

Overview of Fasciolosis

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Abstract

Fasciolosis (fascioliasis) is an important parasitic disease of both animals and humans, caused by *Fasciola hepatica* and *F. gigantica*. These liver flukes have a complex life cycle involving freshwater snails as intermediate hosts, with infection occurring through ingestion of metacercariae on contaminated vegetation or water. The disease is widely distributed, particularly in regions with wetlands or irrigated pastures that favor snail populations. Clinical outcomes range from acute liver damage during the migratory phase to chronic biliary disease, anemia, and impaired productivity in livestock. Diagnosis is based on coprological, serological, and molecular methods, with copro-antigen and antibody-based assays showing improved sensitivity. Control relies mainly on triclabendazole, although increasing drug resistance highlights the urgent need for integrated management strategies, including snail control and vaccine development. This review summarizes current knowledge on the epidemiology, clinical features, diagnosis, and control of fasciolosis, emphasizing recent progress and persisting challenges in both veterinary and human contexts.

Keywords: Control, Diagnosis, Epidemiology, *Fasciola gigantica*, *Fasciola hepatica*, Fasciolosis

Introduction

Fasciolosis (fascioliasis) is a parasitic disease that affects both animals and humans. It is caused by two trematode liver flukes, *Fasciola hepatica* and *F. gigantica* [1–3]. *F. hepatica* occurs mainly in temperate regions but is also found in parts of South America, the Middle East, and Asia. *F. gigantica*, the major cause of tropical fasciolosis, predominates in Africa, Asia, and the Middle East. Together, these parasites infect a wide range of ruminants—including sheep, cattle, goats, buffalo, and camelids—as well as non-ruminant herbivores and humans [4–6].

In livestock, fasciolosis causes significant economic losses due to mortality, reduced weight gain, lower milk yield, decreased fertility, and increased susceptibility to secondary infections [7–10]. For example, studies estimate annual global losses exceeding USD 3 billion, with high condemnation rates of infected livers at slaughter. The disease manifests in two phases. During the migratory (acute) phase, immature flukes traverse the liver parenchyma, causing hemorrhage and tissue destruction. In the biliary (chronic) phase, adult flukes inhabit the bile ducts, leading to fibrosis, cholangitis, and sometimes calcification. Clinical signs vary by stage: acute fasciolosis presents with sudden liver damage, while chronic infection is associated with anemia, hypoproteinemia, weight loss, and progressive hepatic pathology [10,13–15].

Currently, triclabendazole (TCBZ) remains the drug of choice against both immature and adult flukes, but resistance is increasingly reported worldwide [16]. The absence of an effective commercial vaccine further complicates control. Given the zoonotic importance of fasciolosis and its impact on livestock productivity, a synthesis of historical and recent research is crucial to inform prevention and management strategies. This review therefore integrates past and current knowledge on the epidemiology, pathogenesis, diagnosis, treatment, and control of fasciolosis.

Review

Parasitism and its taxonomy

Fasciola hepatica and *Fasciola gigantica* are the primary species of *Fasciola* responsible for fasciolosis in domestic animals, particularly ruminants, owing to their indiscriminate feeding habits [17]. The taxonomic classification of the causative parasite is presented in Figure 1 [18].

Morphology

The distinct morphological characteristics of *Fasciola* species enable their differentiation. *Fasciola hepatica* (Figure 2a) has a leaf-shaped body with a broad, cone-shaped anterior projection

and sharp tegumental spines. Adult flukes reach lengths of up to 3.5 cm, and their eggs (Figure 2c) measure approximately 150×90 μm, typically lacking a prominent operculum. In contrast, *Fasciola gigantica* (Figure 2b) is larger, measuring up to 7.5 cm in length, with a narrower shoulder, blunt posterior end, and a longer, more extensively branched ovary. Its eggs (Figure 2d) are about 190×100 μm and bear a distinct operculum [18].

Etiology and life cycle

Fasciolosis is caused by flukes of the genus *Fasciola*, commonly referred to as liver flukes [17,20]. The two primary species are *Fasciola hepatica*, predominant in temperate climates, and *Fasciola gigantica*, more common in tropical regions. In regions where their

Phylum:	Platyhelminthes
Class:	Trematoda
Subclass:	Digenea
Superfamily:	Fasciolidea
Genus:	Fasciola
Species:	<i>Fasciola hepatica</i> <i>Fasciola gigantica</i>

Figure 1. Taxonomic Classification of *Fasciola hepatica* and *Fasciola gigantica*.

