

COMPARISON OF HUMAN LIVER FLUKES
An Exercise in Parasite Variation

There are six species of trematodes (flukes) that commonly infect the liver of humans: *Fasciola hepatica*, *F. gigantica*, *Clonorchis sinensis*, *Opisthorchis viverrini*, *O. felineus*, and *Dicrocoelium dendriticum*. In addition to the morphological differences, the life cycle patterns of these liver flukes fall into three distinctively different groups.

The eggs of *F. hepatica* and *F. gigantica* are laid in the bile ducts, pass into the intestine, and are evacuated with the feces. The resistant eggs are unembryonated when passed and may remain viable in moist feces for several months but must eventually reach fresh water to survive. The miracidium develops in the egg within a few days, may remain in the egg for several days or weeks depending on the environmental conditions. It leaves the egg via the operculum, and must find and penetrate a suitable snail within about eight hours after emerging or die. This is a critical time in the life cycle for these species. Within the lymph spaces of the snail, the miracidium metamorphoses into a sporocyst the snail. Radiae are produced by budding in the sporocyst and escape through the birth pore into the tissues of the snail. The radiae may produce either daughter radiae of cercariae. Daughter radiae produce cercariae. Cercariae escape the snail and are free-swimming. After a short time (hours), they encyst on vegetation, i.e. grass or water plants, to form metacercariae. Infection occurs when vegetation with encysted metacercariae is ingested by the definitive host. The larvae are released from the cyst in the duodenum, pass through the intestinal wall into the peritoneal cavity, migrate to the liver, enter through the liver capsule, and proceed to the bile ducts. Some of the larvae may become lost and develop in ectopic sites in the body adjacent to the peritoneal cavity. At least 12 weeks or more are required for flukes to reach maturity and begin producing eggs. Adults of both species may reach 3 centimeters in length. The definitive hosts of *F. hepatica* other than humans, include sheep, cattle, other ungulates, horses, camels, monkeys, et al. *F. hepatica* is cosmopolitan whereas *F. gigantica* has a limited distribution and is prevalent in cattle, buffaloes, and other herbivorous animals in Africa and the Orient.

The general pattern of other liver flukes is similar in that they have a snail as the first intermediate host but with marked variations. The eggs of *C. sinensis*, *O. viverrini*, and *O. felineus* are passed from the bile ducts into the intestine. Eggs of these species are fully embryonated when passed in the feces. Eggs must reach fresh water and be ingested by a suitable snail host for the life cycle to continue. The cycle in the snail is similar to that of *F. hepatica*. Cercariae that escape from the snail have about 24 to 48 hours to find and attach to a suitable fish. It penetrates under the scales and enters the muscle of the fish. It loses its tail and secretes a cyst wall to become a metacercaria. Infection occurs when a suitable, definitive host ingests the uncooked meat of the infected fish. In the stomach, the metacercaria is released from the muscle of the fish by gastric juices. The outer wall of the metacercaria is digested by trypsin in the duodenum and the inner wall is broken down by the activity of the larva. Instead of penetrating the intestinal wall, the larva migrates to the common bile duct and enters the biliary passages where it grows to maturity and begins producing eggs in about 30 days. Adult flukes may reach 20 mm in length. Other than humans, the definitive hosts are cats, dogs, hogs, and other fish-eating mammals.

The life cycle of *D. dendriticum* shows greater variation. Like the other liver flukes, adults live in the biliary passages and produce eggs that are passed to the intestine and are evacuated with the feces. The eggs are embryonated when passed in the feces and this is where the variation begins. Instead of having to reach water, eggs are ingested by land snails. The miracidium metamorphoses in the snail to a sporocyst that produces daughter sporocysts. Cercariae produced by the daughter sporocysts, after escaping from the sporocyst, migrate to the respiratory chamber of the snail. They agglomerate in masses of 200 to 400 in slime balls secreted by the snail. Snails shed the slime balls as they move over wet vegetation. In order to continue their life cycle, the slime balls must be eaten by an ant. Infection of the definitive host occurs when ants are ingested with vegetation. The larva emerges from the cyst in the duodenum and penetrates the intestinal wall. It may enter blood vessels and be carried to the liver but more frequently will enter the peritoneal cavity, migrate to the liver, and penetrate through the capsule as do the larvae of *F. hepatica*. The definitive hosts other than humans are sheep and other herbivorous mammals. This species is more or less cosmopolitan.

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Student will be asked to discuss these questions and the life cycle descriptions on Page 1 and will be graded on their performance.

QUESTIONS FOR DISCUSSION:

1. Since all of these flukes invade the bile ducts of the liver, were they all derived from a common ancestor? Consider both yes and no.

NO.

Explain your answer.

YES

2. How would you explain the variation in the life cycles?
3. What type of physical and/or environmental changes may have contributed to these variations?
4. In humans, *F. hepatica* causes the greatest damage to the liver. To what factors do you attribute this?
5. *F. hepatica* and *D. dendriticum* are more or less cosmopolitan whereas *O. viverrini*, *O. felineus*, *C. sinensis*, and *F. gigantica* have limited geographic areas of endemicity. How do you explain this difference?
6. Which of these parasites do you think more closely resembles the primitive common ancestor?
 - a. in life cycle
 - b. in structure (morphology)
 - c. in size.

Give reason for your answers.

7. Which second intermediate host is more primitive? Why?
8. Do you consider these variations in life cycle a result of evolution? Explain your answer.