

(REVIEW ARTICLE)



Review of *Echinococcus granulosus* (Batsch ,1786), (Cyclophyllidae: Taeniidae)

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Abstract

With the exception of Antarctica, all continents are home to *Echinococcus* species. These parasite infections are thought to be quite dangerous, causing high rates of morbidity and mortality as well as large financial losses for the cattle sector from a human and veterinary standpoint, the two primary species to consider are *Echinococcus granulosus* sensu lato (s.l.) and *Echinococcus multilocularis*, which cause cystic echinococcosis (CE) and alveolar echinococcosis (AE), respectively. The present state-of-the-art knowledge on these two parasites is compiled in this study in four major areas that are pertinent to both human and veterinary professionals: diagnosis, treatment and prevention, clinical symptoms and pathogenesis, and transmission and epidemiology. This review ought to provide a general overview of the most significant *Echinococcus* species. For a more thorough knowledge, the reader is encouraged to look for specialized material on certain illnesses and the parasites that cause them.

The goal of this article is to collect sufficient and important information for researchers to identify this parasite and how it is transmitted and diagnosed, in addition to the determination to reduce the incidence of this dangerous epidemic disease.

Keywords: Echinococcosis; Zoonosis; Cystic echinococcosis; Alveolar echinococcosis

1. Introduction

According to (1) cestodes belonging to the genus *Echinococcus* (family *Taeniidae*) are the cause of echinococcosis, a zoonosis. The larval form of *Echinococcus* species is the cause of human echinococcosis, a neglected zoonotic disease. Humans contract tapeworms when they inadvertently consume parasite eggs that are released from the feces of definitive hosts, such as dogs, foxes, and other canids. Cysts form as a result of infection, mostly in the liver and lungs, and they harm the body by getting larger and larger like a slowly spreading tumor. Alveolar *echinococcosis* (AE) and cystic *echinococcosis* (CE), the two most common clinical types of echinococcosis, cause a significant financial and health burden, especially in low-income communities.

An essential component of efforts to control this disease is quantitative epidemiology, which can offer valuable information to enhance comprehension of parasite transmission (2). With the highest endemicity for both the cystic (CE) and alveolar (AE) types of echinococcosis in western China, this grave and almost global illness remains a major public health concern. The genetics, genomes, and molecular epidemiology of the parasites that cause the disease, diagnostic instruments, treatment methods, and control measures, such as the creation and use of vaccinations, have all advanced significantly in the twenty-first century (3). In many Mediterranean nations, including Iraq, considered a hyper endemic region; the disease is endemic primarily in the central and southern regions, which are home to a large population of farmers and the fertile Mesopotamian plain between the Tigris and Euphrates rivers (4).

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Epidemiological models can discover the infectious factors that contribute to transmission, which are generally not well understood. However, no comprehensive review has ever been conducted that highlights the important factors that contribute to echinococcosis in animals. Once 1,935 entries were evaluated and the references of the eligible papers were screened, the findings contained 100 publications. Dogs' access to contaminated offal, their freedom to roam, their age and/or gender, and social behaviors connected to their owners' poor living conditions and health were the main causes of canine infection (2).

2. History and Distribution

Hydatid cysts had been described by Hippocrates and other ancient physicians.

- Adult *E. granulosus* was definite by Hartmann in the small intestine of dog in 1695 and the larval form (hydatid cysts) was documented in 1782 by Goeze.
- Although the disease is widespread around the world, it is most severe in regions of Australia, Africa, and South America that raise sheep and cattle. It is also common in Europe, China and the Middle East. In India, it is a critical health issue. It is more prevalent in temperate climates than in tropical ones. (5) *E. granulosus* is most common in China, Central Asia, South America, North and East Africa, and Australia; in Europe, another endemic region, it is most common in the Mediterranean and Eastern nations, with domestic dogs and ruminants playing a major role in its cycle (sheep, goats, cattle) (6) see Fig 1.

