Heartwater

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Epidemiology

The epidemiology of heartwater depends upon factors relating to the tick vector, the causative organism, and the vertebrate hosts. Important considerations relating to the tick vector are infection rates in the ticks, seasonal changes influencing tick abundance and activity, and the intensity of tick control. As far as the vertebrate hosts are concerned the availability of wild animal reservoirs and the age and genetic resistance of domestic ruminant populations are of importance.

Photograph of Amblyomma hebraeum male
Drawing of *Amblyomma hebraeum* male (By courtesy of JB Walker, OVI, Onderstepoort)

Drawing of *Amblyomma hebraeum* female (By courtesy of JB Walker, OVI, Onderstepoort)

Drawing of *Amblyomma variegatum* male (By courtesy of JB Walker, OVI, Onderstepoort)

Drawing of *Amblyomma variegatum* female (By courtesy of JB Walker, OVI, Onderstepoort)
Distribution

Heartwater occurs wherever ticks capable of transmitting the organism are present. The endemic area encompasses most of sub-Saharan Africa, including the islands of Madagascar, Sao Tomé, Réunion, Mauritius, and Zanzibar. The disease is absent from the Kalahari Desert and dry coastal areas of Namibia and South Africa. Heartwater also occurs on the French Antillean islands of Guadeloupe and Antigua in the Caribbean Sea.
Hosts/Reservoirs

Amblyomma hebraeum ticks feeding on E. ruminantium-infected sheep have been shown to become infected during a period from two days after the commencement of the temperature reaction to two days after the animals have been treated for heartwater. The transmission of E. ruminantium by A. variegatum feeding on Creole goats in Guadeloupe is apparently somewhat different. Ostensibly healthy ruminant hosts have been shown to remain infective to ticks for long periods, at least 361 days in cattle and 11 months in Creole goats. In the latter case the carrier status could not be detected permanently during the 11-month period, demonstrating the danger which could be posed by the movement of apparently negative carrier animals to areas free from the disease.

Heartwater originated in Africa and African wild ruminants probably constitute the natural reservoir of the disease. It appears that the most important natural ruminant reservoirs in southern Africa may be African buffalo and eland. Although blesbok and black wildebeest are potential reservoir hosts, the natural habitat of these two antelope species is unsuitable for A. hebraeum, so it is unlikely that they are important reservoirs under natural conditions, except where these hosts are translocated to heartwater-endemic areas.
When a pathogenic genotype of *E. ruminantium* infects a susceptible vertebrate host either inapparent or overt disease may develop depending on the pathogenicity of the organism and on the species, breed, age, degree of natural resistance and immune status of the host. Young calves, lambs and goat kids possess a reverse age resistance which is independent of the immune status of the dam. This resistance usually lasts for only the first four weeks of life in calves and the first week in lambs and kids, although it may persist for six to eight months in calves. This age resistance is not absolute as infection of some calves less than three weeks of age and of some lambs and kids less than one week old may result in fatal disease.

The susceptibility of different breeds of cattle varies, Zebu (*Bos indicus*) breeds being in general more resistant than are European (*Bos taurus*) breeds. The resistance of local Zebu breeds, such as the Nguni and Sanga, is probably due to an inherited resistance acquired through years of natural selection. Conglutinin in the serum appears to be involved in non-specific resistance to heartwater in cattle.

Sheep are more susceptible to heartwater than are cattle, and variations in susceptibility between breeds of sheep are less than those in cattle breeds. Angora goats are highly susceptible to heartwater and their immunity is of short duration. Genetic resistance has been demonstrated in some goats. Black-headed Persian sheep possess some natural resistance to heartwater, and lambs and kids of all breeds under one week of age have a degree of innate resistance.

From observations made on game animals infected in captivity it appears that antelope such as young black wildebeest (*Connochaetes gnou*), adult springbok (*Antidorcas marsupialis*) and water buffalo (*Bubalus bubalis*) with low levels of serum conglutinin are susceptible, whereas adult black wildebeest, red hartebeest (*Alcelaphus buselaphus*) and scimitar-horned oryx (*Oryx dammah*) with high levels of conglutinin proved to be highly resistant. Helmeted guineafowl (*Numida meleagris*), leopard tortoise (*Geochelone pardalis*) and scrub hare (*Lepus saxitilis*) have also been proven to harbour *E. ruminantium* subclinically.
Heartwater is transmitted by ticks of the genus *Amblyomma*. Most *Amblyomma* spp. are three-host ticks. Larvae and nymphs become infected when they feed on domestic and wild ruminants and possibly also on certain game birds and reptiles at a time when *E. ruminantium* is circulating in the blood of these hosts. The immature stages of the tick commonly feed on smaller species of domestic and wild ruminants and game birds, while the adults prefer cattle and the larger game animals, such as African buffalo (*Syncerus caffer*) and giraffe (*Giraffa camelopardalis*), as hosts. Nymphs or adult ticks transmit *E. ruminantium* to susceptible hosts without losing the infection. Intrastadial transmission has been demonstrated, and transovarial transmission was once demonstrated in very heavily infected ticks under laboratory conditions but it is unlikely that it occurs in the field.

Heartwater occurs only where its vectors are present and 10 *Amblyomma* spp. capable of transmitting the organism occurs in Africa. The major vectors are *A. variegatum* and *A. hebraeum*, the latter being the main vector of heartwater in southern Africa. *Amblyomma variegatum* has the widest distribution in Africa and is the only originally African *Amblyomma* species that has established itself successfully outside the continent (on two islands in the French Antilles).

Among the *Amblyomma* spp. native to the USA, *A. americanum* and *A. cajennense* are only marginally susceptible to infection while *A. maculatum*, on the other hand, has long been known to be capable of transmitting the disease and has a vector efficiency in sheep which is similar to that exhibited by *A. variegatum*. 

Transmission
As ticks remain infective for life, a small number of infected ticks could presumably maintain the infection in a particular herd or area. The infection rates of ticks vary according to the season and locality in which they are collected and may be surprisingly low. Surveys in South Africa have found that one to seven per cent of *A. hebraeum* in some parts of the endemic area were infected at any one time, while somewhat higher rates have been determined in Zimbabwe and Senegal.