Hook worm

Hookworm infection is caused by the blood-feeding nematode parasites of the species *Ancylostomaduodenale* and *Necatoramericanus*. Together, the hookworms infect an estimated 576-740 million individuals today of which 80 million are severely infected. The morbidity associated with severe infection includes intestinal blood loss, anemia, and protein malnutrition.

Agent
Kingdom: Animalia
Phylum: Nematoda
Class: Secernentea
Order: Strongiloidae
Family: Ancylostomatidae
Genus: Necator/Ancylostoma
Species: *Necatoramericanus* and *Ancylostomaduodenale*

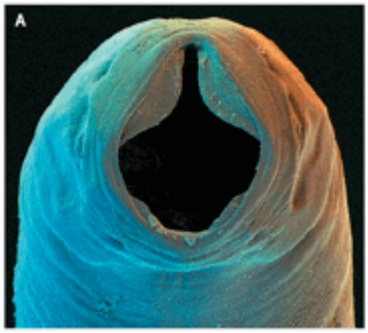
Epidemiology

It is estimated that 576-740 million individuals are infected with Hookworm today. Of these infected individuals, about 80 million are severely affected. The major etiology of Hookworm infection is *N. Americanus* which is found the Americas, sub-Saharan Africa, and Asia. *A. duodenale* is found in more scattered focal environments, namely Europe and the Mediterranean.

Morphology

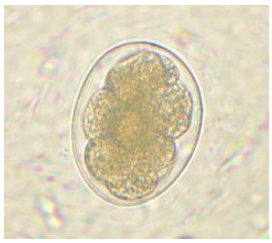
- Adult *A. duodenale* worms are grayish white or pinkish with the head slightly bent in relation to the rest of the body.
- This bend forms a definitive hook shape at the anterior end for which hookworms are named.
- They possess well developed mouths with two pairs of teeth (Figure 1). While males measure approximately one centimeter by 0.5 millimeter, the females are often longer and stouter. males can be distinguished from females based on the presence of a prominent posterior copulatory bursa .
- *N. americanus* is very similar in morphology to *A. duodenale*.
- *N. americanus* is generally smaller than *A. duodenale* with males usually 5 to 9 mm long and females about 1 cm long. Whereas *A. duodenale*possess two pairs of teeth, *N. americanus* possesses a pair of cutting plates in the buccal capsule (Figure 1). the hook shape is much more defined in *Necator* than in *Ancylostoma*

A.duodenale



N.americanus (buccal capsule)

