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Diphyllobothrium and Diphyllobothriasis

DIPHYLLOBOTHRIASIS has a restricted geographical distribution and is not a major public health problem in most areas where it does occur. It is caused by a cestode (tapeworm) but has a life cycle involving two aquatic hosts that is more reminiscent of the life cycles of trematodes.

Description of Pathogen and Disease

There is a very extensive Russian literature on diphyllobothriasis. Only a brief summary of the disease is given in this chapter. The disease has been comprehensively reviewed by von Bonsdorff (1977).

Identification

Diphyllobothriasis is an infection of the small intestine by the broad fish tapeworm *Diphyllobothrium latum*. There are often no clinical symptoms associated with infection, apart from eosinophilia. However, in a proportion of cases there is abdominal pain, loss of weight, anorexia, and vomiting. Megaloblastic anemia occurs in 20 percent of cases in Finland.

Diagnosis is by finding eggs, or occasionally segments, in the feces. Drug therapy is with niclosamide, or any other agent effective against *Taenia* (see chapter 34).

Occurrence

Diphyllobothriasis occurs in temperate countries with many lakes: in Europe, mainly in Finland, the USSR, and Poland with sporadic cases in France, Ireland, Italy, Switzerland, and the Federal Republic of Germany; in Asia, in Japan and Siberia; in the Americas, in the Great Lakes region of Canada and the USA, among Eskimos, and in Chile and Argentina (figure 25-1). It has also been reported from lakeside regions in Africa. Where raw or partly cooked fish is eaten, prevalence may be 10–30 percent locally, and generally increases with age.

Infectious agent

Diphyllobothrium latum, a cestode, is the broad fish tapeworm of man. The hermaphroditic adult measures 3–10 meters in length and may have 4,000 segments, with a small scolex, which has no hooks, embedded in the mucosa of the ileum (figure 25-2). Immediately behind the scolex, and several times its length, is an unsegmented neck region. The neck is followed by newly formed proglottids that become mature. The proglottids measure 2–7 by 10–12 millimeters and contain both male and female reproductive organs. Eggs are evacuated periodically through a uterine pore on each functional proglottid. The eggs measure 55–80 by 40–60 micrometers.

Reservoir

Man is the most important reservoir. Dogs, bears, and other fish-eating mammals may also become infected, but the proportion of viable eggs in dog feces (1 percent) is much less than in human feces (79 percent) (Essex and Magath 1931).

Related tapeworms of nonhuman mammals, that have intermediate stages in fish, also infect man occasionally. Examples include a tapeworm of the fur seal, *Diphyllobothrium pacificum*, in Peru; a tapeworm of the gull, *D. dentricum*, in Siberia; and a tapeworm of the whale, *Diplogonoporus grandis*, in Japan. Man may also act as the intermediate host for tapeworms of the genus *Spirometra*. Adult *Spirometra* live in the intestine of carnivores (but not man), and the intermediate hosts are, first, a cyclops in water and, second, amphibia, reptiles, or mammals, including man.

Transmission

Each worm produces up to 1 million unsegmented eggs daily, that pass out in the feces. If an egg reaches

