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**PART THREE. SPECIFIC EXCRETED PATHOGENS: ENVIRONMENTAL AND
EPIDEMIOLOGY ASPECTS**

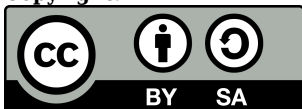
CRYPTOSPORIDIUM SPP.

Walter Betancourt

University of Arizona

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Citation:

Betancourt, W. 2019. Cryptosporidium spp. In: J.B. Rose and B. Jiménez-Cisneros, (eds) Global Water Pathogen Project. <http://www.waterpathogens.org> (R. Fayer and W. Jakubowski, (eds) Part 3 *Protists*) <http://www.waterpathogens.org/book/cryptosporidium> Michigan State University, E. Lansing, MI, UNESCO.
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Last published:

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Summary

Cryptosporidium is a genus of single-celled organisms that cause the diarrheal illness cryptosporidiosis. The organisms are most commonly found in the feces of calves and other ruminants. Infection is typically acquired through the consumption of contaminated water or food. Symptoms include watery, often bloody diarrhea, abdominal cramps, and loss of appetite. The illness is usually self-limiting and resolves within two to six weeks. However, in immunocompromised individuals, the infection can become chronic and severe, leading to malabsorption and weight loss.

The life cycle of *Cryptosporidium* involves a zoonotic cycle where the parasite is shed in the feces of infected animals and ingested by humans. The parasite then penetrates the intestinal lining, where it multiplies and causes inflammation. The resulting diarrhea is a direct result of the parasite's damage to the gut. Treatment is primarily supportive, focusing on hydration and electrolyte balance. In severe cases, specific anti-parasitic medications may be used.

Cryptosporidium species that infect humans include *C. hominis*, *C. parvum*, and *C. meleagridis*. *C. hominis* is the most common cause of human cryptosporidiosis and is often associated with outbreaks linked to contaminated water. *C. parvum* is also a common cause and is frequently found in the feces of calves. *C. meleagridis* is less common and is typically associated with contact with turkeys. The diagnosis of cryptosporidiosis is usually made through microscopic examination of stool samples, which reveals the characteristic pear-shaped, bipolar-trochophore stage of the parasite.

Cryptosporidium is a common cause of acute watery diarrhea in immunocompetent individuals. The illness is typically self-limiting and resolves within two to six weeks. However, in immunocompromised individuals, the infection can become chronic and severe, leading to malabsorption and weight loss.

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1.0 Epidemiology of the Disease and Pathogen(s)

1.1 Global Burden of Disease

Cryptosporidium is a common cause of acute watery diarrhea in immunocompetent individuals. The illness is typically self-limiting and resolves within two to six weeks. However, in immunocompromised individuals, the infection can become chronic and severe, leading to malabsorption and weight loss.

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1.2 Taxonomic Classification of the Agent(s)

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Cryptosporidium species are characterized by their oocyst morphology and the presence of a polar capsule. The oocyst is typically spherical or sub-spherical, with a diameter ranging from 4 to 12 micrometers. The polar capsule is a unique feature, located at one pole of the oocyst, and is composed of a thin, electron-dense layer. The presence of the polar capsule is a key diagnostic feature for Cryptosporidium species. The oocyst is resistant to environmental conditions and can survive for several months in the environment. The species C. hominis and C. parvum are the most common human pathogens, while C. parvum is also a major bovine pathogen. Other species like C. andersoni, C. avium, C. apodemi, C. baileyi, C. bovis, C. canis, C. cuniculus, C. ditrichi, C. ducismarci, C. erinacei, C. fayeri, C. felis, C. fragile, C. galli, C. homai, C. huwi, C. macropodum, C. meleagridis, C. molnari, C. muris, C. occultus, C. proliferans, C. ryanae, C. rubeyi, C. scrofarum, and C. serpentis are also known to infect various animals and humans.