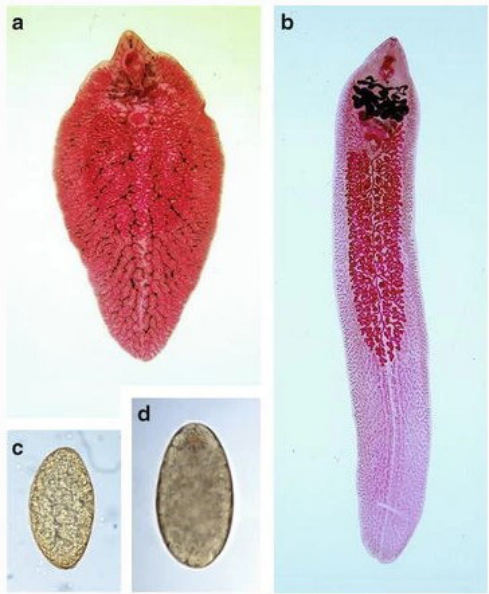


Figure 2. Adult and egg morphology of *Fasciola* species. (a) *F. hepatica* shows two prominent shoulders, converging lateral margins, simple medial branches of the intestinal caeca, and a smaller body size. (b) *F. gigantica* lacks distinct shoulders, has parallel lateral body borders, and is larger. (c) Eggs of *F. hepatica* are large, ovoid, operculated, bile-stained, and unsegmented. (d) Eggs of *F. gigantica* are similar in appearance but larger [19].

distributions overlap, hybrid forms have been reported [21,22]. Molecular techniques—particularly real-time Polymerase Chain Reaction (PCR) quantitative Polymerase Chain Reaction (qPCR) assays targeting *ITS1* rDNA, *ITS2* rDNA, and 28S rDNA—are used to differentiate the genetic profiles of these species [23–25]. The epidemiological implications of hybridization and introgression remain unclear; therefore, precise and consistent use of species terminology is essential, and the names should not be used interchangeably [26].

The life cycle begins when adult flukes residing in the bile ducts of the definitive host produce eggs that are excreted in feces [27]. In aquatic environments, miracidia hatch from the eggs and infect freshwater snails as intermediate hosts. Within the snail, the parasites develop sequentially into rediae and then cercariae. The cercariae emerges, encyst as metacercariae on aquatic vegetation, and are ingested by the definitive host. In the small intestine, the metacercariae excyst, penetrate the intestinal wall, migrate through the peritoneal cavity to the liver, and mature in the bile ducts approximately three months post-infection, thereby completing the cycle [11,28–30] (Figure 3).

Prevalence and epidemiology

Fasciolosis is a globally prevalent disease [32–34]. The snail intermediate hosts typically inhabit stagnant ponds, marshes, and ditches, increasing the risk of infection for animals that graze or drink in such environments [1,35,36]. Geographical factors such as elevation, along with climatic variables including rainfall,

temperature, and humidity, play key roles in the distribution and transmission of the disease. These environmental conditions directly affect the development and survival of parasite eggs and determine the distribution of snail hosts essential to the life cycle. Furthermore, improper use of anthelmintics has contributed to the emergence of drug-resistant strains, making disease control increasingly challenging. Seasonal variations in prevalence are closely associated with environmental patterns that favor parasite transmission, with rainfall and temperature fluctuations strongly influencing snail population densities [14,15,37–41].

Clinical signs

The clinical manifestations of bovine fasciolosis vary depending on the form of the disease. Acute fasciolosis, although uncommon, can lead to sudden death and is typically associated with marked weight loss, anemia, and hypoproteinemia. Subacute cases present with anemia, jaundice, and poor body condition. Chronic fasciolosis—the most common form—is characterized by submandibular edema (“bottle jaw”) resulting from hepatic bile duct obstruction, and may occasionally be accompanied by bacillary hemoglobinuria. In the absence of re-infection, spontaneous recovery usually occurs within six months post-infection [7,42].

Transmission and pathogenesis

Fasciolosis is transmitted primarily through two routes: ingestion of herbage or hay contaminated with metacercariae, and consumption of water containing the intermediate host snails. Humans can also become infected by eating aquatic plants harboring