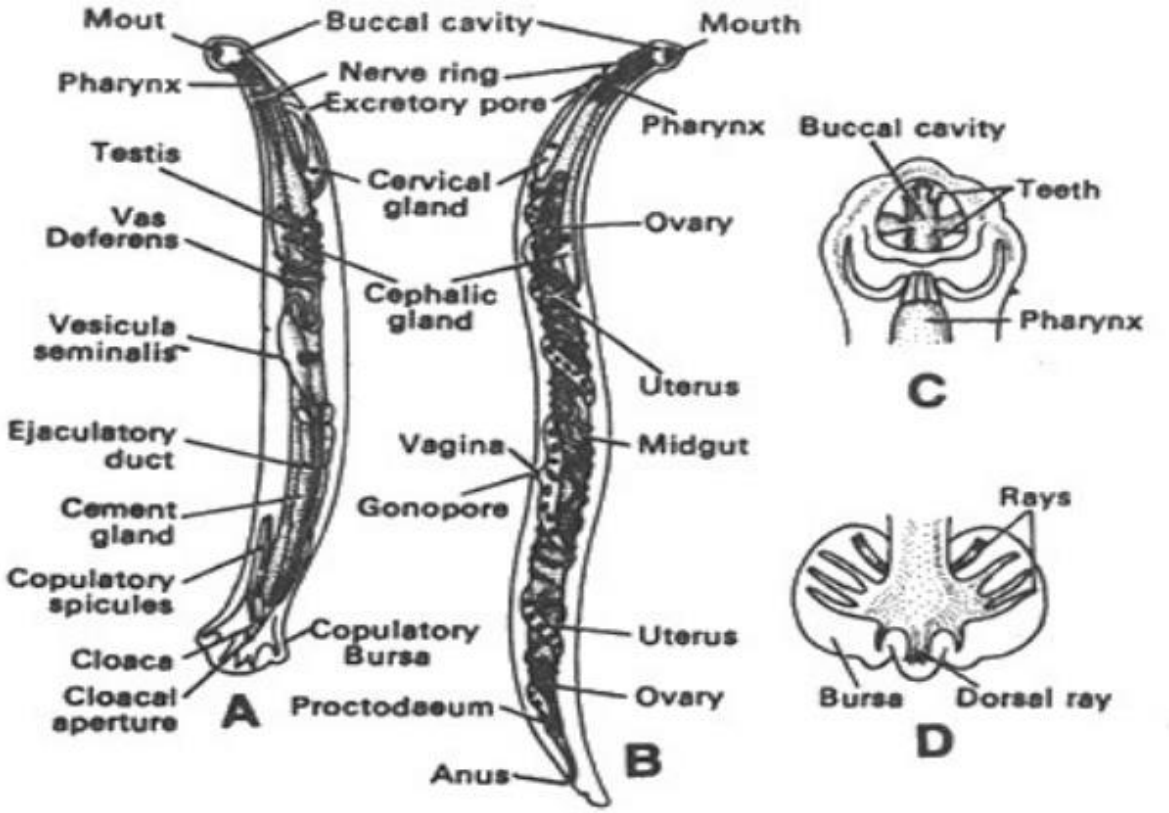
- *A.duodenale* species is dimorphic, the posterior end is expanded as umbrella like structure supported by fleshy rays **(copulatory bursa)**In this worm the number of **rays 13** distributed on **three lobes**, one dorsal and two lateral **(tripatit)** three of these rays supported the dorsal lobe and ten supported the lateral lobes.
- The pattern of distribution of rays helps in distinguishing between the different species. The cloaca is situated in the bursa, there are two long bristle-like spicules project from the bursadistally fused. Females have a vulva located approximately one-third of the body length from the posterior end.
- Both male and female hookworms have two powerful ventral teeth in the adult forms of the parasite, one along each side of the buccal capsule. While *N. americans*copulatory bursa supported by **14 rays** distributed on **twolobes** so this named **(bipartite)**. The copulatory are fused at the end to form barbed tip
- The eggs are blunting rounded ,thin shelled , and are almost - 2- indistinguishable between the different species ,measuring 6o x 40 micrometer, the eggs of Ancylostoma being slightly larger than those of Necator .



egg of hook worm.

The differences between two worms

	A.duodenale	*N.americans*
Size	larger	smaller
Shape	single curve, looks like C	double curves, looks like S
Mouth	2 pairs of ventral teeth	1pair of ventral cutting plates
Copulatory bursa	circle in shape	oval in shape Bursa
Copulatory spicule A terminal hook	1pair with separate ending	1pair of which unite to form spicule
vulva position	post-equatorial	pre-equatorial



Ancylostoma duodenale. A. Adult male; B. Adult female; C. Anterior end; D. Posterior end of male

Life Cycle

N. Americanus and *A. duodenale* eggs can be found in warm, moist soil where they will eventually hatch into first stage larvae, or L1. L1, the feeding non-infective rhabditoform stage, will feed on soil microbes and eventually molt into second stage larvae, L2. L2, which is also in the rhabditoform stage, will feed for approximately 7 days and then molt into the third stage larvae, or L3. L3 is the filariform stage of the parasite, that is, the non-feeding infective form of the larvae.

