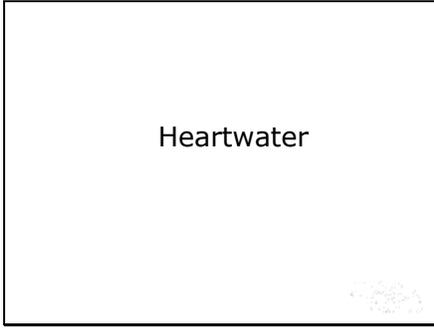


Heartwater

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Heartwater is an infectious, noncontagious, rickettsial disease of domestic and wild ruminants in areas infested by ticks of the genus *Amblyomma*.

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Overview

- Cause
- Economic impact
- Distribution
- Transmission
- Disease in animals
- Prevention and control

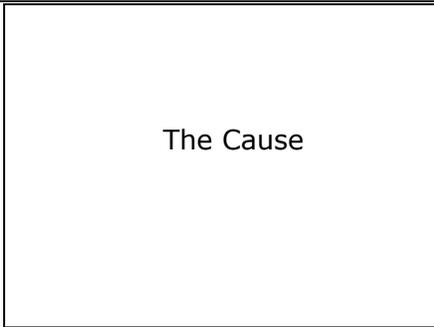


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In today's presentation we will cover information regarding the organism that causes heartwater, its economic impact and where it is distributed in the world. Additionally, we will talk about how it is transmitted, the species it affects and what it looks like (clinical signs). Finally, we will address prevention and control measures for the disease. Photo of *Amblyomma variegatum* (amblee-OHM-ah vaar-EE-gah-tum), the tropical bont tick, from Mat Pound at USDA, ARS.

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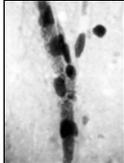


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Heartwater

- *Ehrlichia ruminantium*
 - Rickettsia
 - Found in blood vessels of infected animals
 - Especially ruminant brain
 - Causes "leaking"
 - Cannot live very long outside host

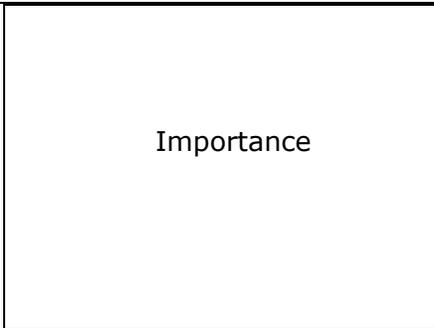


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Heartwater disease is caused by *Ehrlichia (formerly Cowdria) ruminantium* (air-lick-EE-ah ROO-mi-NAN-tium) is a rickettsial bacterium - it lives in cells but is different than a true bacterium. The organism initially reproduces in white blood cells (macrophages), then invades and multiplies in blood vessel cells, especially in the brains of ruminants. This rickettsia causes the blood vessels to "leak" which is why it has the name heartwater disease- fluid leaks out and fills the sack around the heart. The organism is considered an intracellular parasite and cannot survive outside a living host for more than few hours at room temperature. Photo: Brain smear from a goat showing colonies of *C. ruminantium* as the granular blue areas in the cytoplasm of the capillary endothelial cells. From www.vet.uga.edu/vpp/gray_book/photos/pages/061.htm.

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Heartwater is a threat to the U.S. for several reasons. There is a risk of introduction of the disease through infected ticks or of infected ticks on imported wildlife. Additionally, a carrier state of the disease has been discovered in several wild animal species that have been imported to the U.S. Finally, two tick species indigenous to the U.S. have been shown experimentally to serve as vectors for heartwater.