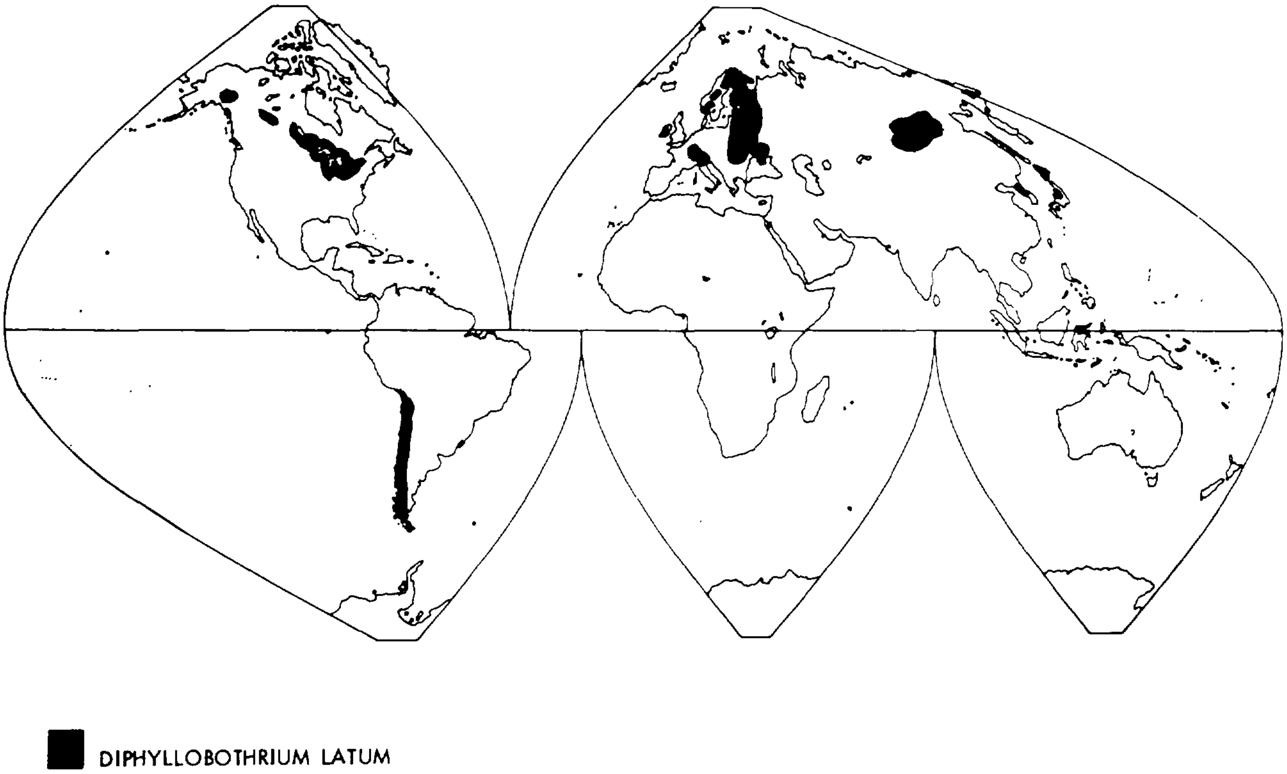

Figure 25-1. *Known geographical distribution of* Diphyllobothrium latum. The infection may occur in areas as yet unrecorded

Figure 25-2. *A length of* D. latum *expelled after treatment.* (Photo: Wellcome Museum of Medical Science)

fresh water it develops—in 12 days to many weeks, depending on the temperature—into a ciliated larva (coracidium).

The coracidium escapes into the water and swims around, surviving for 1–2 days. For further development the coracidium must be ingested by a minute freshwater copepod (of the genera *Diaptomus* or *Cyclops*). Inside the copepod there is further development of the larva, which may take 2–3 weeks. Freshwater fish (pike, perch, salmon, burbot) act as second intermediate hosts. The freshwater fish ingest the copepod, and the larva present in the infected copepod works its way through the fish tissue to the muscles, where it grows into a plerocercoid larva over about 4 weeks. When an infected fish is eaten raw by man, the larva is released in the small intestine, grows into a mature tapeworm in 3–6 weeks, and can live for up to 25 years.

One larva ingested in fish may develop into the hermaphrodite worm, which is sufficient to maintain the infection.

Prepatent and incubation periods

Worms reach maturity about 5–6 weeks after infective larvae in fish are ingested. Symptoms develop slowly or not at all.

Period of communicability

Eggs are passed in the feces as long as mature worms are present. Adult worms may live up to 25 years (Leiper 1936). Larvae in fish are infective to man for the life of the fish and for some time thereafter.