The L3 larvae are extremely motile and will seek higher ground to increase their chances of penetrating the skin of a human host. The L3 larvae can survive up to 2 weeks without finding a host. It is important to note that while *N. americanus* larvae only infect through penetration of skin, *A. duodenale* can infect both through penetration as well as orally.

After the L3 larvae have successfully entered the host, the larvae then travel through the subcutaneous venules and lymphatic vessels of the human host. Eventually, the L3 larvae enter the lungs through the pulmonary capillaries and break out into the alveoli. They will then travel up the trachea to be coughed and swallowed by the host. After being swallowed, the L3 larvae are then found in the small intestine where they molt into the L4, or adult worm stage. The entire process from skin penetration to adult development takes about 5-9 weeks. The female adult worms will release eggs (*N. Americanus* about 9,000-10,000 eggs/day and *A. duodenale* 25,000-30,000 eggs/day) which are passed in the feces of the human host. These eggs will hatch in the environment within several days and the cycle with start anew.

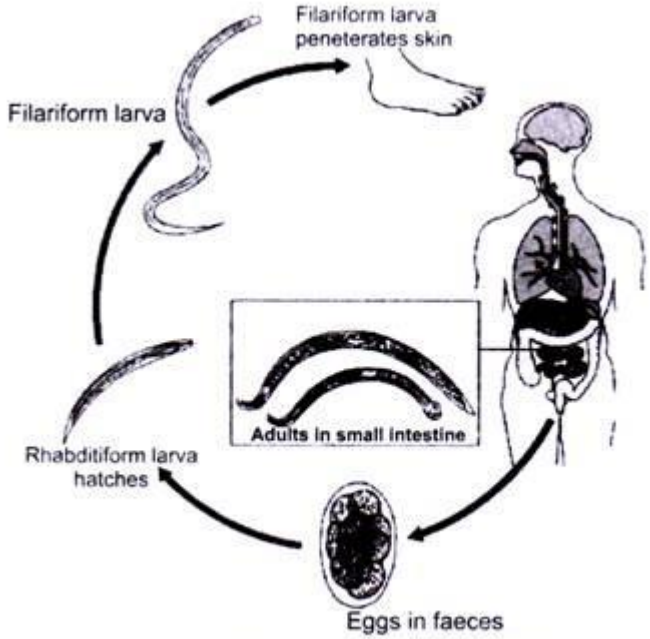


Fig. 9.21 Life Cycle of *A. duodenale*

Pathogenesis and clinical symptoms .

Pathogenesis and clinical symptoms depend on the site where the worms present and their burden (light infection may be not noticed). The clinical disease in hookworm infection may be due to larvae or adult worms.

- **Dermal** : When filariform larvae enter the skin they cause:
  - ✓ Sever local itching .

- ✓ An erythematous popular rash may develop (becoming vascular)
- ✓ Scratching and secondary bacterial infection . This condition ,known as Ground-itch , is more common in infection with Necator than with Ancylostoma .

- **Pulmonary** : When filariform larvae break out the pulmonary cappilliers and enter the alveoli may cause: Minute local hemorrhages, coughing, Chest pain, Wheezing and sometimes fever (with large number of larvae).
- **Gastrointestinal** : When the adult worms attach themselves to the gut mucosa by their buccal capsules they suck into their mouth a portion of intestinal villi , they utilize gut epithelial cells and plasma for their food , are the most important manifestations of Ancylostomiasis (or hookworm disease) .

• By the pumping action of the esophagus the worm sucks in blood , which pass out undigested and unutilized through its intestine .

• The adult Ancylostoma can suck about 0.2 ml blood a day ,while the smaller Necator suck about 0.03 ml a day .

- The secretions of the worm contain anticoagulant activity , bleeding from the site may continue for sometimes ,this add to blood loss . Major morbidity associated with hookworm is caused by: Intestinal blood loss, Iron deficiency anemia and protein malnutrition . All these result mainly from adult hookworms in the intestine ingesting blood, rupturing R.B.Cs ,and degrading hemoglobin in the host .This long- term blood loss can manifest itself self physically through :
- Facial and peripheral edema .
- Eosinophilia .
- Pica caused by iron deficiency anemia .