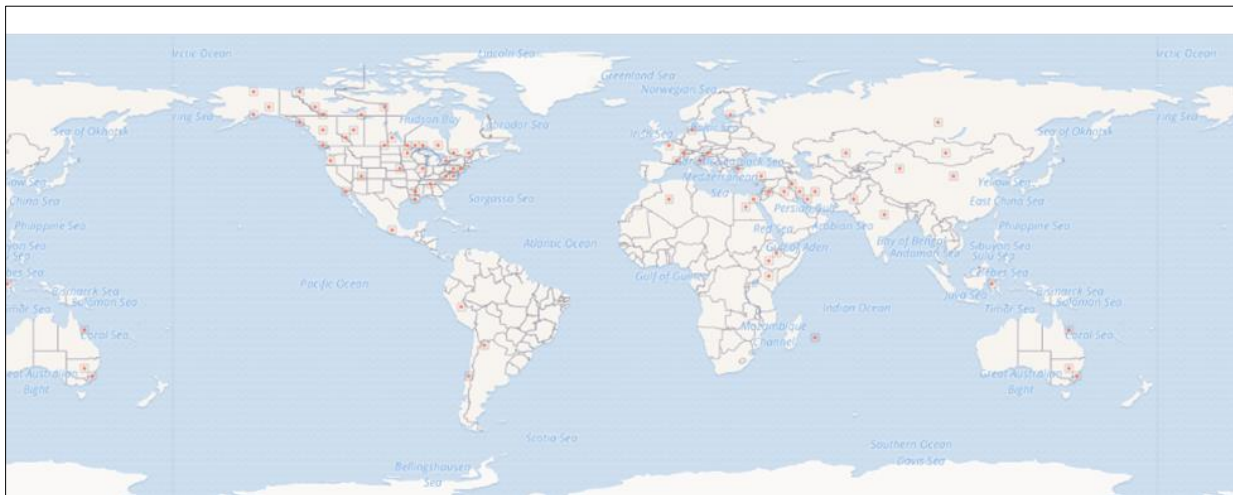


Figure 1 Record of *Echinococcus granulosus* (Batsch, 1786) from (1900 to 2022)

2.1. Classifications of *Echinococcus* spp.

According to, Nakao (7) and Huttner (8) the genus *Echinococcus*, was classified as mentioned below:

- Kingdom: Animalia
- Subkingdom: Metazoa
- Phylum: Platyhelminthes
- Class: *Cestoidea* (Rudolphi 1808) / Cestoda
- Subclass: *Eucestoda* (Southwell 1930)
- Order: *Cyclophyllidea*
- Suborder: *Taeniata*
- Family: *Taeniidae*
- Subfamily: *Echinococcinae*
- Genus: *Echinococcus* (Rudolphi 1801)
- Genus: *E. Granulosus* (Batsch,1786)

The multicellular organisms known as Platyhelminthes, or flatworms, are distinguished by their flat, bilaterally symmetric bodies. The majority of flatworms are hermaphrodites, meaning that a single organism has both male and female reproductive organs. In schistosomes, the sexes are distinct. Adults can range in length from little than 1 mm to many meters. The majority of the phylum's members are symbionts, meaning they reside on or within their hosts'

bodies. The class Turbellaria includes free-living species as well as parasitic forms seen in lower animals. Only parasitic forms are found in the classes Trematoda and Cestoda.

The class Cestoda typically have scolex, a specialized attachment organ, is located anteriorly on the long, ribbon-like, segmented bodies. There is no digestive tract. The small intestine is housed to adult tapeworms or cestodes. For development, cestode larvae need an intermediate host, with the exception of *Hymenolepis nana*. Depending on the species, humans can harbor either adult or larval stages of cestodes. (9).

3. Morphology of Echinococcus

- **The adult:** *E. granulosus* is fortunate. It is a little worm that ranges in length from 2 to 9 mm. It contains three or four segments and a 0.3 mm diameter globular scolex with four cup-shaped oval suckers and a rostellum (Figure 2). (10) The rostellum is adorned with a double crown of large and small hooklets. The majority of protoscolexes have two rows of hooks, each row having an equal number of large and small hooks. The scolex is followed by a short neck and one or two juvenile segments. In the mature segment, the ovaries and testes are fully developed reproductive organs.

Of the three, the gravid section is the longest and widest. Up to 500 eggs can be stored in the gravid unit's uterus before being expelled through the ruptured segment into the stool. The sub spherical egg, which has a brown hexacanth embryo and is 34 to 41 meters in diameter, looks like those of other *Taenia* worms (11).