Heartwater

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History

- 1830: South Africa – sheep
- 1898: Spread through blood
- 1900: Tropical bont tick vector
- 1925: Caused by Rickettsial agent
- 1980: Found in Western Hemisphere
- 1992 and 1997: Florida-imported vector ticks

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The first historic identification of heartwater was made in sheep in South Africa in the 1830's. In 1898, heartwater was found to be spread experimentally by injecting blood from diseased animals into susceptible animals. The tropical bont tick (*Amblyomma variegatum*: amblee-OHM-ah vahr-ee-GAY-tum) was confirmed as a vector of the disease in South Africa in 1900. The causative agent was found in the tissues of infected animals and ticks by Cowdry in 1925 which later led to the name of the rickettsial organism, *Cowdria ruminantium*, in 1947. The first reported occurrence of the disease in the Western hemisphere was in 1980 in Guadeloupe, one of the Caribbean Islands. Since then it has gradually spread to as far north as Puerto Rico, southwards to Barbados and St. Vincent. The potential for the tropical bont tick, and thereby heartwater, to be introduced into the U.S. was demonstrated in 1992 when a cattle egret, banded in Guadeloupe (Caribbean), was found in the Florida Keys. Also, in 1997, the same tick species was found on a traveler to the Caribbean upon her return to Florida.

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Economic Impact

- Zimbabwe
 - US \$5.6 million annual losses
 - Acaricide, milk loss, treatment cost
- Serious threat to the United States
 - Caribbean Islands with infected ticks
 - Migratory cattle egrets
 - Susceptible cattle and deer population
- 40% to 100% death in U.S. expected

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Heartwater is a serious constraint to livestock development in much of sub-Saharan Africa. In an assessment of the economic impact of heartwater and its control in Zimbabwe (*Preventive Veterinary Medicine* 1999; 39:173-189), the estimated total annual national losses due to heartwater were U.S.\$5.6 million. Losses in commercial systems were 25 times greater than losses in the communal system. The greatest components of economic loss were control (acaricide - used to kill ticks) costs (76%), followed by milk loss (18%) and treatment cost (5%). Heartwater is a serious threat to the United States considering the presence of the disease in the Caribbean and the proximity to the southern coast of the United States. Migratory birds, especially cattle egrets (*Bubulcus ibis*), have been demonstrated to fly from the Caribbean to Florida. Additionally, U.S. ruminant populations are naïve, and therefore more susceptible to the severe form of the disease. It has been estimated that between 40% and 100% death rate in the cattle population will be recorded if heartwater enters the United States.

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Distribution

Next we will discuss where heartwater can be found and how severely it affects animals with the disease.

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Geographic Distribution

- Sub-Saharan Africa
- The Caribbean Islands
 - Puerto Rico, Guadeloupe, Barbados, St. Vincent, Antigua, Marie, Galante
- Not reported in Asia
- U.S. has ticks that spread heartwater



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Heartwater occurs where its tick vectors are present. The disease is constantly present (endemic) in Africa and the Caribbean islands. Carrier wildlife in these locations sustain the disease in nature. To date, heartwater has never been reported in Asia despite the presence of many species of *Amblyomma* ticks. The U.S. has two tick species, *A. maculatum* and *A. cajennense*, that have been shown experimentally to be capable of serving as vectors of heartwater.

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Sickness/Death

- Susceptible cattle, sheep, goats
- Sickness: Approaches 100%
- Death rate:
 - 80% in Merino sheep and Angora goats
 - 60% in cattle
 - 6% in Persian or Afrikander sheep

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Untreated non-native cattle, sheep and goats often have sickness rates approaching 100%. Death rates of 80% have been recorded in Merino sheep and Angora goats; rates of 60% have been recorded in cattle. Persian and Afrikander sheep are more resistant to heartwater, with a mortality rate of 6% typically.

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Transmission

Spread of the rickettsia

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Animal Transmission

- Vector-borne
- *Amblyomma* ticks
 - Live 1-4 years
 - Each year on a different host
 - Develop to next stage
 - Egg- larvae - nymph - adult
 - 3 host tick
 - Once larvae, nymph infected, spread to next life stage



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Heartwater is primarily transmitted by ticks of the genus *Amblyomma* (Family Ixodidae). At least twelve species of *Amblyomma* ticks have been shown to transmit *Ehrlichia ruminantium*. *A. variegatum* (tropical bont tick) is the most important transmitter of heartwater, pictured above. The life cycle of these ticks can take from 1-4 years. Each year is spent on a different host as the ticks develop into the next stage. The 4 stages are: egg, larvae, nymph, and adult. The immature stages feed on a wide variety of livestock, wild ungulates, ground birds, small mammals, reptiles and amphibians. Each stage of the tick lives on a different animal species- 3 to be exact, making them a three host tick. Ticks can acquire the infection from the host from the time the fever starts for up to 361 days, or longer. They become infected during larval or nymphal stages and transmit the organism to the subsequent life-cycle stage (transstadial transmission). They probably retain the infection for life. Infected female ticks do not transfer the rickettsia to offspring (transovarial transmission). Photo from The Gray Book at www.vet.uga.edu/vpp/gray_book.

