33

Strongyloides and Strongyloidiasis

SOME ASPECTS of the epidemiology and transmission of *Strongyloides* resemble those of the hookworms described in chapter 22. In other aspects, however, it is entirely different, and it must be considered quite separately from *Ancylostoma* and *Necator*.

Description of Pathogen and Disease

The curious life cycle of *Strongyloides*, and the danger of very severe consequences of strongyloidiasis in immunodeficient or otherwise debilitated individuals, have generated considerable research interest in this worm. A recent review is provided by Carvalho Filho (1978).

Identification

Strongyloidiasis is an infection of the small intestine by the nematode worm *Strongyloides stercoralis*. Symptoms are often vague or absent, but infection is potentially serious, particularly in malnourished or immunosuppressed individuals. Nonspecific symptoms such as diarrhea with abdominal discomfort, recurrent respiratory symptoms, and perhaps a rash are common. In a few patients, enteritis with a malabsorption syndrome, loss of elasticity in the gut, and emaciation occur. When the body's immune responses are deficient, disseminated strongyloidiasis may occur, with larvae attacking most organs of the body; such cases are usually fatal.

Diagnosis is by finding larvae in feces examined under a microscope. Clinically, watery diarrhea with mucus is suggestive of infection if accompanied by lesions on the buttocks, in the anal region, and an eosinophilia of up to 30 percent. Treatment is by oral drug therapy with thiabendazole or mebendazole.

Occurrence

Strongyloidiasis occurs worldwide and particularly in warm, wet climates. In most areas strongyloidiasis is coextensive with hookworm but has a lower prevalence. It is probable that strongyloidiasis is everywhere more common than prevalence figures would indicate, since it is difficult to diagnose.

Infectious agent

Strongyloides stercoralis is a minute nematode parasitizing man. The adult females are only 2–2.5 millimetres long and live embedded in the mucosa of the small intestine (figure 33-1). The eggs are ovoid and measure 50–60 by 30–35 micrometers but are seldom seen because larvae hatch out and are passed in the feces.

Reservoirs

The reservoir of *S. stercoralis* is man, although dogs and apes have been found naturally infected.

Another species, *S. fuelleborni*, infects man in Cameroon, Central African Republic, Congo, Ethiopia, Malawi, Togo, Zaire, Zambia, Zimbabwe, and other African countries and in Papua New Guinea and West Irian (Indonesia). It is a common parasite of monkeys and baboons in Africa and Asia, probably also a natural parasite of man, and the predominant *Strongyloides* species infecting man in the rain-forest belt of Central Africa.

Transmission

The mature parasitic female, which lives embedded in the mucosa of the small intestine, deposits several dozen partially embryonated eggs each day. These eggs hatch and liberate noninfective rhabditiform larvae that migrate into the lumen of the small intestine. The rhabditiform larvae either leave the host with the feces or develop into dwarfed filariform larvae that may invade the mucosa of the lower portion of the small intestine or large intestine and cause infection. The