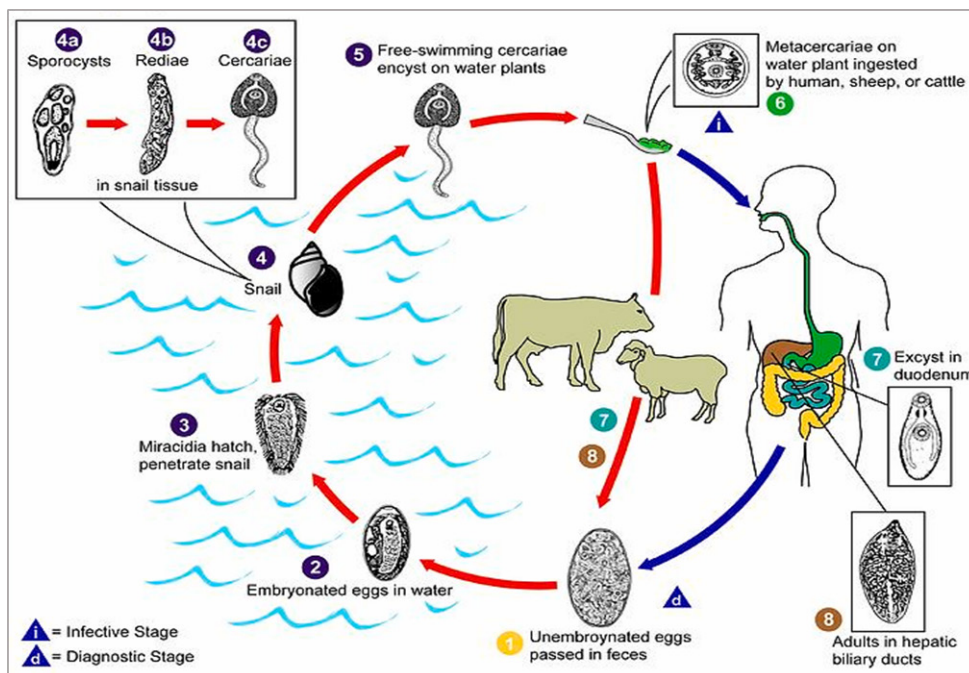


Figure 3. Life cycle of *Fasciola* spp. The cycle begins when eggs are excreted in the feces of the definitive host (1), embryonate in water, and hatch into miracidia (2). The miracidia infect freshwater snails—typically *Galba truncatula*—serving as intermediate hosts (3) and develop sequentially into sporocysts (4a), rediae (4b), and cercariae (4c). Cercariae are released from the snail (5) and encyst on aquatic vegetation as metacercariae (6), the infective stage. After ingestion by the definitive host (7), metacercariae excyst in the small intestine, migrate to the liver (8), and mature into adult flukes within the bile ducts [31].

infectious larvae or by consuming raw liver from infected animals [43]. After ingestion, the metacercariae excyst in the small intestine, and the newly excysted juveniles (NEJs) penetrate the intestinal mucosa. Within 72 hours, they can be detected in the abdominal cavity, from which they migrate across the peritoneum to the liver surface without initially producing noticeable clinical signs [44,45]. NEJs typically target the left hepatic lobe, likely due to its anatomical proximity to the duodenum and ease of access. In heavy infections, however, aberrant migration may occur, with juveniles invading other organs such as the diaphragm and lungs, leading to complications including pneumonia and fibrinous pleurisy [46].

The disease progresses through two distinct phases: the parenchymal phase and the biliary phase. The parenchymal phase begins when NEJs penetrate Glisson's capsule and migrate through the liver parenchyma, causing mechanical injury via their spined tegument and possibly through secreted products that exacerbate tissue damage. This migration produces necrotic and hemorrhagic lesions, triggering inflammation and activating host immune responses [47]. Parasite excretory–secretory products persist within the tissue, continuing to attract immune cells and reflecting the dynamic interplay between parasite activity and host defenses [48].

The biliary phase commences when the parasites enter the bile ducts. Adult flukes inflict mechanical damage with their oral suckers while feeding on blood and surrounding hepatic tissue, sometimes ingesting macerated hepatocytes visible within the sucker or pharynx. This feeding causes epithelial erosion, trauma, and rupture of small blood vessels [44]. In addition to mechanical injury, chemical factors contribute to pathology; for instance, bile duct dilation may be associated with parasite-derived proline, an amino acid essential for collagen synthesis by fibroblasts [49–51]. The combined mechanical and chemical insults elicit marked eosinophilic and granulomatous inflammation, particularly when eggs penetrate the hepatic parenchyma [52], and induce pronounced bile duct hyperplasia [53].

Diagnosis

Traditional diagnosis of fasciolosis relies on detecting *Fasciola* eggs in feces or identifying specific antibodies against *F. hepatica* in serum. More recently, copro-antigen detection assays have been developed, offering improved sensitivity and specificity [54]. These assays, validated in both experimental infections [55] and field studies in endemic and non-endemic areas [56], enable more accurate identification of infected animals. However, most diagnostic tools in cattle remain qualitative, despite the importance of infection intensity in predicting production losses [57].

To support large-scale monitoring without disturbing animals, milk-based testing is increasingly used. The MM3-SERO Enzyme-Linked Immunosorbent Assay (ELISA) has demonstrated high sensitivity and specificity for serodiagnosis, and bulk milk testing allows estimation of within-herd prevalence [58–60]. Immunoassays such as indirect ELISA are favored for their ability to process large sample numbers and detect antibodies early in infection, particularly during the parasite's migratory phase. Antigens can be detected during early infection using sandwich-ELISA; however, once the parasite establishes in the bile ducts, antigen levels decline, making fecal or bile samples more suitable for detection [61].

