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Echinococcus infections in the Baltic region

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ABSTRACT

In the Baltic countries, the two zoonotic diseases, alveolar echinococcosis (AE) caused by *Echinococcus multilocularis*, and cystic echinococcosis (CE) caused by *Echinococcus granulosus*, are of increasing public health concern. Observations from Estonia, Latvia and Lithuania indicate that the distribution of both parasites is wider in the Baltics than previously expected. In this paper, we review and discuss the available data, regarding both parasitoses in animals and humans, from the Baltic countries and selected adjacent regions. The data are not easily comparable but reveal a worrisome situation as the number of human AE and CE cases is increasing. Despite improvements in diagnostics and treatment, AE has a high morbidity and mortality in the Baltic region. For the control of both zoonoses, monitoring transmission patterns and timely diagnosis in humans as well as the development of local control programs present major challenges.

1. Introduction

Species of the genus *Echinococcus* Rudolphi, 1801 are small intestinal cestodes of carnivore definitive hosts. Parasite eggs, which can survive in the environment, are infective to a variety of herbivorous and omnivorous intermediate or accidental hosts. The larval stages (metacestodes) in the intermediate hosts have a high potential for asexual reproduction and production of numerous protoscoleces (Thompson, 1995).

Metacestodes of *Echinococcus granulosus*, a complex of species, strains and genotypes with a taxonomy under revision (reviewed Romig et al., 2015), are causing cystic echinococcosis (CE; hydatic disease) in intermediate and in human accidental hosts, with a high global burden of disease (Budke et al., 2006). Metacestodes (cysts from a few cm to up to 10–30 cm) can be seen during meat inspection, autopsy or necropsy. Therefore, in contrast to many other infectious diseases, historic observations are of value for the understanding of the epidemiology of these zoonotic parasites.

The "northern biotype of *E. granulosus*" (Raush, 1995), currently named *E. canadensis*, which includes the cervid strain or genotypes G8 and G10 (Romig et al., 2015; Oksanen and Lavikainen, 2015), is transmitted almost exclusively in a wild animal cycle with the wolf as definitive hosts and ungulates of the family Cervidae as intermediate hosts. In addition, domesticated reindeer and dogs (as definitive hosts) can be involved in certain epidemiological situations. Only few zoonotic infections with the cervid strain have been observed in humans, associated with relatively moderate pathology, mainly in the lungs (Romig et al., 2015; Oksanen and Lavikainen, 2015). In contrast, in endemic regions of southern and central Europe, *E. granulosus* (sheep strain, genotypes G1, G2, G3), and *E. granulosus* pig strain (genotype G7; also grouped under *E. canadensis*, and proposed as *E. intermedius*) occur mostly in synanthropic cycles with the domestic dog as definitive and sheep (G1) or pigs (G7) as major intermediate hosts, respectively.

Echinococcus multilocularis is transmitted in Europe mainly by wild animals, with the red fox (*Vulpes vulpes*), the wolf (*Canis lupus*) and the raccoon dog (*Nyctereutes procyonoides*) as definitive hosts

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Table 1
Echinococcus species recorded until 2014 in the Baltic countries Estonia, Latvia and Lithuania.

Country	Species, strain (genotype)	Definitive hosts	Intermediate and aberrant[a] hosts, (human)	References
Estonia	*E. granulosus*	Dog	Pig, cattle, sheep, moose	Saar (1931); Lešins (1955); University of Tartu (zoological collection)
	E. granulosus (G1)	Dog		Laurimaa et al. (2015b)
	E. canadensis, cervid strains (G8, G10)	Wolf	Moose, roe deer	Moks et al. (2006, 2008); I. Jõgisalu (pers. comm.)
	E. multilocularis	Fox, raccoon dog		Moks et al. (2005), Laurimaa et al. (2015c)
Latvia	*E. granulosus*		Pig, sheep	Vaivarina (1950)
	E. canadensis, cervid strain (G10)	Wolf		Bagrade and Saarma (unpublished)
	E. multilocularis	Fox, wolf, raccoon dog		Bagrade et al. (2008, 2009);Bagrade, (2008);Poļakova, (2009)
Lithuania	*E. granulosus*	Dog, wolf	Pig, cattle, sheep (human)	Historic citations see Sections 5.1.1 and 5.2.1
	E. granulosus; pig strain (G7)	Dog	Pig, cattle,[a] human	Bružinskaitė et al. (2009); Marcinkutė et al. (2006)
	E. multilocularis	Fox, raccoon dog, dog	*Ondatra zibethicus*, (*Microtus* sp.; pig,[a] human)	Mažeika et al. (2003) ; Bružinskaitė et al. (2007, 2009); Bružinskaitė-Schmidhalter et al. (2012); (Loibiene R. and Šarkūnas M., personal communication)

[a] Non-fertile metacestodes, therefore no significance for transmission.

and rodents mainly of the genera *Arvicola*, *Microtus* and *Myodes* as intermediate hosts (Eckert et al., 2011). Domestic dogs and, to a lesser extent, cats can be involved in the transmission cycle (Deplazes et al., 2011). The parasite is endemic in the northern hemisphere: the highest prevalence of infection is reported in Central Europe, North America (mostly in Alaska and the northern part of Canada) and in the arctic, subarctic and temperate climate zones of Asia (Eckert et al., 2011).