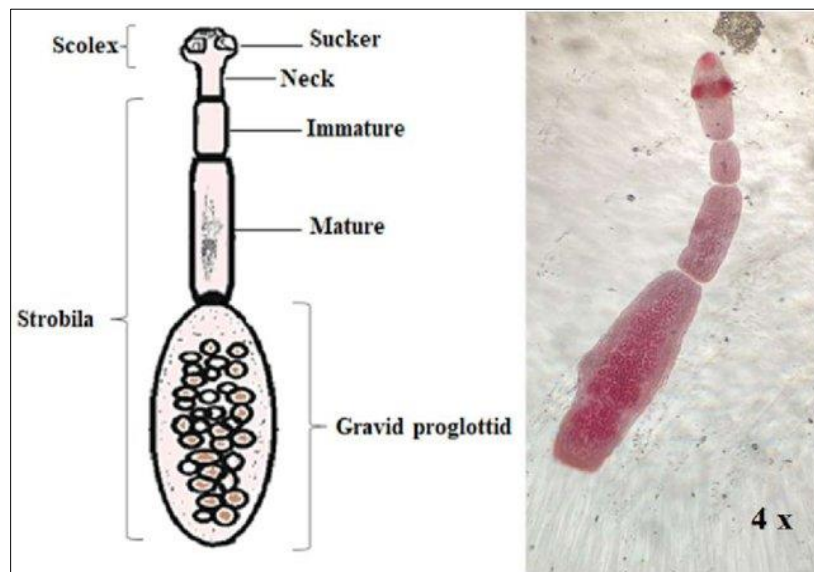


Figure 2 Morphology of adult worm of *Echinococcus granulosus* Source (12)

- **The egg:** The eggs are round or ovoid and measure between 30 and 40 μm in diameter (Fig. 3). Similar to other Taeniid eggs, the eggs are thick and range in color from dark brown to yellow. They include oncospheres, or hexacanth embryos, which are shielded by several membranes and covered in a coating of keratinized, incredibly resilient substance (13)(14).
- **The cyst:** is typically spherical in shape, unilocular, and varies in size according on the region. It has three structural layers with hydatid fluid inside (Fig. 4). The first layer, known as the adventitial layer (peri cyst), is made of host cells and surrounds the cyst with a thick, fibrous barrier that prevents big macrophages from entering the sac. (15)(16). The middle layer, known as the ectocyst layer or laminated membrane, is non-cellular, whitish, and composed of coarse elastic material. The parasite produces this layer, which is made up of a polysaccharide-protein complex. This layer is between one and two millimeters thick, and it gets thicker with age (17) (18). The third layer, known as the inner germinal layer (endo cyst), is 20–25 micrometers thick and a live component of the cyst wall. Its tasks include regulating the cyst's permeability, asexual reproduction, and the creation of the hydatid fluid that fills the cyst cavity (19)(20).



Figure 3 The egg of *E. granulosus* in dog feces

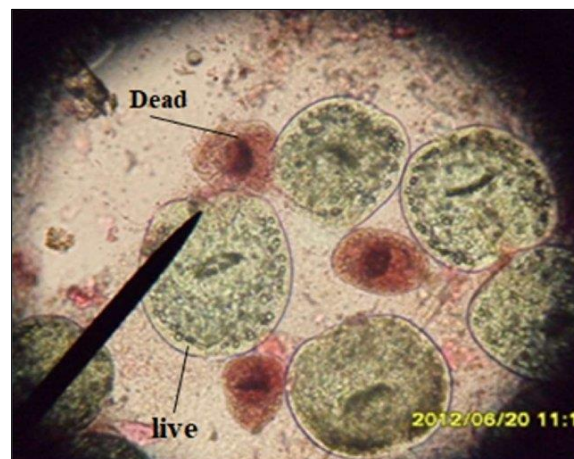


Figure 4 The metacestode of *Echinococcus granulosus*

4. The Hosts of *echinococcus* sp

- the adult worm inhabits in Dogs and other canine carnivores, such as wolves and foxes in their jejunum and duodenum. • Both humans and herbivorous animals (e.g., sheep, goats, cattle, and horses) have the larval stage (hydatid cyst) (5).

