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Is Cryptosporidium a Problem in Texas?

Although Found in Small Amounts, the Health Threat May be Significant

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Cryptosporidium is one of the most maddening, frustrating, and elusive mysteries facing scientists and water managers today, but it can't be ignored. It's too deadly.

Amy Kinney and Leah Wickersham of TAMU Stephenville are collecting samples at sites near Central Texas dairies for the presence of cryptosporidium.

Protozoan parasites, cryptosporidium species can be found in humans and many animals including dairy and beef cattle, many other wild and tame animals, fish, reptiles and birds.

People and animals become infected after they come in contact with or ingest water or food contaminated with cryptosporidium egg-like structures called oocysts. Cryptosporidium is important because it causes the disease Cryptosporidiosis, which can result in diarrhea, vomiting, abdominal cramps, headaches, and fever. In people with immune system deficiencies (caused by AIDS, chemotherapy, and organ transplants) it can be fatal. Typically, symptoms last for roughly two weeks in healthy people, while symptoms in persons with compromised immune systems may persist over a longer time period. Currently, there are no medicines people can take that have been designed specifically to deal with cryptosporidiosis, although nine drugs are now being tested by the U.S. Food and Drug Administration and other medicines are being developed by private laboratories.

What makes cryptosporidium so frustrating?

For starters, no one knows exactly how many species of cryptosporidium exist in water supplies and whether they can make humans ill. Health professionals are most worried about Cryptosporidium Parvum, although there are as many as 21 other species that infect other animals that may also cause human health problems. Little is known about how cryptosporidium can be spread from one animal to another.

The next difficulty is trying to identify which species of cryptosporidium you have found. Typically, scientists identify individual strains of cryptosporidium by associating them with the host animal it was isolated from. When cryptosporidium runs off into a river or lake, it is nearly impossible to tell which potential source it originated from.

Once you've overcome those hurdles, many other obstacles still remain. It's difficult to detect cryptosporidium using currently recommended methods. An individual cryptosporidium oocyst is small (just 5 microns in diameter or one half the size of a giardia cyst). You can fit 1,000 oocysts onto a single grain of sand. Often, scientists have to filter 250 gallons of raw water to find a single oocyst. Detecting the presence of cryptosporidium isn't enough. Scientists also have to determine if the oocysts are alive (viable) and capable of infecting humans. Many improved testing methods are now being explored including polymerase chain reaction, improved filtration, and genetic and DNA techniques to more precisely identify the specific cryptosporidium species.

Other fundamental questions remain unresolved. There is a lack of consensus on the magnitude of health problems caused by cryptosporidium. Diarrhea and other symptoms of cryptosporidiosis are often misdiagnosed as a common cold or the flu. It's unlikely that someone who visits the doctor for diarrhea will be tested for cryptosporidium unless many others in the area have already been infected. It's difficult to determine how much cryptosporidiosis is occurring.

Cryptosporidium causes uneasiness among many agricultural producers who feel they are being unfairly singled out as the major source of the problem. In the mind of the much of the public, cryptosporidium results from a single problem -- runoff of water from dairies that are contaminated when newborn calves become ill. The media placed much of the blame for the serious outbreak in Milwaukee in 1993 on the dairy industry. The problem may not be that simple or straightforward. Because it is so difficult to determine the relative contribution of the many different strains and sources of cryptosporidium to human health, some experts believe that dairies and other agricultural livestock activities may not necessarily be the major source of the problem.

"I don't believe you can establish a definite connection between dairies and cryptosporidium populations without considering the other potential sources of the organism," says F.C. "Buddy" Faries of the Texas A&M University (TAMU) College of Veterinary Medicine (CVM). "I know there is probably some cryptosporidium at some dairies, but it can also be found in human sewage and rivers and lakes."

Karen Snowden (left) and Dana Cohen of TAMU are sampling horses for cryptosporidium.

Is cryptosporidium a major problem facing Texas? Opinions differ and it really depends on who you talk to. For example, the most notable instance of a suspected cryptosporidium outbreak in Texas occurred in Braun in Bexar County in the early 1980s. No one really knows if it was caused by cryptosporidium, raw sewage, or something else.

Dale Dingley, who heads the Texas Department of Health (TDH) lab that tests for cryptosporidium, says his group has been searching for cryptosporidium in many different Texas rivers and lakes, but they have never been able to find significant numbers of it. "We do detect the organism in seeded water filters at concentrations of about 1 oocyst in 250 gallons of water," Dingley says. "I'm concerned about our inability to detect cryptosporidium in Texas waters, even though we recognize it must be there in low numbers."

