

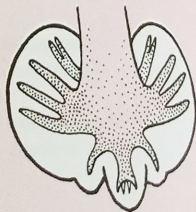
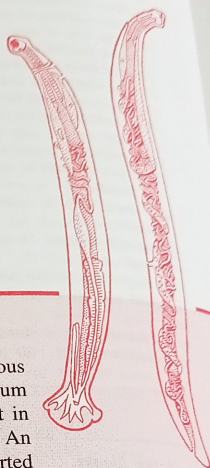
Ancylostoma duodenale : The Common Hookworm

Hookworms are the most dangerous parasitic roundworms, causing serious infections in humans. They belong to the order Strongyloidea of phylum Nematoda. They differ from ascaroid nematodes in the absence of **lips** but in the presence of a cuticulate buccal capsule of taxonomic importance. An outstanding morphological feature is a **copulatory bursa** in male, supported by rays, disposition of which is also of taxonomic significance. Following description applies mainly to *Ancylostoma duodenale*, the common hookworm. It was discovered in 1838 in an autopsy of an Italian peasant woman by **Dubini**.

Ancylostoma duodenale

SYSTEMATIC POSITION

Phylum	Nematoda
Class	Phasmodia
Order	Strongyloidea
Family	Ancylostomidae
Genus	<i>Ancylostoma</i>
Species	<i>duodenale</i>



Ancylostoma duodenale

GEOGRAPHY

About one-half world population is infected with *Ancylostoma duodenale* in the 'Old World' tropical, subtropical, and temperate regions of Africa, Europe, and Asia. Some *A. braziliense* and *A. malayanum* are also found in the tropics.

Hookworms are found where conditions are favorable for their development and survival.

GEOGRAPHICAL DISTRIBUTION

About one-half billion people, or nearly 25% of world population, are infected by hookworms. *Ancylostoma duodenale*, is commonly known as the 'Old World Hookworm'. It is common in tropical, subtropical and temperate regions of Asia, Africa, Europe, Pacific Islands and two Americas. However, the incidence is greater in Europe and Asia. Some other species, namely, *A. caninum* and *A. braziliense*, both in dogs and cats, and *A. malayanum* in bears, are also common.

HABITS AND HABITAT

Hookworms flourish under primitive conditions where people go barefoot, modern sanitary conditions do not exist and human faeces are deposited on ground. The adult worms live

parasitically in the intestine of man where they suck blood, lymph, bits of mucous membrane and tissue fluids from the lining of the intestinal wall. The infective juveniles enter the human host percutaneously from the soil contaminated by faeces in which they abound.

MORPHOLOGY

[I] External Features

They are called 'hook-worms' because the male has a hook-shaped body. Besides, prominent hooks are present in the genital bursa of male, while smaller hooks occur within the mouth of both sexes.

1. Shape and size. Sexes are separate.

Mature worms are cylindrical in shape and white or grey in colour. Adult male is 8 to 11 mm long and 0.4 to 0.5 mm in diameter; while adult female is generally larger, 10 to 13 mm long and 0.6 mm in diameter.

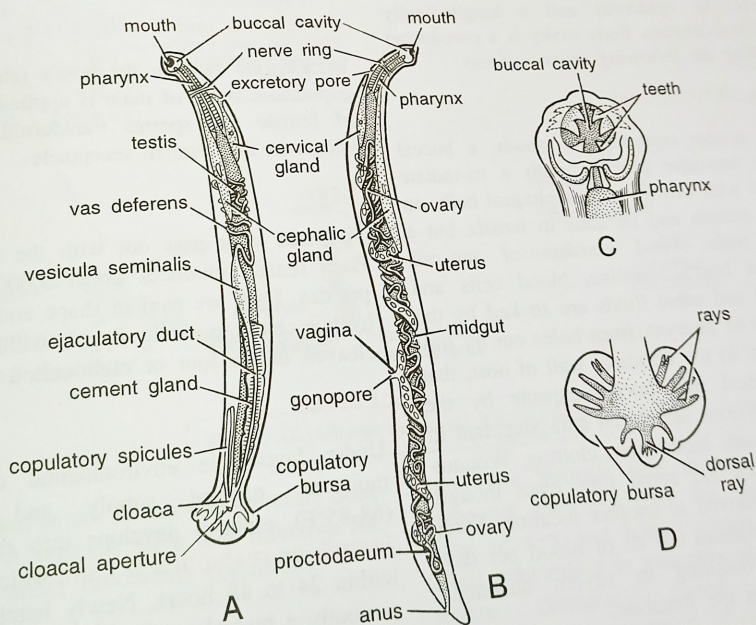


Fig. 1. *Ancylostoma duodenale* : A. Adult male. B. Adult female. C. Anterior end. D. Posterior end of male.