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Table 1. Formally described *Cryptosporidium* species, their oocyst sizes, major hosts and reported human infections

<i>Cryptosporidium</i> species	Mean Oocyst Dimensions (µm) ^a	Major Host(s)	Reported Human Infection
<i>C. andersoni</i>	8-12	Cattle	Immunocompromised individuals
<i>C. avium</i>	8-12	Cattle	Immunocompromised individuals
<i>C. apodemi</i>	8-12	Cattle	Immunocompromised individuals
<i>C. baileyi</i>	8-12	Cattle	Immunocompromised individuals
<i>C. bovis</i>	8-12	Cattle	Immunocompromised individuals
<i>C. canis</i>	8-12	Dogs	Immunocompromised individuals
<i>C. cuniculus</i>	8-12	Rabbits	Immunocompromised individuals
<i>C. ditrichi</i>	8-12	Cattle	Immunocompromised individuals
<i>C. ducismarci</i>	8-12	Cattle	Immunocompromised individuals
<i>C. erinacei</i>	8-12	Cattle	Immunocompromised individuals
<i>C. fayeri</i>	8-12	Cattle	Immunocompromised individuals
<i>C. felis</i>	8-12	Cats	Immunocompromised individuals
<i>C. fragile</i>	8-12	Cattle, sheep, goats	Immunocompromised individuals
<i>C. galli</i>	8-12	Cattle	Immunocompromised individuals
<i>C. homai</i>	8-12	Cattle	Immunocompromised individuals
<i>C. hominis</i>	8-12	Humans	Immunocompromised individuals
<i>C. huwi</i>	8-12	Fish	Immunocompromised individuals
<i>C. macropodum</i>	8-12	Cattle, sheep, goats	Immunocompromised individuals
<i>C. meleagridis</i>	8-12	Turkey	Immunocompromised individuals
<i>C. molnari</i>	8-12	Cattle	Immunocompromised individuals
<i>C. muris</i>	8-12	Cattle	Immunocompromised individuals
<i>C. occultus</i>	8-12	Cattle	Immunocompromised individuals
<i>C. parvum</i>	8-12	Cattle, sheep, goats	Immunocompromised individuals
<i>C. proliferans</i>	8-12	Cattle	Immunocompromised individuals
<i>C. ryanae</i>	8-12	Cattle	Immunocompromised individuals
<i>C. rubeyi</i>	8-12	Cattle	Immunocompromised individuals
<i>C. scrofarum</i>	8-12	Cattle	Immunocompromised individuals
<i>C. serpentis</i>	8-12	Cattle	Immunocompromised individuals

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1.4 Population and Individual Control Measures

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2.0 Environmental Occurrence and Persistence

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2.1 Detection Methods

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2.2 Data on Occurrence

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Table 3. Occurrence of *Cryptosporidium* spp. in surface water and recreational waters

Country	Sample Type	Percent Positive Samples	Concentration Average (Range) Oocyst/L	Reference
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Country	Sample Type	Percent Positive Samples	Concentration Average (Range) Oocyst/L	Reference
India	Water	100	1000 100000000	Chakrabarti et al. (2004)
India	Water	100	10000 100000000000	Chakrabarti et al. (2004)
India	Water	100	1000 100000000000	Chakrabarti et al. (2004)

Table 1. Prevalence of *Cryptosporidium* in water samples from India.

Cryptosporidium is a common cause of diarrhoeal illness in humans and animals. It is a protozoan parasite that forms oocysts which are resistant to chlorine disinfection. The parasite is found in the faeces of various animals, including cattle, sheep, goats, and wild birds. In humans, it causes cryptosporidiosis, which is characterized by watery, bloody stools, abdominal cramps, and diarrhoea. The parasite is also found in water bodies, where it can be ingested by humans and animals. The prevalence of *Cryptosporidium* in water samples from India is high, ranging from 100% in some studies. This indicates that the parasite is widespread in the environment and poses a significant public health risk. The concentration of oocysts in water samples can vary widely, from 1000 to 100,000,000 oocysts per litre. This highlights the need for effective water treatment methods to reduce the risk of cryptosporidiosis.