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Animal Transmission

- Oral
 - Via colostrum- cow to calf
- Vector spread - ticks
 - Wild ruminant reservoir
 - Blesbok
 - Wildebeest
 - Wild bird reservoir
 - Cattle egret
 - Helmeted guinea fowl



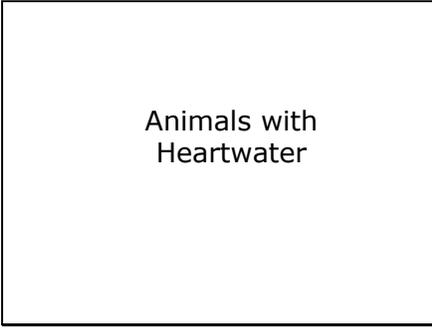
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In areas where heartwater is always present (endemic), there has been evidence of transmission from infected cows to their calves through colostrum (oral). The ticks can also pick up infection from wild ruminants such as blesbok (*Damaliscus dorcas phillipi*) and black wildebeest, and wild birds like the cattle egret, helmeted guinea fowl, leopard tortoise (*Geochelone paradalis*) and scrub hare because these animals harbor the rickettsia *E. ruminantium* subclinically for long periods.

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Let's review what heartwater does to affected animals.

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Affected Species

- Severe disease
 - Cattle, sheep, goats, water buffalo
 - White-tailed deer (experimentally)
- Mild disease
 - Indigenous African breeds of sheep and goats
- Inapparent disease
 - Blesbok, wildebeest, eland, springbok

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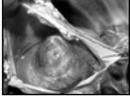
Heartwater causes severe disease in cattle, sheep, goats and water buffalo; experimentally white-tailed deer have been found to be susceptible; mild disease in some indigenous African breeds of sheep and goats; and inapparent disease in several species of antelope indigenous to Africa, such as blesbok, wildebeest, eland and springbok. Additionally, *Amblyomma maculatum*, an experimentally proven vector of heartwater, is a common parasite of white-tailed deer in the U.S.

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Clinical Signs

- Time period from exposure to signs of disease: 14 to 28 days
- Four forms of disease
 - Peracute- rare
 - Acute- most common
 - Subacute- rare
 - Mild or subclinical- calves



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The time period from exposure to signs of disease (incubation period) ranges from 14–28 days, typically being shorter in sheep in goats than in cattle but was less in experimentally infected animals. Clinical signs and lesions result from injury to the blood vessel walls and cause “leaking” of the vessels (increase in vascular permeability). The name heartwater is because there is fluid around the heart as pictured on the right (called hydropericardium). Disease can be peracute (rare), acute (most common), subacute (rare), mild or subclinical (calves) determined by various strains of the heartwater agent and animal susceptibility. Photo from The Gray Book at www.vet.uga.edu/vpp/gray_book.

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Clinical Signs: Acute

- Most common form
- Sudden fever (107°F)
- Loss of appetite, depression, rapid breathing, respiratory distress
- Nervous signs
 - Chewing movements, eyelid twitching, tongue protrusion, circling, high stepping gait, “moonstruck”
- Death in 1 week

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The most common form of heartwater is the acute form. This is seen in both nonnative and indigenous domestic ruminants. Animals develop an acute high fever, loss of appetite, depression, respiratory distress and rapid breathing. Nervous system signs can soon follow and be seen as excessive chewing movements, eyelid twitching, tongue protrusion, walking in circles and with a high stepping gait. Some animals may have convulsions. Galloping movements and “moonstruck” (head tipped back and eyes rolled back) are commonly seen before death, which can occur in less than one week.