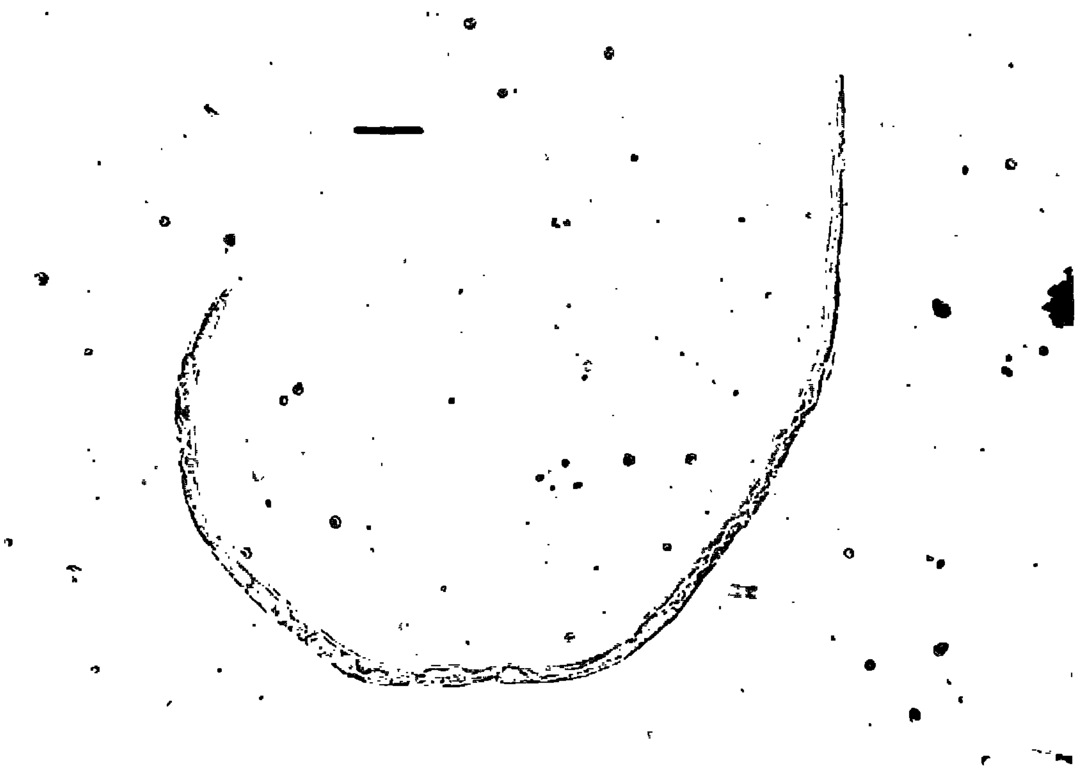

Figure 33-1. *An adult* Strongyloides stercoralis *under a light microscope.* Scale bar = 0.1 millimeters. (Photo: Wellcome Museum of Medical Science)

latter course is known as autoinfection. Autoinfection can also occur when rhabditiform larvae in feces are deposited on the perianal skin and develop into infective filariform larvae that penetrate the body through the skin. Thus, *Strongyloides* is the one human helminth that can increase its numbers within the intestine without any form of reinfection or external transmission.

The rhabditiform larvae passed in the feces continue their development in the soil. When conditions are favorable (high nutrient concentration and high moisture in soil), they develop into free-living adults. These adults continue a free-living life cycle in the soil as long as conditions allow. When conditions are unfavorable (low nutrient concentration and low soil moisture), the rhabditiform larvae develop into infective filariform larvae that can remain alive in moist soil for a few weeks. These infective filariform larvae penetrate the skin, usually of the foot, and are carried in the blood, through the heart, to the lungs. The larvae penetrate capillary walls around the alveoli (lung sacs), enter alveoli, ascend the bronchus and trachea to the epiglottis, and descend the digestive tract to reach the upper part of the small intestine where development of the adult parasite is completed.

A new infection can be initiated by the penetration of a single larva. An adult female worm can produce eggs without fertilization by a male worm (parthenogenesis), and male adults are rarely found in the intestine.

The transmission and life cycle of *S. fuelleborni* is similar to *S. stercoralis* except that eggs, rather than larvae, are shed in the feces.

Prepatent and incubation periods

Worms become mature, and larvae appear in the feces, 17–28 days after skin penetration by filariform larvae. Symptoms may develop slowly or not at all.

Period of communicability

As long as mature females are present in the small intestine, larvae will be passed in the feces. Because autoinfection is common, patients may pass larvae for many years. Larvae in soil live for less than 2 weeks, but free-living cycles can occur under favorable conditions to prolong contamination of soil for an unknown period.

Resistance

Susceptibility is general, but there is good evidence for limited immunity.

Epidemiology

The epidemiology of strongyloidiasis has been little studied, and most prevalance figures are probably underestimates because microscopic examination of feces for larvae detects only some infections. *Strongyloides* is usually, although not always, coextensive with hookworm infection. Promiscuous defecation, poverty (no shoes), and a wet humid climate are conditions favoring the transmission of both infections. Strongyloidiasis typically is rarer than hookworm infection, which is surprising in view of the greater egg production of the *Strongyloides* female and its free-living cycle, which may build up higher populations of infective larvae in the soil. Counter influences are that the *Strongyloides* rhabditiform larva in the feces is less rugged than the hookworm egg, and the infective filariform larva of *Strongyloides* is shorter lived than that of the hookworm.

Studies in Cali (Colombia) during 1956–61 showed an overall prevalence of strongyloidiasis of 14 percent, with a maximum of 30 percent among people 40–49 years old (Faust and Mugaburu 1965). As with hookworm, infection was more common in males than females. Other reports of strongyloidiasis in developing countries include those from Brazil (Asami, Enomoto and Miura 1970; Dias 1968), Cuba (Razón 1971), India (Nawalinski, Schad and Chowdhury 1978), Iran (Ghadirian and Amini 1970), and Tunisia (Dancesco and others 1971).

Strongyloidiasis is found in some areas of some industrialized countries. It occurs throughout the USA but is more common in the rural south (Blumenthal 1977; Burke 1978; Warren 1974). Infection rates are high in some institutions, especially in homes for the mentally retarded. Continuing autoinfection can maintain strongyloidiasis in individuals long after they leave endemic areas, and these infections may become serious and even fatal if resistance is lowered by other diseases or by certain types of drug therapy (Weller, Copland and Gabriel 1981). It has recently been shown in Britain (Gill and Bell 1980) and Australia (Grove 1980) that up to 28 percent of former prisoners of war of the Japanese have chronic strongyloidiasis, even 40 years after their supposed infection in eastern Asia. For British ex-prisoners, strongyloidiasis is significantly more common among those who worked on the Thai-Burma railway (21 percent) than among those who did not (9 percent). Other accounts of strongyloidiasis in developed countries include those from Japan (Tanaka 1968), Poland (Soroczan 1976), the USSR (Shablovskaya 1964; Stefanov 1970), and Yugoslavia (Bezjak and Breitenfeld 1969).

