

Threat of *Echinococcus multilocularis* infection in Poland – in the light of investigations conducted by the National Veterinary Research Institute in Puławy

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Alveolar echinococcosis (AE) is a dangerous zoonotic disease caused by the larval forms of *Echinococcus multilocularis* tapeworm. *E. multilocularis* is considered the most dangerous parasitic zoonotic agent in the Northern Hemisphere, and AE is usually fatal if left untreated. In the life cycle of this parasite, the red fox (*Vulpes vulpes*) plays the role of a typical definitive host (in its intestines mature forms of this tapeworm develops). Rodents are a typical intermediate host where *E. multilocularis* larvae develop. In the life cycle, human acts as a nonspecific intermediate host.

The source of infection for humans are *E. multilocularis* eggs present in the environment, previously excreted with the faeces by the definitive hosts. Because the red fox is the typical definitive host (and the main species responsible for the dispersion of invasive eggs in the environment) therefore a lot of attention is paid to the epidemiological study of the population of these animals. Based on the knowledge of the prevalence of these tapeworms in red foxes, it can be concluded about the risk of infection in humans. In Europe, such studies have been conducted in many countries for decades. In Poland, the first case of positive red fox was described by the Institute of Parasitology of the Polish Academy of Sciences in 1995. Since then, studies have been carried out covering selected areas of Poland, confirming the presence of this tapeworm in the country. In the years 2009–2013, the Department of Parasitology and Invasive Diseases of the National Veterinary Research

Institute in Puławy (PIWet) began investigation on *E. multilocularis* infection in the red foxes covering the entire territory of Poland. The study conducted in all provinces with using the reference method (sedimentation and counting technique – SCT) revealed the presence of *E. multilocularis* in 16.5% of red foxes. There were significant differences in the prevalence depending on the region. Namely, in the eastern part of Poland, the percentage of infected foxes was relatively high, and in some provinces (Warmińsko-Mazurskie and Podkarpackie) it reached 50%. However, in the provinces of the western part of the country, the prevalence usually reached only several percent. In the following years, the PIWet started the continuous monitoring of the epidemiological situation in red foxes in selected regions of Poland (with high and low prevalence). The results show a persistently high prevalence in the South-East region. On the other hand, a significant increase in the percentage of infected foxes was observed in the area previously considered to be the region with the lowest prevalence. The dynamic situation in this region may indicate expansion from the area of relatively high prevalence of infections in Poland towards the west.

In addition to red foxes, a dog (and even a cat) can also be the definitive host for *E. multilocularis*. PIWet conducted investigation in this direction in hyperendemic regions (south-eastern Poland) in dogs and cats from a rural environment and from shelters. For the first time in Poland, the presence of *E. multilocularis* in dogs and cats was confirmed.

The low percentage of positive results is important due to the close contact of these animals with human. The presence of invasive eggs in the environment close to humans is also indicated by studies conducted by PIWet in slaughter animals that can act as non-specific intermediate hosts. The larval forms of *E. multilocularis* in pigs have been identified for the first time in Poland. The presence of *E. multilocularis* in pigs may be a specific indicator of the presence of invasive eggs of this tapeworm in the environment. To the similar conclusions lead the results of the study conducted by the team of the Department of Parasitology at the Faculty of Veterinary Medicine in Lublin, where the presence of *E. multilocularis* larvae was confirmed in rats and in horse livers, as well as studies of the Medical University of Gdańsk where the genetic material of this tapeworm was identified in soil and water.

Phylogenetic studies conducted in Europe and around the world indicate a relatively large genetic diversity of *E. multilocularis* species, which is mainly related to the migration of the parasite's hosts over the last thousand years. Studies conducted in Europe indicates the historical center

of this tapeworm's occurrence (a region including Switzerland), from which the parasite spread across Europe to the west, north and east. On the other hand, research conducted in Asia suggests the movement of different genetic groups of this parasite from the eastern parts of this continent to the west, towards Europe. Poland, with its geographical location, is a very interesting area for such research. In PIWet, genetic investigations were carried out with the use of isolates from foxes from all over Poland. On the basis of sequence analysis of three mitochondrial genes and 15 haplotypes of *E. multilocularis* were distinguished. Fourteen of them were grouped in the European clade (including one dominant haplotype characteristic for Poland and Estonia), while one haplotype was classified to the group of Asian haplotypes. A study in Poland showed the location of the Asian haplotype furthest to the west of Europe. They show a significant influence of both typically European and Asian haplotypes in shaping the genetic diversity of this parasite in Central and Eastern Europe.

References are available from the authors.