Public health officials argue that although it may not appear high numbers of cryptosporidium are present in Texas, this is not a reason to ignore the potential health threats the disease may cause. Cynthia Chappell of the University of Texas School of Public Health (UTSPH) has studied the potential of cryptosporidium to cause health problems in healthy humans. Her research shows that even small doses of cryptosporidium can cause diarrhea and serious health complications. "I hope that one of the `red lights' that goes up as a result of our work is that it only takes a few cryptosporidium organisms before a large number of people become seriously ill," she says. "Cryptosporidium levels in water should be as low as possible to protect human health."

A report published by the American Association of People with AIDS suggests that Dallas and Houston may have potentially significant cryptosporidium problems, although that report was based on the frequency of testing and treatment methods, not the actual finding of the organisms.

Because of the health risks, cryptosporidium has become a subject of many research projects at universities and agencies in Texas. Studies include assessments of the levels of cryptosporidium in waters, the impact of agricultural activities on cryptosporidium populations, development of better testing methods, and human health impacts.

Background Information

Cryptosporidium is a relatively new phenomenon. Even though it was discovered and named in the early 1900s, cryptosporidiosis was a relatively obscure disease until the early 1980s, when it was identified as a health threat to people with AIDS. Public concern about cryptosporidium increased dramatically after an outbreak in the Milwaukee public water system in 1993 in which 403,000 people became ill and 60 died. In 1994, a cryptosporidium outbreak in Las Vegas led to 19 deaths and 100 others became ill.

The American Microbiological Society published a report, *A Global Decline in the Microbiological Safety of Water*, in 1995 that warns of impending increases in the incidence of waterborne disease outbreaks and epidemics in both developed and developing countries. The report suggests that 80% of the infectious diseases throughout the world are likely water-related and that each year diarrheal diseases, including cryptosporidiosis, kill roughly 2 million children and cause more than 900 million infections.

Although the general public may believe that cryptosporidium is most commonly linked to runoff from dairies and livestock cattle, many experts contend that its source can also include human wastes (especially children and workers at daycare centers) and other animals. Ways for humans to become contaminated include drinking and coming in contact with untreated water, swimming and water recreation, changing diapers, and some sexual activities.

Cryptosporidium has been isolated from newborn lambs, goat kids, foals and piglets as well as wild deer, feral hogs, coyotes, rats, birds, reptiles, and fish. The parasite is a particular problem for livestock producers because it lives in the intestines of many animals, including young calves used in the dairy and beef cattle industries, and can kill them. It is a major concern to the industry for its human and bovine health consequences. Because dairies often concentrate groups of cattle in small areas, dairy waste could be a factor in the presence of the parasite in water supplies.

It is especially difficult to control because oocysts are resistant to chlorine disinfection and, because of its small size, can pass through filters that do not have a fine enough mesh. Current techniques now used by many water treatment plants reduce giardia cysts by more than 99%, but are less effective at treating and removing cryptosporidium.

The U.S. Environmental Protection Agency (EPA) is funding significant research into barriers that lessen the risk of contamination, testing methods, and populations of cryptosporidium in surface and ground waters.

The U.S. Centers for Disease Control (CDC) has been working to identify health risks associated with cryptosporidium. In 1994, CDC convened a national workshop that explored methods to sample, monitor, and test for cryptosporidium in water supplies, epidemiological studies, public health responses, and the impact of cryptosporidiosis on

people with compromised immune systems. The report suggests that all outbreaks of waterborne cryptosporidiosis in the United States from 1984 to 1993 occurred in communities in which water utilities met all federal and state standards for safe drinking water that were applicable at that time. The workshop recommends that local, state, and national public health agencies should cooperate to develop surveillance and epidemiological studies to assess the health impacts of cryptosporidium in drinking water.

Research at Texas Universities

Many Texas universities are now conducting research and extension efforts to learn more about cryptosporidium, methods to easily detect it, and strategies to prevent and control it.

A project in Central Texas involves scientists from the TAMU Agricultural Research and Extension Center in Stephenville, the TAMU Research and Extension Center in El Paso, and CVM to gather data about cryptosporidium levels from dairies near Stephenville. Amy Kinney Moravec and Leah Wickersham of TAMU Stephenville are collecting water samples from hutches at dairy feedyards where young calves are housed, as well as from four creeks and river segments. Fecal samples are taken monthly and water samples are collected after each rainfall event that generates runoff. Since September 1996, seven rainfall events that produced runoff have been sampled. These samples are analyzed by Suresh Pillai at TAMU El Paso and the TAMU Veterinary Medicine Diagnostic Laboratory.

