Hook worms

- Ancylostoma duodenale (old hookworms)
- Necator americanus (new hookworms)
**Ancylostoma duodenale**

- **Common name:** Old world hookworm
- **Habitat:** Small intestine
- **Definitive host:** Human
- **Route of infection:** Filariform larvae penetrate the skin of human
- **Infective stage:** Third stage larvae (filariform)
- **Diagnostic stage:** Eggs in Stool
- **Disease:** Hookworm infection, Ancylostomiasis
- **Geographic Distribution:** Southern Europe, North parts of Africa, China, India, and Japan.

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Morphology:
1- Adult female is about 9-13 mm, and the male is smaller than 5-11 mm.
2- The *anterior end* have *buccal capsule* (analogous to mouth) armed with two ventral pairs of teeth.
3- The *posterior end* of the *male* has *copulatory bursa* to attach the female during the copulation, females have simple *conical tail*.
Ancylostoma hooks

Chitinous teeth plates

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Ancylostoma duodenale

- Copulatory bursa of male

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Ancylosyoma

Necator

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Egg

- **Shape**: oval with an empty space between the shell and content
- **Size**: 60 x 40 μm
- **Shell**: thin egg shell
- **Color**: colorless and transparent
- **Content**: 4-8 cell unembryonated
- Immature eggs pass in feces (20,000 eggs / day).
3-Rhabditiform larva:
- thin
- size: 200-400 μ
- long buccal cavity.
- rhabditiform oesophagus, very small genital
- pointed tail end.

4-Filariform larva:
- size: 600-700 μ.
- cylindrical oesophagus (one third of the body length)
- sharply pointed tail

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Ancylostoma duodenale

Old world

Buccal capsule
2 pairs of teeth

Bursa
Dorsal ray, shallow cleft, tips tridigitate

60 x 40 μm

Ovum

New world

Buccal capsule
Cutting plates

Bursa
Dorsal ray, deep cleft, bifid tips, spicules fused and barbed

70 x 38 μm

Ovum

Pneumonitis

Jejunum

Occult blood

Eosinophilia
Anaemia

Enter circulation, and via heart, lungs, respiratory tree and oesophagus migrate to the intestine. Maturation in humans 35 days

Rhabditiform

Filariform

Allergy

Ground itch

Maturation in soil 7-8 days
Clinical manifestations:

1-Invasion stage:
The skin, at the site of entry of filariform larva
Maculopapular lesions “ground itch” or “dew itch”
Itching, edema.

2-Migration stage: passage of the larvae in the lung leads to:
Haemorrhages and pneumonia, cough, fever, eosinophylia.
Ground itch or “dew itch”
3-Intestinal stage:
3-Intestinal stage:

1) sucking of blood by the worm (iron-deficiency anaemia),
   • Severe anaemia leads to weakness.
   • 0.15-0.26 mL of blood may be withdrawn by a Ancylstoma in 24 hours.
   • Approximately 50% of the red blood cells are hemolyzed

2) Bleeding at the site of attachment and after movement to a new sites.

3) Toxic substances.
   -intestinal ulcers: flatulence, nausea, vomiting, diarrhea.

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Feeding hookworms

Hookworms do not permanently attach in one spot, but move around the gut and reattach when they are ready to feed.
Diagnosis:

1-Diagnosis can be determined by looking for hookworm eggs in a recently collected stool sample.
2-Blood tests for anemia and nutritional deficiencies, particularly iron, can help to confirm the diagnosis.
Hookworms of Dogs and Cats
Hookworms are among the most pathogenic and common parasites of dogs and cats. They are called hookworms because the anterior end is bent dorsally, giving them a slightly "hooked" appearance. A large sub-globular buccal capsule containing characteristic teeth or cutting plates is present to function in the feeding and blood sucking habits of this group. "Hookworms" are parasites of the small intestine.
The buccal cavity has three pairs of chitinous "teeth" at its anterior margin which can be used to conveniently differentiate this species from the two other species that occur in dogs, *Ancylostoma braziliense*. 