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Country	Sample Type	Percent Positive Samples	Concentration Average (Range) Oocysts/L	Reference
USA	Water	100%	1000	USA
USA	Water	0%	0	USA
USA	Water	100%	1000	USA
USA	Water	100%	1000	USA
USA	Water	100%	1000	USA

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Cryptosporidium parvum

3.0 Reduction by Sanitation Management

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Table 7. A Summary of studies on the removal efficiency of *Cryptosporidium* oocysts by different wastewater treatment processes

Country	Plant	Population Served	Primary Treatment	Secondary Treatment	Tertiary Treatment	Disinfection	Oocyst/L Influent Average	Oocyst/L Effluent Average	Log ₁₀ Removal	Reference
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Country	Plant	Population Served	Primary Treatment	Secondary Treatment	Tertiary Treatment	Disinfection	Oocyst/L Influent Average	Oocyst/L Effluent Average	Log ₁₀ Removal	Reference
USA	Plant 1	100,000	Primary	Secondary	Tertiary	Disinfection	100	10	1	Reference 1
USA	Plant 2	200,000	Primary	Secondary	Tertiary	Disinfection	200	20	2	Reference 2
USA	Plant 3	300,000	Primary	Secondary	Tertiary	Disinfection	300	30	3	Reference 3
USA	Plant 4	400,000	Primary	Secondary	Tertiary	Disinfection	400	40	4	Reference 4
USA	Plant 5	500,000	Primary	Secondary	Tertiary	Disinfection	500	50	5	Reference 5
USA	Plant 6	600,000	Primary	Secondary	Tertiary	Disinfection	600	60	6	Reference 6
USA	Plant 7	700,000	Primary	Secondary	Tertiary	Disinfection	700	70	7	Reference 7
USA	Plant 8	800,000	Primary	Secondary	Tertiary	Disinfection	800	80	8	Reference 8
USA	Plant 9	900,000	Primary	Secondary	Tertiary	Disinfection	900	90	9	Reference 9
USA	Plant 10	1,000,000	Primary	Secondary	Tertiary	Disinfection	1,000	100	10	Reference 10

Table 1. Summary of *Cryptosporidium* spp. data from various studies.

3.1 Excreta and Wastewater Treatment

3.1.1 Excreta Treatment

Excreta treatment involves the collection, transport, and treatment of human and animal waste.

Excreta treatment is a critical component of wastewater management, particularly in areas with high population density and limited natural water resources. The primary goal is to reduce the pathogen load, including *Cryptosporidium*, before the effluent is discharged into the environment. This is achieved through a combination of physical, chemical, and biological processes. Physical processes such as screening and sedimentation help to remove large particles and solids. Chemical processes, including chlorination and ozonation, are used to disinfect the effluent and destroy pathogens. Biological processes, such as activated sludge treatment, can also be used to break down organic matter and reduce the pathogen load. The effectiveness of these processes depends on the specific treatment technology used and the quality of the influent. For example, chlorination is highly effective against *Cryptosporidium* oocysts, but the required chlorine dose and contact time must be carefully controlled to ensure adequate disinfection. Similarly, ozonation is a powerful oxidant that can destroy *Cryptosporidium* oocysts, but it is more expensive than chlorination. Biological treatment processes are generally less effective against *Cryptosporidium* oocysts, but they can be used in combination with other treatment processes to improve overall effluent quality. The choice of treatment technology depends on a variety of factors, including the size of the population served, the available resources, and the local environmental conditions. In general, a combination of physical, chemical, and biological processes is the most effective way to treat excreta and wastewater, and to reduce the risk of *Cryptosporidium* infection to the public.

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3.2 Disinfection

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