This technician at TAMU-Stephenville uses a "rag doll" developed to collect dragonflies and damselflies from a Central Texas pond. The rag doll was developed by Forrest Mitchell.

Pillai, a microbiologist, is the lead scientist on the project. He is assessing the viability of cryptosporidium oocysts near these dairies and how such factors as heat and dryness can destroy cryptosporidium. "Once we know the fate of the oocyst stage of the parasite in dairy waste, we can determine how to handle dairy waste to reduce the chances of cryptosporidium reaching the water supply," said Pillai. Later, the team wants to develop and implement management strategies that may lessen the chance that cryptosporidium will run off into the water supply. Management strategies being tested include composting dairy wastes, spreading manure on dry pastures when rain isn't likely, and storing manure in pits or stacks before waste is spread on dry pastures. Preliminary results of field studies led by Pillai show that 13 of 30 surface water samples collected near these dairies were confirmed positive for cryptosporidium oocysts and that 63% of cryptosporidium oocysts collected from a dairy

holding pen after a rainfall event were viable. The research also shows that cryptosporidium was able to move through 4 inches of soil under simulated rainfall conditions. "The results are promising," Pillai says. "They indicate better management and care of young calves, such as the use of slatted hutches and improved waste management practices, may reduce cryptosporidium loadings into watersheds." Recently, Pillai and graduate student Scott Dowd developed a method to combine the detection of oocysts and to determine their viability into a single step, which may save time and money for testing and analysis.

"We want to work with dairy managers to develop best management practices to lessen cryptosporidium risks," Faries says. "We want to assess if dairies are a significant source of cryptosporidium and to compare the risks from dairies and other sources."

"We've been observing small levels of cryptosporidium in streams after rains, but not in calves," Moravec says, "and that makes us wonder if dairy animals are really the source of the problem or if the organisms are coming from wild animals that also live in the watershed. Our research shows that it's more likely that we will find cryptosporidium in intermittent streams nearer the dairies than in major river reaches."

Moravec and other staff at TAMU Stephenville are working with dairy operators to educate them about cryptosporidium and to advise them on how to control it at their dairies. "Most of the dairy operators in this area are very enthused about learning more about cryptosporidium and trying to control it," Moravec says. She advises dairy managers to make sure infected calves are kept in dry areas and isolated from other calves that are not infected. She also recommends that cattle be kept away from surface waters and groundwater wellheads.

Forrest Mitchell, an entomologist at TAMU Stephenville, is focusing on relationships between damselflies and a parasitic protozoan called a gregarine in area waters. Mitchell is investigating how damselfly nymphs are infected by the gregarines, which are distributed in the water supply by oocysts, as are cryptosporidium. He believes that by investigating the epidemiology of the gregarine infection in damselfly populations, insights into the distribution and abundance of cryptosporidium in the water supply will be revealed.

Unlike cryptosporidium, gregarines are easy to detect in their hosts. Mitchell performs laboratory work in which he examines the guts of the damselflies and looks for gregarines. By using a special stain that makes gregarines turn bright red, he is able to determine the intensity of parasitism and disease prevalence and incidence.

Not only are the gregarines easy to detect, but collecting damselflies has gotten easier. James Lasswell, a research associate on the project, has developed a collecting device dubbed the "rag doll." Rag dolls resemble the roots of willow trees (a favorite haunt of the damselfly) and are placed in lakes and streams. Collecting damselflies involves retrieving the device and shaking into a bag or pan.

Ultimately, Mitchell wants to test the hypothesis that a damselfly population with an increased prevalence of gregarine infection can be used as an indicator of water at risk for increased levels of cryptosporidium oocysts.

Projects are underway at the TAMU College of Veterinary Medicine. Researchers Noah Cohen and Karen Snowden and senior clinical resident Dana Cole are assessing cryptosporidium levels from horses in many regions of Texas. The researchers are now collecting fecal samples from adult show horses, mares and foals. The samples are analyzed using three different diagnostic tests and these methods will be compared for accuracy, ease of use, and the time it takes to complete the analyses. They are also identifying factors that may increase the likelihood that horses may contract cryptosporidiosis, including the source of water, the age of the horses and foals, and whether horses are pastured with cattle. "The research is needed because we can't now define methods to control diarrhea in foals with cryptosporidium parvum infections," Snowden says. "It's important to determine if horses are a significant carrier of cryptosporidium because some states are considering legislation that would limit the activities of horses near surface waters in order to lower cryptosporidium risks."