Post-treatment, antibody levels may remain elevated for extended periods, complicating interpretation. This limitation reinforces

the value of combined approaches—such as pairing indirect and direct ELISA—for more accurate assessment [42,61]. Similar immunodiagnostic strategies have been developed for *F. gigantica*, with validation based on sensitivity, specificity, and accuracy [10,62]. Fasciolosis is frequently associated with anemia, reflected by reduced hemoglobin levels, packed cell volume (PCV), and total erythrocyte count (TEC). Red blood cell indices and PCV values can help characterize the type of anemia. Leukocytosis—particularly eosinophilia and neutrophilia—typically indicates the host's immune response. Biochemical indicators of hepatic damage include elevated serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin, and gamma-glutamyl transferase (GGT). Reduced serum total protein, albumin, and globulin concentrations further suggest impaired hepatic function and protein metabolism [63–69].

Necropsy remains the gold standard for confirming fasciolosis [62]. Gross lesions often include enlarged bile ducts containing adult flukes or eggs, discoloration and nodularity of the liver parenchyma, and fibrosis indicative of chronic infection. Hemorrhage and necrosis may appear as reddish-brown discoloration or focal necrotic spots. Periportal fibrosis, characterized by collagen deposition around bile ducts, contributes to a firm liver texture. Chronic inflammation can result in thick fibrous bands and adhesions between liver lobes or adjacent tissues. In severe cases, flukes may aberrantly migrate to extrahepatic sites such as the lungs or abdominal cavity, producing nodules or cystic lesions [70–78].

Microscopic examination reveals a progression from acute to chronic inflammatory changes. Early lesions are dominated by neutrophils and eosinophils, progressing to chronic inflammation with lymphocyte and macrophage infiltration. Fibrosis, with collagen deposition around bile ducts and periportal areas, is often accompanied by granuloma formation around degenerating parasites or eggs. Migration of immature flukes produces hemorrhage, necrosis, and focal lesions, while bile duct epithelium undergoes hyperplasia and hypertrophy as part of tissue repair. Long-standing inflammation and fibrosis can lead to bile stasis, cholangitis, and ultimately biliary cirrhosis, markedly impairing liver function [70,74–76,78,79].

Prevention and control

Effective prevention and control of fasciolosis require integrated strategies targeting both the parasite and its intermediate hosts [33,56,80,81]. One key approach involves eradicating snail intermediate hosts using molluscicides or biological control agents such as competitor snails like *Marisa cornuarietis*. Chemical molluscicides—including niclosamide and copper sulfate—can be effective when applied seasonally and in targeted habitats. However, their practical application is often limited by labor intensity, cost, environmental pollution, and rapid recolonization of snail habitats. Moreover, chemical interventions may adversely affect non-target species [81–85]. Biological control methods employing snail predators and parasites show promise but remain challenging to implement at scale [86–89]. Grazing management practices that restrict animal access to contaminated pastures effectively reduce infection risk. Additionally, improving drainage in wetlands limits snail habitats and curtails their population growth [36,90,91].

Vaccine development efforts have shown potential; experimental vaccines using irradiated metacercariae or parasite extracts have

induced partial resistance in ruminants. Nonetheless, commercially viable vaccines remain elusive due to challenges in efficacy and limited funding [5,92–95]. Currently, anthelmintic drugs are the primary means of treatment, targeting flukes at various life stages [96–98]. Effective chemotherapy is essential to reduce environmental contamination by interrupting egg shedding. Albendazole is commonly used in dairy herds infected with *F. hepatica*, offering broad-spectrum activity against gastrointestinal nematodes but with possible impacts on milk production. Oxyclozanide is effective against mature flukes older than 14 weeks [99,100], while triclabendazole remains the drug of choice due to its efficacy against all parasite stages [16]. However, widespread and indiscriminate use has led to emerging resistance, complicating control efforts. Combination therapies involving older drugs have demonstrated high efficacy against both immature and mature flukes [35,101–104].

Conclusion

Fasciolosis is a globally distributed parasitic disease affecting diverse hosts and resulting in significant economic losses. Its complex life cycle, coupled with profound impacts on liver function, underscores the challenge it poses to animal health and productivity. Advances in diagnostic techniques have improved detection and surveillance, yet control remains hindered by emerging drug resistance and environmental factors. Integrated prevention strategies—targeting snail intermediate hosts, optimizing grazing management, and advancing vaccine development—are essential for sustainable control. Addressing these challenges is critical to mitigating the burden of fasciolosis in both livestock and human populations worldwide.

Author Contributions

All authors contributed equally and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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