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Clinical Signs: Subclinical

- “Heartwater fever”
- Asymptomatic
- Fluctuating fever



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The mild form of the disease is called “heartwater fever”. It is present in some affected regions among indigenous breeds with resistance or partial immunity to heartwater and antelope species. The only symptom is a fever that fluctuates. Photo: wildebeest.

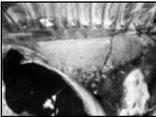
Heartwater

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Clinical Signs: Other Forms

- Peracute- rare
 - Heavily pregnant cows
 - Sudden death
 - Fever, severe respiratory distress, convulsions, ± severe diarrhea
- Subacute- rare
 - Prolonged fever, coughing, fluid in lungs, mild incoordination
 - Recovery or death in 1-2 weeks



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There are two other forms of heartwater that are rarely seen. The peracute form of heartwater typically occurs in non-native breeds of cattle, sheep and goats introduced into an area where the disease is already present. Heavily pregnant cows are especially prone to develop the peracute form of the disease. Sudden death is the typical manifestation for this form. Clinical signs possibly seen prior to death may include fever, severe respiratory distress, and convulsions. Additionally, some breeds of cattle (Jerseys and Guernseys) may develop severe diarrhea. Clinical signs of the subacute form include prolonged fever and coughing due to fluid in the lungs- pictured right along with fluid in the chest cavity. Animals may show mild incoordination and either recover in 1-2 weeks or die. Photo from The Gray Book at www.vet.uga.edu/vpp/gray_book.

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Actions to Take

Contact your veterinarian
Stop all animal movement

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If you suspect a case or outbreak of heartwater, contact your veterinarian immediately and stop all animal movement.

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Heartwater in Humans

- Humans are not susceptible to heartwater disease

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Heartwater does not infect or produce disease in humans.

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Prevention and Control

There are various prevention and control methods that can be applied to heartwater. These will be discussed next.

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Prevention

- Tick control program
 - Acaricides
 - Regular inspection of animals, pastures
- Eradication of the tropical bont tick from the Caribbean
 - Program since 1995



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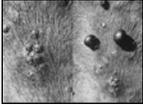
Preventative measures for heartwater include implementation of an effective tick control program using acaricides which are products aimed at killing ticks (which is being applied in the photo), as well as regular inspection of animals and pastures for ticks. There are efforts to try and eliminate the tropical bont tick from the Caribbean so that heartwater will be less of a risk in those areas and in the U.S. Since 1995, a project carried out by the Food and Agriculture Organization (FAO) and national governments, and funded by the United States, the International Fund for Agricultural Development, and the European Union, has radically reduced the number of affected animals. Photo of acaricide

being applied to the back of a cow; source: FAO accessed at http://www.fao.org/english/newsroom/field/2003/0703_bonttick.htm

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Control

- Importation control and monitoring
 - Quarantine all wild ruminants imported from Africa, all wild ungulates, birds, and reptiles imported to US
 - Inspect for ticks
- Universally effective vaccine not developed



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There are importation control measures that requires all incoming wild ruminants, ungulates, birds and reptiles to be quarantined. This exercise requires placing all incoming animals under intense examination for carrier status of heartwater and for presence of the ticks. There is not a universally effective vaccine on the market. Photo of bont ticks on the hide of a cow; source: FAO accessed at http://www.fao.org/english/newsroom/field/2003/0703_bonttick.htm

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Control

- Treatment
- Early stage
 - Oxytetracycline
- Late stage
 - Treatment worthless when neurological signs appear



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Tetracycline antibiotics (especially oxytetracycline) are very effective in the treatment of heartwater, especially when used EARLY in the course of the disease. Treatment is usually ineffective if the first dose of oxytetracycline is not administered until neurological signs appear.

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Additional Resources

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Internet Resources

- Center for Food Security and Public Health website
 - www.cfsph.iastate.edu
- World Organization for Animal Health (OIE) website
 - www.oie.int
- USAHA Foreign Animal Diseases – “The Gray Book”
 - www.vet.uga.edu/vpp/gray_book

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Further information on heartwater can be obtained from the web at the Center for Food Security and Public Health website, the World Organization for Animal Health website, and the webpage of the USAHA Foreign Animal Diseases book. The website addresses are given here.

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Acknowledgments

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