Children who suffer from chronic hookworm infection can suffer from growth retardation . Early stage symptoms of gastrointestinal infection are : Epigastric pain . Indigestion . Nausea . Vomiting . Constipation .Diarrhea can occur early or in later stage. Signs of advanced sever infection are those of anemia and protein deficiency including :Emaciation . Cardiac failure . and abdominal distention with ascites .

Diagnosis

Depend on finding characteristic worm eggs on microscopic examination of the stools , although this is not possible in early infection . The eggs are oval or elliptical ,measuring about 60 micrometers by 40 micrometers ,colorless, not bile stained and with a thin transparent hyaline shell membrane. When released by the worm in the intestine ,the eggs contains an unsegmented ovum . During its passage down the intestine , the ovum develops and thus the eggs passed in feces have segmented ovum , usually with 4 to 8 blastomeres

Prevention

The infective larvae develop and survive in an environment of damp dirt,particularly sandy and loamy soil .

1-Do not defecate in places other than latrines ,toilet ..etc.

2-Do not use human excrement or raw sewage or untreated night soil as manur/ fertilizer in agriculture .

3-Do not walk barefoot in known infected areas .

Ancylostomabraziliense&Ancylostomacaninum

- Ancylostoma braziliense eggs are passed into the environment through feces of cats and dogs. The eggs incubate on warm, moist soil.
- Adult hookworms live in the small intestines of many vertebrates.
- Hookworms of this type share a common morphology as the anterior end curves like a hook and the buccal capsule is sclerotized and lined with teeth. Within the family Ancylostomidae, the anterior end is curved dorsally. The nematode body is covered with a non-living cuticle shed by molting.
- Humans are accidental, dead-end hosts for hookworms. Infectious juveniles can penetrate the epidermis of humans by taking advantage of broken skin or hair follicles.
- Inside the human host, the juveniles migrate through the epidermis, commonly called the creeping eruption. As the juveniles migrate, they cause serpinginous eruptions on the skin, and they cause a tingling sensation.
- The lesions on the skin are typically 3 mm wide, but in some cases the lesions can expand to reach 15 to 20 cm.

- The juveniles advance through the epidermis at a rate of a few mm per day. As the worms migrate, they frequently change direction, and vesicles begin to form in their trail.
- The vesicles often become inflamed, and as a result the trails of the juvenile are visible on the surface of the skin. The most common site of infection of humans is the feet.Although the juveniles create uncomfortable lesions on the skin, they die before causing any serious harm because humans are dead-end hosts

Enterobius

Classification:

Metazoa (Animalia) (multicellular eukaryotes, animals)
Nemathelminthes(nematodes)
Secernentea (Phasmidea) (with chemoreceptors known as phasmids)
Oxyurida (pinworms; pointed tails)
Oxyuroidea (eggs attached around anus of host)

Family:Oxyuridae
Oxyurid worms are commonly called "pin-worms" because of their characteristic tapering shape and pointed tails. They have simple direct life-cycles involving faecal-oral transmission of eggs containing infective larvae. The eggs, however, are oviposited around the anus (perineum) where they are subsequently dislodged and ingested by their hosts. Pinworms are common in many animal species, and infections in humans may cause intense pruritis (itching), irritability, insomnia and sometimes diarrhoea.

Enterobiusvermicularis **[this species causes perianal pruritis (enterobiasis) in humans]**

Parasite morphology:

These worms form three developmental stages:

- eggs, larvae and adults. The eggs are elongate-oval in shape, measure 50-60µm in length by 20-30µm in width, and are characteristically asymmetric about the long axis being distinctly flattened on one side.
- Infective larvae develop rapidly within the eggs.
- Adult worms appear as elongate whitish tubes with pointed tails. They have three lips surrounding the anterior mouth, a large oesophageal bulb, and a conspicuous anterior cuticular inflation (swollen head). Male worms are 1-4 x 0.2-0.4mm in size, have a single spicule 100-140µm long, and their posterior

ends are strongly curved ventrally. Female worms are 8-13 x 0.3-0.6mm in size and have pronounced slender pointed tails.

