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Setaria tundra, an emerging parasite of reindeer, and an outbreak it caused in Finland in 2003-2006

Abstract

Recent Finnish studies have revealed an array of filarioid nematodes and associated diseases that appear to be emerging in northern ungulates. All filarioid species produce microfilariae that are present in the host blood, and known vectors are haematophagous arthropods.

The life history of Setaria tundra in Finland

Infections attributable to a species of the genus *Setaria* appear to have emerged in Scandinavian reindeer in 1973. The infections were associated with an outbreak of peritonitis. In the same year, tens of thousands of reindeer died in the northern part of the reindeer herding area of Finland. Severe peritonitis and large numbers of *Setaria* sp. worms were common findings. However, the prevalence of *Setaria* sp. in Scandinavian reindeer subsequently diminished.

Outbreak

In Finland, the latest outbreak of peritonitis in reindeer started in 2003 in the southern and middle parts of the reindeer herding area. The proportion of reindeer viscera condemned due to parasitic lesions identified during meat inspections increased dramatically. These increases caused substantial economic losses and increased the workload associated with meat processing. The focus of the outbreak moved northward by approximately 100 km/yr, and by 2005 only the reindeer in Upper Lapland were free of lesions. During the same period, the peritonitis outbreak was apparently fading away in the southern area. The causative, agent based on morphological and molecular data, was identified as *Setaria tundra*.

Disease

Reindeer calves with heavy infections of S*. tundra* expressed decreased thriftiness, poor body condition, and an undeveloped winter coat. Meat/post mortem inspection of diseased reindeer carcasses revealed ascites fluid, green fibrin deposits, adhesions, and live and dead *S. tundra* nematodes. Histopathology indicated granulomatous peritonitis with lymphoplasmacytic and eosinophilic infiltration. No specific bacterial growth was found. No significant impact on pH values of meat or on the organoleptic evaluation of meat was found. There was a significant positive correlation between worm counts and the degree of peritonitis, and a negative correlation between the degree of peritonitis and the back-fat layer. Based on the evidence in both ante and post

mortem inspections and histological examinations, present studies and historical data indicate that *S. tundra* can act as a significant pathogen in reindeer.

Microfilariae

The prevalence and density of *Setaria* microfilariae (smf) were higher in reindeer calves than in adults; the overall prevalence was 42%. In order to monitor the dynamics of *S. tundra* in nature, wild cervids also were sampled. The overall smf prevalences for moose, wild forest reindeer and roe deer were 1.4-1.8%, 23% and 44%, respectively. The focus of microfilaremia in reindeer moved north while simultaneously declining in the south as the observed peritonitis outbreak decreased. Experimentally, in reindeer calves infected in their first summer of life the peak microfilaremia was recorded in their second summer. Captive reindeer were smf positive throughout the year, but smf disappeared from the blood after 2 years. The prepatent period of *S. tundra* was estimated to be about 4 months, with a life span of at least 14 months.

Reservoirs

Moose are apparently not a suitable reservoir host for the *S. tundra* haplotype occurring in reindeer. The previous report of a peritonitis outbreak in moose associated with *Setaria* sp. nematodes in Finnish Lapland in 1989 was caused by another *S. tundra* haplotype.. It may well be that among other factors, the high percentage of wild forest reindeer with signs of peritonitis caused by *S. tundra* may also have contributed to a substantial population decline for this herd in Kainuu (1700 to 1000 in 2001-2005). Although *S. tundra* is at present maintained primarily in the reindeer population, roe deer seem to be a suitable host and asymptomatic carrier.

Vectors and life cycle

Mosquitoes, particularly *Aedes* spp. and to a lesser extent *Anopheles* spp., play an important role in the transmission of *S. tundra* in reindeer herding areas in Finland. The prevalence of *S. tundra* larvae in naturally infected Finnish mosquitoes varied from 0.5-2.5%. The rate of development in mosquitoes is temperature-dependent.

The life cycle of *Setaria tundra*; Adult nematodes inhabit the peritoneal cavity of reindeer and produce microfilariae in to the host's blood circulation, especially on summer months. The life span of the adult *S. tundra* female is at least 14 months. Microfilariae get with the blood meal into the intermediate mosquito (Culicidae) host. Microfilariae penetrate the gut of the mosquito and develop through two moults into infective third-stage larvae. The development is temperature dependent and takes about two weeks at 21°C (mean). When the mosquito is feeding again, the third-stage larvae break out and penetrate the skin of the host through mosquito's puncture wound. Then they

develop to the adult stage through two moults in the host and find their way to the abdominal cavity. The prepatent time is approximately 4 months.

Prevention

Ivermectin has good efficacy against adult *S. tundra* nematodes and circulating smf, and therefore there is an obligation to treat heavily infected reindeer calves with ivermectin by injection for animal welfare reasons. At the population level, massive antiparasitic treatment with ivermectin can reduce the number of carriers among reindeer population. The fact that this could not prevent the emergence of the *S. tundra* outbreak in new areas in the North indicates that the transmission dynamics of *S. tundra* are efficient.

Climate

The 1973 outbreak of *S. tundra* in Sweden was associated with unusually warm weather and abnormally high numbers of mosquitoes and gnats. The summers of 1972 and 1973 in Finland were also very warm, as were those in 2002 and 2003. Warm summers apparently promote transmission and the genesis of disease outbreaks by favouring the development of *S. tundra* in its mosquito vectors, by improving the rate of mosquito development and reducing their mortality from frost, and finally, by forcing reindeer to stay in herds on mosquito-rich wetlands.

Mosquito-borne diseases are among those most sensitive to weather and obviously will be influenced by climate change. Thus, I predict that global climate change will promote the further emergence of filarioid nematodes and diseases caused by them in the subarctic ecosystem. Moreover, I believe that future outbreaks can be predicted based on the mean temperatures of two consecutive summers.

This study indicated that *S. tundra* probably has an important impact on boreal ecosystems. It also revealed the absence of baseline knowledge concerning temporal parasitic biodiversity in cervids at high latitudes. Therefore, it is important to gain knowledge about these parasites, their ecology, transmission dynamics, and their impact on human and animal health. The putative relationship between climate change and a vector-borne disease identified in this thesis indicates the potential and obvious threats to the individual and population health of arctic ungulates.