2. Buccal capsule. Anterior end of male and female is similar, somewhat narrower and curved dorsally, probably the reason for their being called the hookworms. Mouth leads into a large cup-shaped cavity or **buccal region** or capsule, lined internally by cuticle. Entrance to mouth is armed with a pair of chitinous ventro-lateral cutting plates bearing teeth. Two sharp teeth or lancets are also present at the base of buccal capsule which serves for attachment with the intestinal wall of host. Dorsal curving of anterior end of body presumably permits a better grip of chitinous plates and lancets on the hosts intestinal epithelium.

3. Copulatory bursa. Posterior end of female tapers, while that of male is in the form of a broad, umbrella-like structure, the **copulatory bursa**, surrounding the cloaca. Bursa is supported by fleshy bursal rays having a definite arrangement. Bursal rays and teeth in buccal capsule are of taxonomic value.

[II] Body Wall

In cross section, bodywall includes from outside a cuticle, an epidermis and a longitudinally directed musculature. Body cavity is a pseudocoel surrounding the following organ systems.

[III] Digestive System

Digestive system comprises a mouth, a buccal capsule, a muscular pharynx with a tri-radiate lumen lined with cuticle, an oesophageal bulb, an intestine, a rectum and an anus in female but a cloaca in male. Food consists of mucous membrane of host's intestine, blood cells and serum. Blood and other fluids are sucked by the sucking action of pharynx from holes cut by tiny teeth or lancets, in the intestinal wall of host, that has been pinched into buccal capsule by the cutting plates. Worms secrete an anti-coagulant in wound that prevents blood from clotting. Wounds keep oozing blood for some time even though the worms have moved to another location. Each adult worm sucks about 0.8 cc of blood per day from the host, resulting in severe anaemia. Digestion occurs in the intestine.

[IV] Excretory System

Excretory system is similar to that of *Ascaris*. It includes two longitudinal canals in the lateral cords

and short anterior excretory canal which opens to the exterior through the excretory pore.

[V] Reproductive System

Male has a single tubular thread-like testis twisted around the intestine in the middle of body. It leads posteriorly into a vas deferens, followed by a seminal vesicle. Posterior end of seminal vesicle tapers into an ejaculatory duct which enters the cloaca.

Female has two much convoluted ovarian tubules, one anterior and the other posterior, at the level of gonopore. Each ovary leads into a short oviduct that opens into a dilated seminal receptacle. From the latter arises a muscular uterus that terminates into a vagina. Two vaginæ become confluent and open through the common gonopore or vulva.

LIFE CYCLE

Copulation and Fertilization

Hookworms mate in the host's intestine. During copulation, bursa of male is applied on the vulva of female and sperms transferred. Fertilization occurs in the seminal receptacles.

Eggs

Fertilized eggs pass out with the host's faeces. Each female produces about 9,000 fertile eggs per day. Eggs are oval in shape and protected by hyaline chitinous shells. Zygote within has already cleaved into a four or eight-celled embryo.

Larvae

Under favourable environmental conditions of moisture, oxygen supply and temperature (68-85°F), embryo develops into the **first-stage juvenile** or **rhabditiform larva** which hatches out within 24 to 48 hours. Newly hatched larva has a mouth, a buccal capsule, an elongated pharynx with an oesophageal bulb, and an intestine. It feeds on bacteria of faeces or other organic debris of soil for 4 to 5 days and moults twice to form a **third-stage juvenile** or **filariform larva**. This juvenile is about 0.5 mm long and infective for