4.1. Life cycle

The worm completes its life cycle in two hosts:

- Definitive hosts: Dog (optimal host), wolf, jackal and fox.
- intermediate host: Sheep and cattle. Sheep is the ideal intermediate host.
- Man acts as an accidental intermediate host (dead end).
- Hydatid cysts are produced when the parasite passes through its larval stage in intermediate hosts, such as humans. Dogs and other canine animals' tiny intestines are home to the adult worm. Numerous eggs are released by these animals in their feces.
- Intermediate hosts (sheep and cattle) ingest them while grazing (5).

Echinococcus granulosus is a significant cyclophyllid cestode that causes cystic hydatidosis (CH), a zoonotic disease that has a significant annual impact on livestock and public health around the world. When definitive hosts, particularly dogs, consume the cystic viscera of an intermediate host, primarily sheep, they may get infected. (21)(22).

Protoscolexes (PSCs) of the cystic organs are discharged in this situation and adhere to the intestinal mucosa's duodenum and jejunum. Consequently, the development of adult worms with gravid proglottid and the proliferation and differentiation of PSCs in the major sections of the gut epithelium are essential for the pathogen's biological life cycle (23) (24). When the eggs hatch in the intestine, they release oncospheres that travel through the portal and lymphatic vessels to the liver, where they typically settle and develop as larvae (metacestodes or hydatid cysts). Less frequently, they may also reach the lungs, brain, bones, or any other organ of the human or intermediate host. Eggs are consumed by humans or the intermediate hosts. The metacestode releases the fertile forms of the parasite, known as protoscolexes, into the hydatid fluid. When consumed by the definitive host, the protoscolexes evaginate their scoleces with the help of bile salts and mature into adult worms that produce eggs after adhering to the intestinal wall.(1)

Numerous eggs in the gravid proglottid have the potential to infect a large region. The sheep-dog strain of *E. granulosus* (G1 genotype) is primarily responsible for the parasite's transmission to humans in numerous echinococcosis-endemic locations (25) (26). life cycles of the *Echinococcus* spp. are dependent on predator-prey associations involving two mammalian hosts. Humans are typically not directly involved in the transmission of CE or AE, although in certain special and unusual situations, such as those reported in the Turkana region of Kenya, humans can act as intermediate hosts for *E. granulosus*. Adult tapeworms are definitively hosted by carnivores (canids and felids), while their herbivorous prey (ungulates, rodents, and lagomorphs) serve as intermediate hosts for the metacestodes. (1).

5. Epidemiology & Risk Factors

Cystic echinococcosis (CE), also known as hydatidosis (hydatid cysts), is an infection that can cause anything from asymptomatic illness to death. In many situations, ultrasound (US) enables CE screening, diagnosis, differential diagnosis, therapy recommendation, and follow-up. Although they can affect many other organs, hydatid cysts are most commonly found in the liver. Here, we provide a review outlining the distinctive imaging characteristics of the wide range of organs that may be involved, as part of a series of publications (27).