*A. caninum* buccal cavity
A. caninum Life History
A. caninum development after ingestion of larvae in food or water

Infected larvae acquired by direct ingestion enter the mucosa of the small intestine, remain for a few days, return to the lumen, attach to the mucosa to feed and mature. Egg production occurs 15-16 days after infection. This direct development is the rule after oral ingestion, but a few larvae may undergo tracheal migration, especially in resistant dogs.
Infective larvae have the capability to actively penetrate the intact skin. Larvae enter the blood and lymphatic vessels, pass to the heart and lungs, break out into the alveoli and small bronchioles and are coughed up and swallowed. Larvae that undergo tracheal migration are in the small intestine as fourth stage larvae in 2 days to 1 week after skin penetration. Patency occurs in $2^{1/2}$ to 4 weeks after initial infection by this route.
A. caninum Prenatal - Transplacental Infection

When pregnant bitches are exposed orally or cutaneously, some larvae enter the blood stream and pass to the tissue of the fetus where they remain until birth. Worms mature after the birth of the pups and patency may occur 10-12 days later.
Bitches that are exposed orally or cutaneously accumulate larvae in the mammary glands or surrounding tissue. When birth of pups occurs, larvae are found in the milk. Although the vast majority of larvae are acquired in the first milk or “colostrum” of bitches, a few larvae may be passed for up to twenty days after whelping. The transmammary route is considered to be the most common source of infection for nursing pups, and only very small numbers (<2%) of worms are acquired “prenatally” by the transplacental route for *Ancylostoma caninum*. Tracheal migration is not thought to occur after transmammary passage of larvae and patency occurs 12-16 days after birth (faster by 1-2 weeks than the average after infection by the oral or skin penetration routes).
A. caninum Pathogenesis

Ancylostoma caninum is one of the most damaging parasites of young dogs. The primary pathogenic factor of hookworm disease is intestinal blood loss, although malabsorption, intoxication by metabolic products, or secondary microbial invasion of the intestinal wall may have relatively minor importance.

Damage is associated with feeding and mating activity of adult worms in the small intestine. The worms "graze" on the intestinal villi, moving from one location to another. During the feeding activity, laceration of small vessels occurs and blood is sucked through the worm or is lost around the point of attachment due to anticoagulant factors produced by the worm. A. caninum is a voracious blood sucker and as much as 0.01 to 0.2 ml of blood/worm/day may be lost.
A. caninum Pathogenesis

Acute or chronic hookworm disease may occur in older pups or more mature animals. Damage done by worms depends on several factors such as age of the host, intensity of infection, nutritional status, and previous exposure. Hookworm disease is generally more severe in young animals.

Dermatitis initiated by skin penetration of the infective larvae may occur, especially on body contact points and the feet, and can progress from moderate to marked skin thickening characterized by acanthosis and hyperkeratinization. If massive infections occur by this route, pulmonary signs (moist rales, cough, etc.) are observed due to tracheal migration of larvae.
Necropsy findings

At necropsy, the small intestine shows punctiform hemorrhages at the point of attachment of worms.

In more severe cases, a diffuse mucosal reaction with patch of hyperemia, thickening, ulceration and hemorrhage into the lumen is seen.
Necropsy findings

Intestinal blood loss leads to a black, tarry loose stool as the blood is acted upon by the host digestive process ("melena").
A. *caninum* Clinical Signs

Clinical signs observed are those associated with blood loss anemia.

This pup is typical of what may be seen with heavy hookworm infections. Depression, weakness, and poor growth or emaciation are typical.
After skin penetration, larvae continue to migrate for a time under the skin, leading to tortuous superficial tract-like lesions. Other hookworms including *A. caninum* may penetrate the human skin but cause only a local reaction and do not continue migration.