areas that *Habronema* parasites and their larvae damage are around the eyes, on the skin and in the stomach.
- **GASTRIC HABRONEMIASIS**
 - *Habronema* and *Drachia* species are responsible.
 - The *Habronema* species is less pathogenic, usually causes mild gastritis without clinical symptoms.
 - The *Drachia spp.* is more pathogenic and parasites causes a massive mass and nodule formation, obstruction and perforation.
- **LUNG HABRONEMIASIS**
 - By inhalation, through the skin or stomach through the L3 reaching the lungs.
 - Larvae in the lungs do not mature and found in fibrous nodules.
 - Clinical diagnosis is not possible and is not significant.

o SKIN/CUTENOUS HABRONEMIASIS

- o Lesions caused by the invasion of skin wounds or excoriations by the larvae (L3) of *Habronema spp.* and *Drachia megastoma*.
- o Larvae do not mature
- o Due to continuous irritation of the L3, the wound does not heal and granulomatous reactions are observed.
- o Commonly affected areas (granulomatous) include legs, penis, preputial sheath, eyes, and open skin wounds.
- o The granulomas that appear in summer (summer sores), when the weather is cold and fly activity is over, granulomatous also end up depending on them.
- o This form is also known as SUMMER  SORES and granular dermatitis.
- o Larvae rarely have wart-like lesions of 3-4 mm in diameter on the skin and membranous nictitans in the eye.

Diagnosis, Treatment and Protection

o **Gastric habronemiasis:** The appearance of eggs in faces is difficult.

For eggs and mature parasite to see, the stomach need to lavaged with 2% sodium bicarbonate.

o **Skin habronemiasis:** diagnosis is generally based on the clinical appearance and behavior of the lesions.

In many cases tiny yellow granules are visible within the granulomatous reactions.

It is done by the sight of larvae in the excavations taken from these places (There is a spined bulge on the tail of the larvae).

Ivermectin..... 0.2-0.3 mg/kg p.o.(stomach and skin)

Moxidectin..... 0.4 mg/kg p.o.

Albendazole.... 5.5-10 mg/kg p.o.(stomach)

Oxfendazole..... 15 mg/kg p.o.

Fenbendazole... 30-60 mg/kg p.o.

- o Removal and cauterization of the granulation tissue if its necessary.
- o Insecticide pomat may be applied around the wound to prevent the reaction.
- o Care should be taken not create any wound on the fly during the season.
- o Skin wounds can be treated with fly repellent or antiseptic+insecticide combination medications.

Parafilariosis

- ✓ This filarial parasite of cattle and equides cause subcutaneous lesions.
- ✓ These parasites infest the subcutaneous and intramuscular connective tissues.
- ✓ The worm is whitish and 3-7cm long.
- ✓ Life cycle is indirect.
- ✓ Flies of the species **Musca** act as intermediate hosts. In horses it is transmitted by **Haematobia spp.**
- **Species:**
 - ✓ **Parafilaria multipapillosa** - Equide
 - ✓ **Parafilaria bovicola** - Ruminants

Life Cycle

- ✓ Eggs or larvae of the parasites are present in the exudates from bleeding points in the affected animal's skin.
- ✓ These eggs and larvae are ingested by flies.
- ✓ In which they then develop to L3 within several weeks to months, depending on air temperature.
- ✓ Parasites are then transmitted when infected flies feed on the lacrimal secretions, or skin wounds of non-infected cattle.
- ✓ Female parasite migrates to dermis and epidermis
- ✓ Oedematous and hemorrhagic nodules occur.
- ✓ Parasite lay eggs and remove microfilariae from egg.
- ✓ Microfilariae of the bleeding foci on the skin surface are taken by the fly.
- ✓ Larvae migrating to subcutane that mature in 6 months.

Pathogenesis and Clinical signs

- ✓ Nodules in the size of peas or nuts start bleeding within a few hours. And bleeding continues for 24-48 hours.
- ✓ Bleeding stops but another nodule forms immediately adjacent to the nodule and events continue in this way.
- ✓ Lesions disappear in cold weather, it starts again in hot weather = **SUMMER BLEEDING** ★
- ✓ The disease can continue for 4 years.

Diagnosis and Treatment

- ✓ Clinical signs make the disease suspect.
- ✓ Eggs or microfilariae search taken from haemorrhagic foci that taken from this haemorrhagic foci's blood.
- ✓ Treatment is difficult. It may not give the desired result.
- ✓ Antibiotics may be used against bacterial infections that may occur.
 - Ivermectin 0.2 mg/kg p.o. / s.c.
 - Moxidectin 0.2 mg/kg p.o.
 - Fenbendazole 50 mg/kg p.o. 5 gün
 - Metrifonate 35 mg/kg p.o. 4-6 gün
 - Diethylcarbamazine 6-8 mg/kg p.o. 10-20 days
- ✓ Fly fight must be done for control.