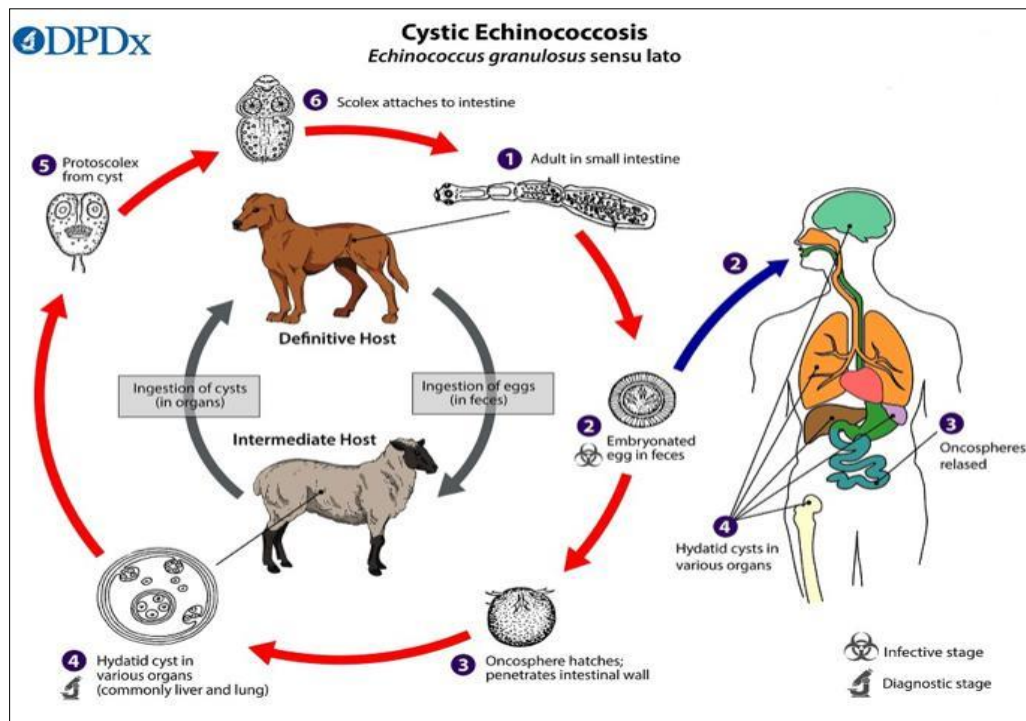


Figure 5 The life cycle of *Cystic echinococcosis (CE)* as shown in figure which is the animal consider as primary host and the humans the secondary host

Echinococcus granulosus infection at the larval stage is the cause of cystic echinococcosis (CE). Africa, Europe, Asia, the Middle East, Central America, South America, and, in rare instances, North America are all home to CE. Dogs can contract the parasite by consuming the organs of other animals that have hydatid cysts. In the dog, the cysts grow into adult tapeworms. Dogs with the infection excrete tapeworm eggs, which contaminate the ground. In the polluted ground, tapeworm eggs are consumed by sheep, cattle, goats, and pigs. Once consumed, the eggs hatch and form internal organ

cysts. The most frequent way for the disease to spread to people is through unintentionally consuming food, water, or soil tainted by the excrement of *Echinococcus* eggs that have been deposited in soil can stay viable for up to a year. Because the sheep serve as an intermediate host for the parasite and since working dogs are permitted to consume the infected sheep, the disease is most frequently observed in persons who raise sheep (27).

Echinococcus multilocularis larval infection is the cause of alveolar echinococcosis (AE). Although AE is found all over the world, it is more common in North America, Asia, and Europe's northern latitudes. Adult tapeworms typically infect dogs, coyotes, and foxes. When people consume food or water tainted with tapeworm eggs, they become infected with the larval stages. (27)

The final host's small intestine is home to the adult *Echinococcus multilocularis*, which has a length of 1.2 to 4.5 mm. The eggs released by gravid proglottids are instantly contagious and are transmitted in the feces. Eggs hatch in the small intestine after being consumed by a suitable intermediate host, and a six-hooked oncosphere image is released. This image passes through the intestinal wall and travels via the circulatory system to several organs, mainly the liver for *E. multilocularis*. The oncosphere matures into a thin-walled (alveolar), multi-chambered (or "multilocular") hydatid cyst image that spreads by successive outward budding. In these cysts, many protoscolices form. By consuming the organs of the infected intermediate host that contain cysts, the final host contracts the infection. Within 32 to 80 days of ingestion, the protoscolices image evaginates, adheres to the intestinal mucosa image, and matures into an adult stage image (28).

Ingestion food with eggs can infect humans, who are unusual intermediary hosts. Cysts form in the liver picture, and oncospheres are released in the gut. Sometimes referred to as "secondary echinococcosis," metastatic or spread to other organs (such as the lungs, brain, heart, or bone) may occur if protoscolices are released from cysts (28).

