

include diarrhea, vomiting, and abdominal pain. Fever and weight loss may also be present. Symptoms generally resolve within 10 days.

Parasitic Enterocolitis

Although viruses and bacteria are the predominant enteric pathogens in the United States, parasitic disease and protozoal infections affect more than one half of the world's population on a chronic or recurrent basis. The small intestine can harbor as many as 20 species of parasites, including nematodes, such as the roundworms *Ascaris* and *Strongyloides*; hookworms and pinworms; cestodes, including flatworms and tapeworms; trematodes, or flukes; and protozoa. Parasitic infections are covered in Chapter 8; those that are common in the intestinal tract are discussed briefly here.

Ascaris lumbricoides. This nematode infects more than a billion individuals worldwide as a result of human fecal-oral contamination. Ingested eggs hatch in the intestine and larvae penetrate the intestinal mucosa. Larvae then migrate from splanchnic to systemic circulation and, finally, enter the lungs to grow within the alveoli. Approximately 3 weeks later, the larvae are coughed up and swallowed. Upon return to the small intestine, the larvae mature into adult worms, which induce an eosinophil-rich inflammatory reaction (Fig. 17-31B) that can cause physical obstruction of the intestine or biliary tree. Larvae can also form hepatic abscesses and cause *Ascaris* pneumonitis. Diagnosis is usually made by detection of eggs in stool samples.

Strongyloides. The larvae of *Strongyloides* live in fecally contaminated ground soil and can penetrate unbroken skin. They migrate through the lungs, where they induce inflammatory infiltrates, and then reside in the intestine while maturing into adult worms. Unlike other intestinal worms, which require an ova or larval stage outside the human, the eggs of *Strongyloides* can hatch within the intestine and release larvae that penetrate the mucosa, causing autoinfection (Fig. 17-31B). Hence, *Strongyloides* infection can persist for life, and immunosuppressed individuals can develop overwhelming autoinfection. *Strongyloides* incite a strong tissue reaction and induce peripheral eosinophilia.

Necator duodenale and Ancylostoma duodenale. These hookworms infect 1 billion people worldwide and cause significant morbidity. Infection is initiated by larval penetration through the skin and, after further development in the lungs the larvae migrate up the trachea and are swallowed. Once in the duodenum the worms attach to the mucosa, suck blood, and reproduce. This causes multiple superficial erosions, focal hemorrhage, and inflammatory infiltrates and, in chronic infection, iron deficiency anemia. Diagnosis can be made by detection of the eggs in fecal smears.

Enterobius vermicularis. Also known as pinworms, these parasites infect people in industrialized and developing countries; in the United States as many as 40 million people have pinworms. Because they do not invade host tissue

and live their entire life within the intestinal lumen, they rarely cause serious illness. Infection by *E. vermicularis*, or enterobiasis, is primarily by the fecal-oral route. Adult worms living in the intestine migrate to the anal orifice at night, where the female deposits eggs on the perirectal mucosa. The eggs cause intense irritation. Rectal and perineal pruritus ensues. The intense itching leads to contamination of the fingers, which promotes human-to-human transmission. Both eggs and adult pinworms remain viable outside the body, and repeat infection is common. Diagnosis can be made by applying cellophane tape to the perianal skin and examining the tape for eggs under a microscope.

Trichuris trichiura. Whipworms primarily infect young children. Similar to *E. vermicularis*, *Trichuris trichiura* does not penetrate the intestinal mucosa and rarely cause serious disease. Heavy infections, however, may cause bloody diarrhea and rectal prolapse.

Schistosomiasis. This disease involving the intestines most commonly takes the form of adult worms residing within the mesenteric veins. Symptoms of intestinal schistosomiasis are caused by trapping of eggs within the mucosa and submucosa (Fig. 17-31C). The resulting immune reaction is often granulomatous and can cause bleeding and even obstruction. More details are presented in Chapter 8.

Intestinal Cestodes. The three primary species of cestodes that affect humans are *Diphyllobothrium latum*, fish tapeworms; *Taenia solium*, pork tapeworms; and *Hymenolepis nana*, dwarf tapeworms. They reside exclusively within the intestinal lumen and are transmitted by ingestion of raw or undercooked fish, meat, or pork that contains encysted larvae. Release of the larvae allows attachment to the intestinal mucosa through its head, or scolex. The worm derives its nutrients from the food stream and enlarges by formation of egg-filled segments termed proglottids. Humans are usually infected by a single worm, and since the worm does not penetrate the intestinal mucosa, peripheral eosinophilia does not generally occur. Nevertheless, the parasite burden can be staggering, since adult worms can grow to many meters in length. Large numbers of proglottids and eggs are shed in the feces. Clinical symptoms include abdominal pain, diarrhea, and nausea, but the majority of cases are asymptomatic. Occasionally, *D. latum* causes B₁₂ deficiency and megaloblastic anemia because it competes with the host for dietary B₁₂. Identification of proglottids and eggs in stools is the most efficient method of diagnosis.

Entamoeba histolytica. This protozoan causes amebiasis and is spread by fecal-oral transmission. *E. histolytica* infects approximately 500 million people in countries such as India, Mexico, and Colombia, and causes 40 million cases of dysentery and liver abscess annually. *E. histolytica* cysts, which have a chitin wall and four nuclei, are resistant to gastric acid, a characteristic that allows them to pass through the stomach without harm. Cysts then colonize the epithelial surface of the colon and release trophozoites, ameboid forms that reproduce under anaerobic conditions.