A colleague at the TAMU Veterinary Extension Office, Bruce Lawhorn, developed an easy to read fact sheet for the Texas Agricultural Extension Service (TAEX). It answers many common questions about cryptosporidium and its threat to human and livestock health.

At the University of North Texas (UNT), scientists are developing and testing new methods to detect cryptosporidium oocysts. The research was conducted by graduate student David Stone and researchers Ken Dickson and Art Goven of the UNT Institute of Applied Sciences. The studies focus on the concept that cryptosporidium and other protozoans can be isolated from a water sample by utilizing a species-specific antibody which is attached to a pan or other substrate. In theory, the cryptosporidium should stick to the antibody while non-targeted substances will easily wash off. Research results suggest that up to 50% of oocysts can be recovered using this method, compared to typical recovery rates of only 5% obtained by currently approved methods.

At UTSPH in Houston, Cynthia Chappell, Herbert DuPont, and Pablo Okhuysen are studying health related aspects of cryptosporidium. One study focused on the capability of cryptosporidium to infect healthy adults. Twenty-nine participants were given doses of cryptosporidium ranging from 30 to 1 million oocysts. Chappell found that as few as 132 oocysts caused infection in 50% of the study population, and more than 50% of the volunteers studied became ill after exposure to the protozoan. They are studying the health risks posed by different strains of cryptosporidium and how people with AIDS may be especially affected. "Part of our efforts look at how cryptosporidium impacts different segments of the population, including those with compromised immune systems who may be most threatened," Chappell says. "Obviously, cryptosporidium is a nuisance to healthy adults but it is much more than that to people with AIDS and compromised immune systems." Chappell has worked with Clinton White and colleagues at the Baylor College of Medicine in Houston to investigate why some people become infected with

low doses of cryptosporidium while others who are subjected to high doses of the protozoan remain healthy. The project studies the relationships between human immune systems, the dose and type of cryptosporidium, and how the protozoan physically affects cells and their functions.

At the University of Texas Southwestern Medical Center in Dallas, Patricia Hicks and Janet Squires of the Pediatrics, Pathology, and Microbiology Department are assessing the impact of cryptosporidium on children with AIDS and other immune systems disorders. The research shows that children with these conditions may be more at risk than immune compromised adults. In another project, Joseph Capra, and Jonathan Hexham of the Microbiology Department are testing potential antibodies that may prevent or inhibit infections by many pathogens, including cryptosporidium. Research shows that immune-compromised children, for example, children suffering from AIDS or cancer, are at greater risk than healthy children.

Researchers at the University of Texas Medical Branch (UTMB) at Galveston recently published a book titled *Medical Microbiology*. The book, edited by Samuel Baron of the UTMB Microbiology and Immunology Department, includes sections on the structure, classification, growth, and development of cryptosporidium and other protozoans, and detailed information about protozoans that inflict the intestinal tract of humans and other animals.

Since the Fall of 1996, the Edwards Aquifer Research and Data Center (EARDC) at Southwest Texas State University has monitored the San Marcos River and nearby alluvial groundwater wells for cryptosporidium. EARDC staff members Glenn Longley, Vidja Rao, and Aaron Brown lead the project, which includes sampling and laboratory testing for other protozoans and microorganisms.

Research by Other Groups

Research and education programs about cryptosporidium are underway in many agencies in Texas.

Bill Purdy, a microbiologist with the U.S. Department of Agriculture/ Agricultural Research Service (USDA/ ARS) at Bushland began sampling a playa lake near a feedlot for cryptosporidium in November 1996. Initially, the research involved incubating bacteria, fungi, and parasites in test tubes with water samples taken from the playa lake and determining if the conditions in the lake foster the viability of cryptosporidium oocysts. Water

Bill Purdy USDA/ ARS in Bushland is sampling this playa lake near a feedlot to gather baseline data on cryptosporidium levels.

samples are being collected after high rainfall events that are likely to produce runoff. Later, Purdy hopes to gather data from many playa lakes in the region.

"We simply don't have a lot of data about cryptosporidium populations from playa lakes near feedlots and grazed playas," Purdy says, "but we want to answer public concerns about potential sources of the protozoan." Purdy hopes to obtain data that will provide insights about how populations of cryptosporidium and other microorganisms may be affected by pH, ultraviolet light, air and water temperatures, oxygen levels, and the presence of predatory organisms.