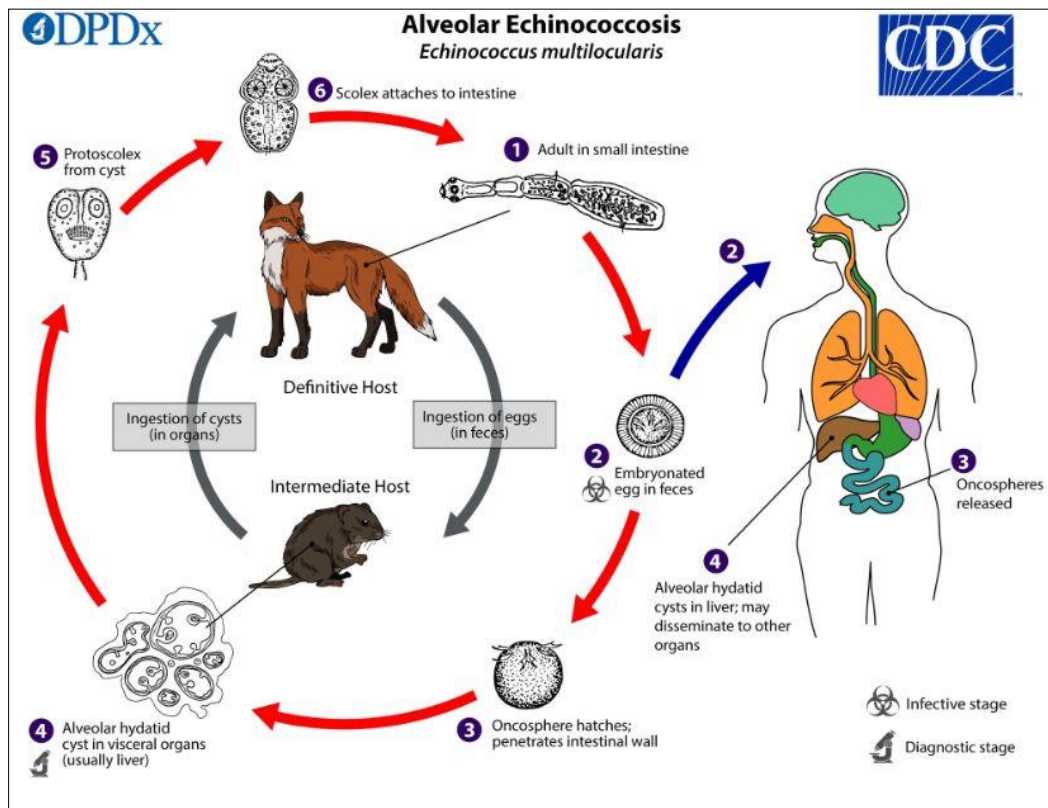


Figure 6 The life cycle of Alveolar echinococcosis (AE) the human consider as intermediate host as shown in figure and the animal is definitive host

Table 1 Types of Echinococcus

Parasite type	Definitive host	Stage	Intermediate host	Stage	Accidental host	Stage
<i>Cystic echinococcosis</i> (CE)	Dogs	Cysts in organs	Sheep, cattle, goats, and pigs	Egg in grass	Human	Embryonated egg
			Cattle	egg		
			Goats	egg		
			Pigs	egg		
<i>Alveolar echinococcosis</i> (AE)	foxes	Cysts in organs	Rodents	Egg in feces	Human	Embryonated egg
	coyotes	Cysts in organs	Small mammals	Egg in grass		
	dogs	Cysts in organs	Cats and dogs	Egg in feces		

6. Pathogenesis & symptoms

Echinococcus causing life-threatening diseases called echinococcosis. Human *echinococcoses* caused by two parasite species: *E. granulosus*, the causative agent of cystic echinococcosis or hydatid disease; and *E. multilocularis*, which causes alveolar echinococcosis (28). Although cysts can form in any organ, they most commonly occur in the liver and lungs, with less common occurrences in the brain, ovary, testis, central nervous system, bones, kidneys, spleen, muscles, and abdominal cavities (29)(30). The sickness in livestock is not identified, and the animals may be killed before the symptoms show up (31).

The quantity and location of the cysts determine how the symptoms manifest. Reduced milk supply, slow growth, fragility, poor wool, jaundice, and bronchopneumonia in the event of a lung infection are among the distinguishable signs (32) (33). Clinical symptoms may be impacted by issues with cyst rupture, protoscolices dissemination, and bacterial infections. (34).

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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