Humans may get infected by uptake of eggs, and the tumour-like growth of the metacestode stage of *E. multilocularis*, mainly in the liver, may lead to a serious disease—alveolar echinococcosis (AE).

The numbers of recently reported human AE cases have increased in some endemic areas in Central Europe as well as in the Baltics (Bružinskaitė et al., 2007) and Poland (Nahorski et al., 2013). Although generally a rare disease, AE is of considerable public health importance because of the severe pathology of the tumour-like infection, the high lethality rate of untreated cases and high cost of treatment (WHO, 2001; Vuitton et al., 2015).

Since the 1990s, extensive epidemiological studies have revealed that the known central–European endemic area of *E. multilocularis* is much larger than previously known, including regions in the north and east (WHO, 2001; Romig et al., 2006; Sikó et al., 2011; Vuitton et al., 2015). The parasite has been reported in the Baltics in Lithuania (Mažeika et al., 2003), Estonia (Moks et al., 2005) and Latvia (Bagrade et al., 2008), and in neighbouring Poland (Malczewski et al., 1995) and Belarus (Shimalov and Shimalov, 2001).

In this paper, we review historic and recent epidemiological data from the Baltic region, including locally published reports that are not easily available to a broader readership.

2. *Echinococcus* spp. in the Baltic countries

Since the 1990s, due to the changes in the epidemiological situation or improved diagnostic techniques and medical care, the number of registered human CE and later on AE cases started to increase in Lithuania and Latvia, while remaining at relatively low levels in Estonia.

Most information on *Echinococcus* infections is available for animals. Recent and historic data are reviewed for the different Baltic countries in the following chapters. As shown in Table 1, four confirmed genotypes of the *E. granulosus* complex, namely the sheep strain (G1), pig strain (G7), and cervid strains (G8 and G10), have been identified in different hosts. The first report on an *E. multilocularis* infection in the region was published in 2003 in Lithuania (Mažeika et al., 2003), followed shortly by reports from the two other Baltic countries. To date, most data are available from definitive hosts, whereas the intermediate rodent hosts have not been systematically investigated for the presence of *E. multilocularis* in the Baltic region.

3. Occurrence and transmission of *Echinococcus* spp. in Estonia

3.1. Animal infections in Estonia

3.1.1. Echinococcus granulosus *complex*

Historically, the first Estonian record of *E. granulosus* dates back to 1904 when the parasite was included in the zoological collection of the University of Tartu. The material was collected near the town Tartu. Unfortunately, the host was not documented and the sample is not preserved. However, *E. granulosus* cysts were reported in the 1930s from pigs (Saar, 1931), and later in pigs, sheep and wild cervids (Lešins, 1955). Notably, 147 (15.7%) out of 938 pigs were infected (Lešins, 1955). Prevalences ranged between 5 and 31.4% in different areas and were highest in counties near the Latvian border and Lake Peipus. The parasite was also detected in other intermediate host species: in 10 out of 244 sheep (4.1%) and in 7 out of 1117 (0.6%) large cervids (unspecified, presumably moose, *Alces alces*). After that, there were no more reports of *Echinococcus* infections for almost half a century, neither from the meat inspections nor from parasitological investigations of wild cervids in the 1970s (Järvis, 1993).

In more recent studies, *E. granulosus* has been found in Estonian wildlife. Wild intermediate host species include moose and roe deer (*Capreolus capreolus*), whereas the grey wolf has been identified as the definitive host. In domesticated intermediate hosts, the parasite has been detected in pigs, sheep and cattle (Tables 1 and 2; Estonian Veterinary and Food Laboratory, 2014).

In 2003, adult stages of the *E. granulosus* complex were detected in 1 out of 26 investigated grey wolves (3.8%; Moks et al., 2006). The parasite was identified as *E. canadensis* (G10).

Infection in wolves and wild cervids (Moks et al., 2006, 2008; I. Jõgisalu, Estonian Environmental Agency, personal communication) suggest a wild animal cycle for this tapeworm in Estonia. In 2004–2005, *E. canadensis* cysts were detected in 16 (0.8%) out of