Resistance

There is no evidence of innate or acquired resistance to infection.

Epidemiology

Raw or smoked fish is the main source of infection. Pike roe (caviar) and pike spawn are also major sources of infection in the USSR (Karaseva and Egorova 1965). The age and sex distribution of infection is related to dietary habits. Diphyllobothriasis is mainly an infection of adults.

Chefranova (1964) studied the epidemiology of diphyllobothriasis in the Evenk National District (USSR). The prevalence rate of diphyllobothriasis was 69 percent. The infection rates of fish harboring larvae of *Diphyllobothrium* were: *Coregonus peles*, 82 percent; *Esox lucius*, 11 percent; *Lota lota*, 10 percent; *C. lavaratus*, 4 percent; and *Perca fluviatilis*, 4 percent. No *Diphyllobothrium* were found at autopsy of sables, gluttons, polar foxes, and wolves. One of twenty-one dogs examined was infected.

Other accounts of diphyllobothriasis include those from Canada (Turgeon 1974), Finland (Wikström 1972), Japan (Tomita and others 1979; Uhari and others 1975), Peru (Baer and others 1967), and the USSR (Artamoshin 1968, 1972).

Control Measures

Mass chemotherapy with niclosamide, combined with health education measures, has markedly reduced prevalence locally. Thorough cooking, freezing, or salting of fish will kill larvae. Preventing untreated human feces from reaching freshwater will greatly reduce transmission.

Successful integrated control campaigns in the USSR have been reported from the Danube Delta (Smolinschi and others 1970) and the Astrakhan River (Epstein and others 1967).

Occurrence and Survival in the Environment

Diphyllobothrium eggs may be found in fecally contaminated waters in endemic areas. They have been isolated from river water and sediment (Goryachev 1947; Usacheva 1951) and from sewage (Vassilkova 1936, 1941) in the USSR.

Diphyllobothrium eggs in freshwater at 15–25°C develop within 11–15 days. The lower the temperature, the slower the development. Eggs are killed after 2 days at −10°C or 30 days at 2–6°C (Essex and Magath 1931; Fedorov 1956). The minimum concentration of oxygen in water needed for eggs to hatch into coracidia is 1.4 milligrams per liter at 24°C (Romanov 1972). At lower oxygen levels eggs can survive for many months but will not develop unless transferred to a more oxygenated environment (Fedorov 1956). Eggs in water at depths of over about 20 meters do not hatch (Razumova and Artamoshin 1969). Eggs are rapidly killed by desiccation (Essex and Magath 1931).

Eggs in feces on the ground, or on ice in winter, die within 3 days (Chefranova 1964).

The encysted plerocercoid larvae in fish muscle and viscera live for the life of the fish and for some time after. The larvae survive in dead fish in river water for up to 10 days (Pronin 1967). The larvae can be killed by freezing, salting, or cooking, but each of these operations must be very thorough to be effective. Studies on infected pike (Titova 1955) showed that effective freezing regimes were: at −6°C, 7 days with a 9-kilogram fish, 6 days with a 2-kilogram fish, or 3 days with a 0.7-kilogram fish. At −18°C, larvae were destroyed after 4 days in 2-kilogram fish and 2 days in 0.5-kilogram fish. Salting and cooking also need to be carried out for longer in large fish than in small fish to destroy larvae.

Inactivation by Sewage Treatment Processes

Little is known about *Diphyllobothrium* eggs in sewage treatment plants. Sedimentation will remove a high proportion to the sludge layer and will be more effective if a coagulant is used (Döschl 1972). In the absence of specific data, it may be assumed that *Diphyllobothrium* eggs react to sewage treatment in the same manner as *Ascaris* eggs (chapter 23).

Inactivation by Night Soil and Sludge Treatment Processes

Any process effective against *Ascaris* eggs (chapter 23) will be highly effective against *Diphyllobothrium* eggs.

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