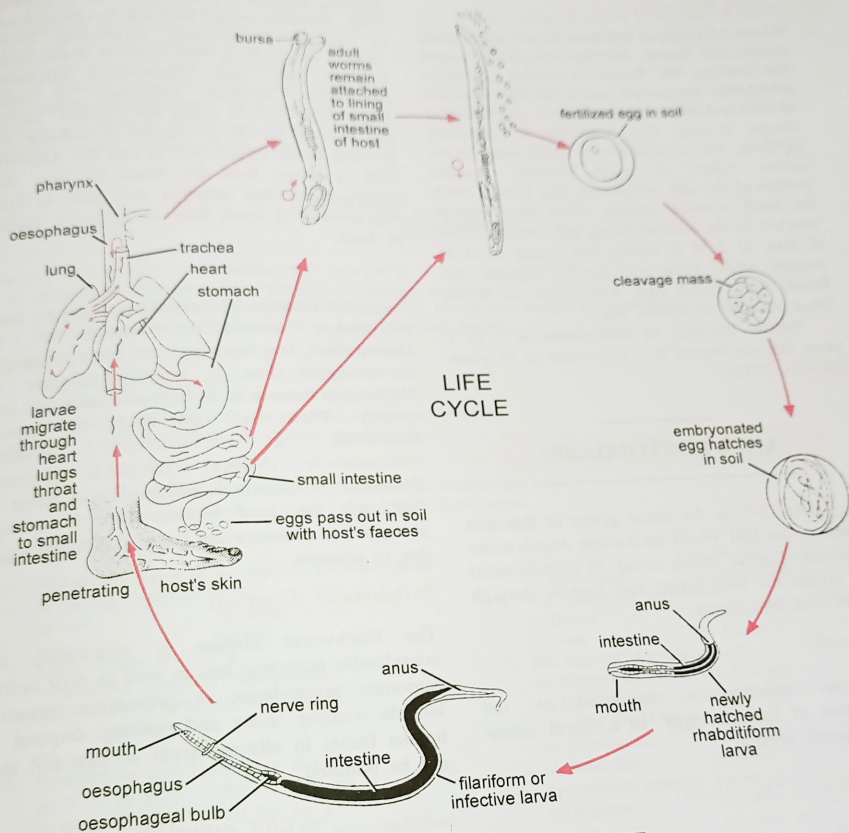


Fig. 2. *Ancylostoma duodenale*. Life cycle.

man. It has a non-patent mouth and therefore does not feed, But it remains alive and infective for several weeks under favourable conditions.

Infection of a New Host

Filariform larva **infects** a new host (man) by chance contact with his skin. Its anterior end is equipped with oral spears which enables larva to penetrate skin of a potential human host. Larvae

may bore through skin in any part of body. Generally they penetrate the soft skin on the sides of feet and hands, through hair follicles. Their penetration is generally accompanied by a severe dermatitis called 'ground itch', characterized by ulceration of skin about wounds. Besides percutaneous entrance, infection is also possible through ingestion of contaminated food and water.

Larval Migration

Within 24 hours of infection, larvae reach blood vessels and follow the same migratory course described for the larvae of *Ascaris*. In blood stream they are carried first to the right ventricle of heart and then to lungs by way of pulmonary arteries. In lungs they break out of pulmonary capillaries into alveolar spaces. From lungs larvae ascend trachea to reach pharynx, become swallowed through oesophagus and finally reach the small intestine (ileum), where they become attached to the mucous lining and feed on blood of host. In 5 to 6 weeks, they moult twice to become adult. Male and female copulate and female starts laying eggs which pass out in the faecal material of human host.

Normal life-span of hookworms is 5 to 7 years that can extend to a maximum of 16 years (Taylor, 1933).

ANCYLOSTOMIASIS

Ancylostomiasis is the name given to infection caused by the Old World hookworm *Ancylostoma duodenale*. Larvae which occur in contaminated soil, invade the host (man) and burrow through skin of feet into blood.

Diagnosis

Hookworm infection is diagnosed by the observation of hyaline 'eggs' in a faecal smear from infected person.

Pathogenesis (Symptoms)

Pathogenicity is fairly extensive involving skin, lungs and small intestine. Penetrating **larvae** cause characteristic tiny and irritating sores, called **dew sores** or **ground itching**, and inflammation of skin. In lungs, migratory **larvae** cause petechial haemorrhages and bronchial pneumonitis. But greatest damage occurs in small intestine by the adult worms. Here, the punctured wounds continue to bleed for some time so that more blood is lost than worms can consume. This results in severe

anaemia, decrease in general immunity and bloody stools. Intestinal wounds may lead to various forms of detrimental infections. Deleterious toxins secreted by glands in head region of worms cause stomach pain, food fermentation, diarrhoea, constipation, dyspnea, palpitation of heart, eosinophilia, loss of health and collapse. Mental and physical growth is retarded in children and growing youth. Patient tries to ease the epigastric pain by eating, even dirt, hence the term 'dirt eaters'. Unchecked infection may lead to fatty degeneration of heart, liver and kidneys, ending in death.

Therapy (Treatment)

Treatment involves administration of drugs, such as carbon tetrachloride, thymol, oil of chenopodium, hexylresorcinol, etc. Most commonly recommended drug is tetrachloroethylene or blephenium because of its high efficiency and low toxicity. These days the drugs for human hookworm are **Albendazole** (Zentel), **Mebendazole** (Mebex) **Pyrantel Pamoate** (Nemocid). Treatment is followed by a purge to flush out the dead worms. Iron is usually prescribed to overcome the haemoglobin deficiency due to anaemia.

Prophylaxis (Control)

The Hookworm disease is responsible for considerable economic loss as well as poor health. Important prophylactic or preventive measures include wearing shoes and sanitary disposal of human faeces in affected areas so that soil may not be polluted.

Necator americanus

Another important human hookworm is the 'New World hookworm' or *Necator americanus*, which literally means the 'American killer.' It is the causative agent of the hookworm disease or **Necatoriasis** in man in Africa, Asia, Sri Lanka and tropical America. It is believed to be introduced into America, before their civil war, with the infected slaves from central and southern Africa. It was first discovered in 1902 by **Stiles**.