Host range: The species *E. vermicularis* is the most common worm found in humans worldwide, particularly in temperate regions. They are commonly found as group infections in children, in families and in institutions (where contact between individuals is high and hygiene may be low). They are estimated to infect some 400 million people, but few countries consider them to be of public health significance due to their low pathogenicity.

Site of infection: Adult worms tend to congregate in the ileocaecal region of the gut where they attach to the mucosa, but they may wander throughout the intestines from the stomach to the rectum. Fertilized female worms migrate out through the anus and deposit eggs of the perianal skin.

Pathogenesis: While many infections remain asymptomatic, worm burdens may increase with time resulting in damage to the intestines by adult worms and/or damage to the perineum resulting from egg deposition. Adult worms attach to the mucosa and feed on intestinal content, bacteria and possibly epithelial cells, causing minute ulcerations which may lead to mild catarrhal inflammation with diarrhoea, eosinophilia and bacterial infection. More commonly, however, infections are characterized by intense perianal itching caused by host sensations and reactions to female worms depositing sticky eggs on the skin. Patients vigorously scratch themselves attempting to relieve the itching, but in doing so, often cause skin damage, bleeding, bacterial infection and intensified itching. Heavy infections in children may cause restlessness, irritability, anorexia, insomnia, nightmares, bed-wetting, nausea and vomiting. Occasionally, wandering worms have been associated with appendicitis, vaginitis, and rarely, extra-intestinal granulomas in ectopic sites.

Mode of transmission:

- Pinworms have direct life-cycles involving the oral ingestion of eggs containing infective larvae.
- The eggs are not excreted with faecal material, but are attached to the perianal skin. Such transmission is therefore not strictly faecal-oral, but rather contaminative, involving the transfer of eggs to the mouth via host behaviours or inanimate objects.
- Gravid females migrate out through the anus onto the perineum, particularly during the night, and leave trails of eggs (up to 10,000) as they crawl about. After oviposition, the females die whereas the males die soon after copulation. Larvae develop within the eggs within six hours and become infective.
- The eggs are dislodged by host scratching and contaminate hands, bedding, clothing, toys, and furniture. They are very light and easily disseminated with

house dust by the slightest of air currents.

- They remain viable in cool moist conditions for up to one week. Following ingestion, the eggs hatch in the small intestine and the larvae migrate to the large intestine and mature over 2-6 weeks.
- eggs trapped in perianal folds may hatch and the larvae may enter the intestines directly via the anus (process called retro-infection).
- Occasionally, larvae may enter the vulva and infect the vagina of women. The parasite may complete its whole life-cycle in 2-13 weeks, and infections may become progressively heavier due to continual parasite uptake (through auto-infection, re-infection and retro-infection).