Accounts of *S. fuelleborni* infection in man include those from Papua New Guinea (Vince and others 1979), Zambia (Hira and Patel 1980), and elsewhere in central Africa (Pampiglione and Ricciardi 1971, 1972).

Control Measures

Mass chemotherapy is an ingredient of any control program, but it is hampered by the limited effectiveness and possible side effects of the drugs available.

Environmental and educational control measures are similar to those for hookworm (chapter 22) and must emphasize excreta disposal, excreta treatment prior to agricultural application, and the wearing of shoes. The free-living *Strongyloides* cycle and the risk of continuing autoinfection, however, suggest that environmental and educational measures will be less effective against *Strongyloides* than against hookworm.

Successful reduction of strongyloidiasis in mental institutions by a combination of chemotherapy and environmental improvement has been reported from Hungary (Bánki and others 1963), the USA (Jeffery 1960), and the USSR (Shablovskaya and Smaga 1967).

There has been little work on the control of endemic strongyloidiasis in villages in developing countries. An exceptional report comes from Costa Rica (Arguedas and others 1975). In 1965, the inhabitants of the village of Palomo were given mass treatment with thiabendazole in a dose of 75 milligrams per kilogram, repeated after 6 weeks. A neighboring village, Purisil, was used as a control. For the first 2 years there was a dramatic drop in the prevalence of strongyloidiasis in Palomo from 19 to 1 percent, whereas Purisil showed a drop only from 18 to 10 percent. Hookworm, *Trichuris*, and *Ascaris* infection rates were not improved after 2 years. Seven years after the mass treatment, another survey was done in 1973. Meanwhile, sanitary and socioeconomic conditions had improved: latrines, piped water, and electricity had been installed. The prevalence of *Strongyloides* had dropped to 6 percent in Purisil but remained very low at 0.5 percent in Palomo. These findings suggest that mass treatment with thiabendazole, combined with concurrent social and environmental improvements, had a considerable long-term effect.

Occurrence and Survival in the Environment

The eggs of *S. stercoralis* are not found in the environment, although those of *S. fuelleborni* are. The larvae of *S. stercoralis* may be expected in night soil and sewage in endemic areas and have been reported from sewage in the German Democratic Republic (Kalbe 1956).

S. stercoralis larvae typically live for less than 3 weeks, even in soil under optimal conditions. The optimal conditions for the infective filariform larvae are 20–25°C and high moisture. Larvae die rapidly in dry soil or at temperatures of over 46°C. Rhabditiform larvae are less able to withstand desiccation than filariform larvae, and at low temperatures they will not develop further (Kreis 1932; Little and Gutierrez 1968; Melashenko 1963).

It was observed in Colombia that most human feces were buried by dung beetles within a few hours after being deposited on the ground (Little and Gutierrez 1968). It was concluded that, although the burial of feces by dung beetles might have reduced the number of infective larvae developing in the soil, it probably also increased the chances of people coming in contact with the larvae that did develop. Since dung beetles kept the surface of the defecating sites relatively clean, people tended to return repeatedly to the same site to defecate and thus increased their chances of becoming infected. Studies in the Ukraine (USSR) showed that rhabditiform and filariform larvae of *S. stercoralis* did not move vertically in soil, but that free-living adults penetrated to a depth of 0.3 meters (Shablovskaya 1963).

A variety of alkalis and acids, especially hydrochloric acid and alcohol, are effective larvicides (Karbach 1966; Melashenko 1963; Rai 1935). Larvae are also susceptible to halogens, especially iodine (Thitasut 1961). Thiabendazole has also been used as a larvicide. Some plants and plant products (such as *Cymbopogon citratus*, *Eucalyptus globulus*, and *Mentha spicata*) have larvicidal properties (Goulart and others 1972).

Inactivation by Sewage Treatment Processes

S. stercoralis exists in sewage as a delicate larva, not as a robust egg, and it is to be expected that complete elimination will take place during most sewage treatment processes. *S. fuelleborni* eggs may react to sewage treatment processes in a manner similar to hookworm eggs (chapter 22). No studies have been reported.

Inactivation by Night Soil and Sludge Treatment Processes

S. stercoralis exists in night soil and sludge as a delicate larva, not as a robust egg, and it is to be expected that complete elimination will take place during most night soil and sludge treatment processes. *S. fuelleborni* eggs in night soil and sludge treatment processes may be eliminated in a manner similar to hookworm eggs (chapter 22). No studies have been reported.

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