The American Water Works Association Research Foundation (AWWARF) supports and funds many research projects focusing on cryptosporidium. Some of those are being carried out by Texas universities, water utilities, and private firms. Dallas Water Utilities and the Houston Department of Public Works are participants in a project titled "Enhanced and optimized coagulation for removal of particulates and microbial contaminants." The study will include bench-scale studies to remove protozoan oocysts and cysts and other microbiological contaminants. The University of Texas at Austin and the Waco Water Treatment Plant are participating in a study titled "Quantitative particle count method development." The study will develop and evaluate methods to easily and accurately quantify microbiological populations in raw and treated waters.

Monitoring Efforts

Agencies that are most involved in cryptosporidium studies include the EPA, the Texas Natural Resources Conservation Commission (TNRCC) and the TDH.

The TNRCC works with cities that rely on surface water as a drinking water source and coordinates monitoring efforts. The EPA supervises cryptosporidium testing under the Information and Collection Rule (ICR), which is part of the new Safe Drinking Water Act. The act requires that utilities serving more than 100,000 people have to conduct microbiological monitoring for 18 months, beginning this year, and will have to submit an analysis of their treatment methods and test their treatment process. The microbiological monitoring includes cryptosporidium, giardia, total viruses, total coliform bacteria, and fecal coliform bacteria. Major cities now testing for cryptosporidium include Waco, Austin, El Paso, Dallas, Houston and Fort Worth.

Larry Mitchell leads the TNRCC cryptosporidium program. He says that there is a lack of knowledge about the extent of cryptosporidium levels in Texas that can't be corrected until more data are gathered under the ICR program. Still, many cities and water suppliers are taking preventative action to make sure cryptosporidium doesn't get into their drinking water supply. "We're seeing a lot of enthusiasm among water suppliers to improve treatment to reduce cryptosporidium risks. These efforts will help ensure that drinking water supplies are safe and relatively free of cryptosporidium." Techniques being utilized include changing disinfection procedures from chlorine dioxide to ozone, and maximizing the efficiency of filtration. TNRCC is working to detect cryptosporidium

in alluvial aquifers and in agricultural watersheds with large dairy and livestock activities.

TDH works with TNRCC to analyze water samples for cryptosporidium oocysts. In the past two years, the lab has tested 200 samples from river and lake waters, groundwaters, and wastewater for cryptosporidium.

The City of Austin monitors raw and finished water each month at three plants near Town Lake and Lake Austin that take water from the Colorado River. They report that no confirmed cryptosporidium samples were found in the finished water.

The City of Dallas Water Utilities has implemented a comprehensive program to test its source waters for cryptosporidium and to inform the public if and when outbreaks occur. Since 1993, Dallas has been monitoring 27 sites including lakes, tributaries and intake waters for cryptosporidium. Results of tests from 1995 show that 24 sites below Ray Roberts Dam and along the Elm Fork of the Trinity River exhibited measurable amounts of cryptosporidium. The Dallas Water Utilities Community Relations Department is leading efforts to develop a public education campaign about the occurrence of cryptosporidium, potential adverse health impacts, and persons with AIDS and compromised immune systems. Efforts include newsletters in English and Spanish, education of the medical community, development of an early warning system, and briefings before health commissioners and advisory groups.

For the past two years, the City of Houston has been sampling cryptosporidium levels from raw and finished waters in Lake Houston and Lake Livingston. Houston monitors for giardia and cryptosporidium, but officials say neither organism has been detected in significant numbers. To safeguard against cryptosporidium, Houston treats its water with anthracite or coal and sand filters.

Summary

Cryptosporidium poses a significant potential threat to many parts of the world, including Texas. Even a small outbreak of the organism can cause an outbreak of cryptosporidiosis, which can be harmful to healthy people and deadly to those with weak immune systems.

Still, we need to know more about the levels of cryptosporidium in Texas waters and to find out which conditions cause the greatest risk. Are dairies and cattle feedlots more of a potential problem than other areas? Do we know enough about urban sources of the organism and the threat they pose? Has the impact of human wastes on cryptosporidium levels been investigated thoroughly?

Many groups in Texas are researching aspects of the cryptosporidium problem. This is an example where an interdisciplinary approach, involving veterinarians, medical doctors, agricultural engineers, entomologists, and many others are working together to build a comprehensive analysis and solution to a difficult problem.

For More Information

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