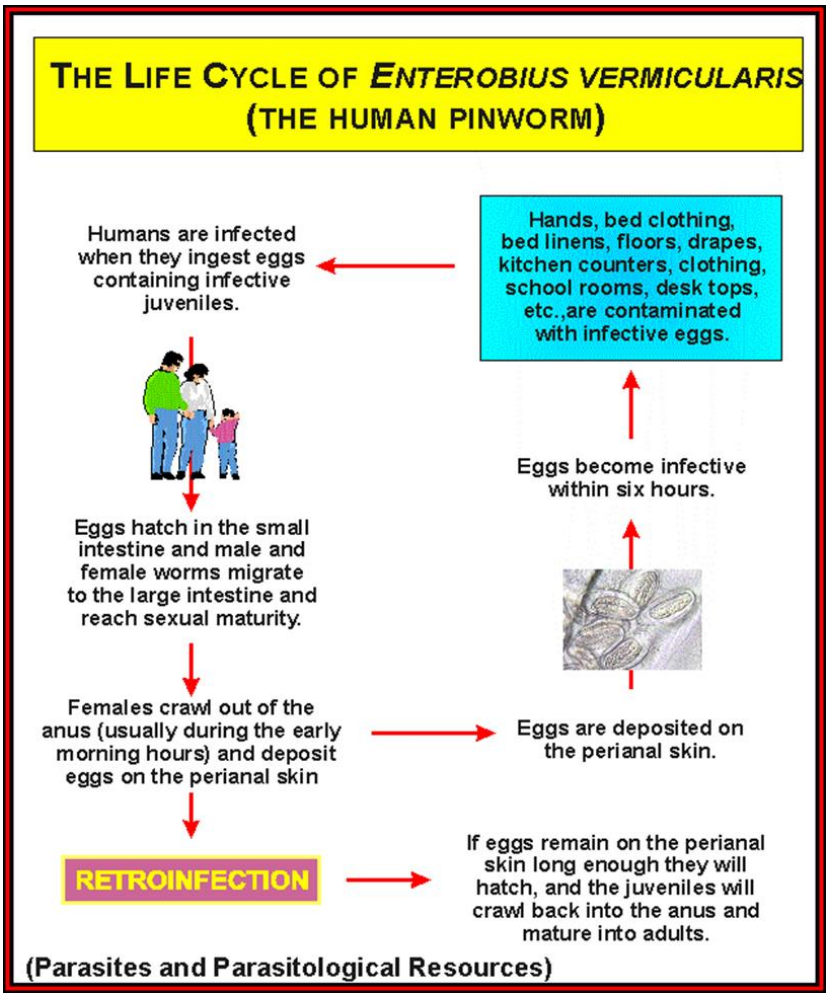
Differential diagnosis:

- Worm eggs are rarely found in faeces so conventional examination techniques are not used.
- infections are best diagnosed by the macroscopic detection of adult worms or the microscopic detection of eggs on the perineum.
- Motile worms may be seen on perianal skin glistening under bright light when close visual examinations are conducted during the night or early in the morning. Adult worms may sometimes be observed on the surface of fresh stool samples.
- Alternatively, sticky-tape may be quickly applied to the perianal skin first thing in the morning and then stuck onto a glass slide for microscopic examination of adherent eggs (aptly-named perianal sticky-tape test).

Treatment and control: The drug of choice is mebendazole, although albendazole, levamisole and pyrantelpamoate are also effective. Treatment should be repeated after about 10 days to kill any newly-acquired worms. It is advisable to institute whole group treatment where appropriate, so that other group, cohort or family members do not continue to act as sources of infection. To avoid constant re-infection, it is imperative that strict personal hygienic precautions are introduced, particularly frequent hand-washing. Household decontamination is difficult as infective eggs can survive for many days in cool moist house dust and for a few days on toys or furniture. clothes, bed linen and towels should be laundered in hot water, dusty areas should be well vacuumed and potentially contaminated surfaces should be cleaned. While the eggs are very resistant to many disinfectants, they are susceptible to desiccation in dry.

adult

egg


THE LIFE CYCLE OF ENTEROBIUS VERMICULARIS
(THE HUMAN PINWORM)
Humans are infected when they ingest eggs containing infective juveniles.
Hands, bed clothing, bed linens, floors, drapes, kitchen counters, clothing, school rooms, desk tops, etc.,are contaminated with infective eggs.
Eggs become infective within six hours.
Eggs hatch in the small intestine and male and female worms migrate to the large intestine and reach sexual maturity.
Females crawl out of the anus (usually during the early morning hours) and deposit eggs on the perianal skin
Eggs are deposited on the perianal skin.
RETROINFECTION
If eggs remain on the perianal skin long enough they will hatch, and the juveniles will crawl back into the anus and mature into adults.
(Parasites and Parasitological Resources)