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Reappearance of *Taenia ovis krabbei* muscle cysts in a roe deer (*Capreolus capreolus*) in Denmark after 60+ years, with a possible role of a grey wolf (*Canis lupus*) as definitive host

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Background:

Taenia ovis krabbei is a parasite of carnivore definitive hosts and cervid intermediate hosts (1). Accidental ingestion of eggs of *T. o. krabbei* is the primary cause of infection in intermediate hosts, in which larvae develop in heart and skeletal muscles and may cause severe illness (2). The life cycle is completed when definitive hosts ingest infected meat (3), which is, for aesthetic reasons, not regarded of high quality and discarded upon meat inspection in abattoirs (4). This report describes infections with *T. o. krabbei* in a roe deer and a grey wolf in Denmark.

Methods:

In May 2012, a male roe deer was hunted in Pajheden forest, in northern Jutland, Denmark. White spots in the thigh muscle were analyzed by microscopy (5) and histology (Fig. 1).

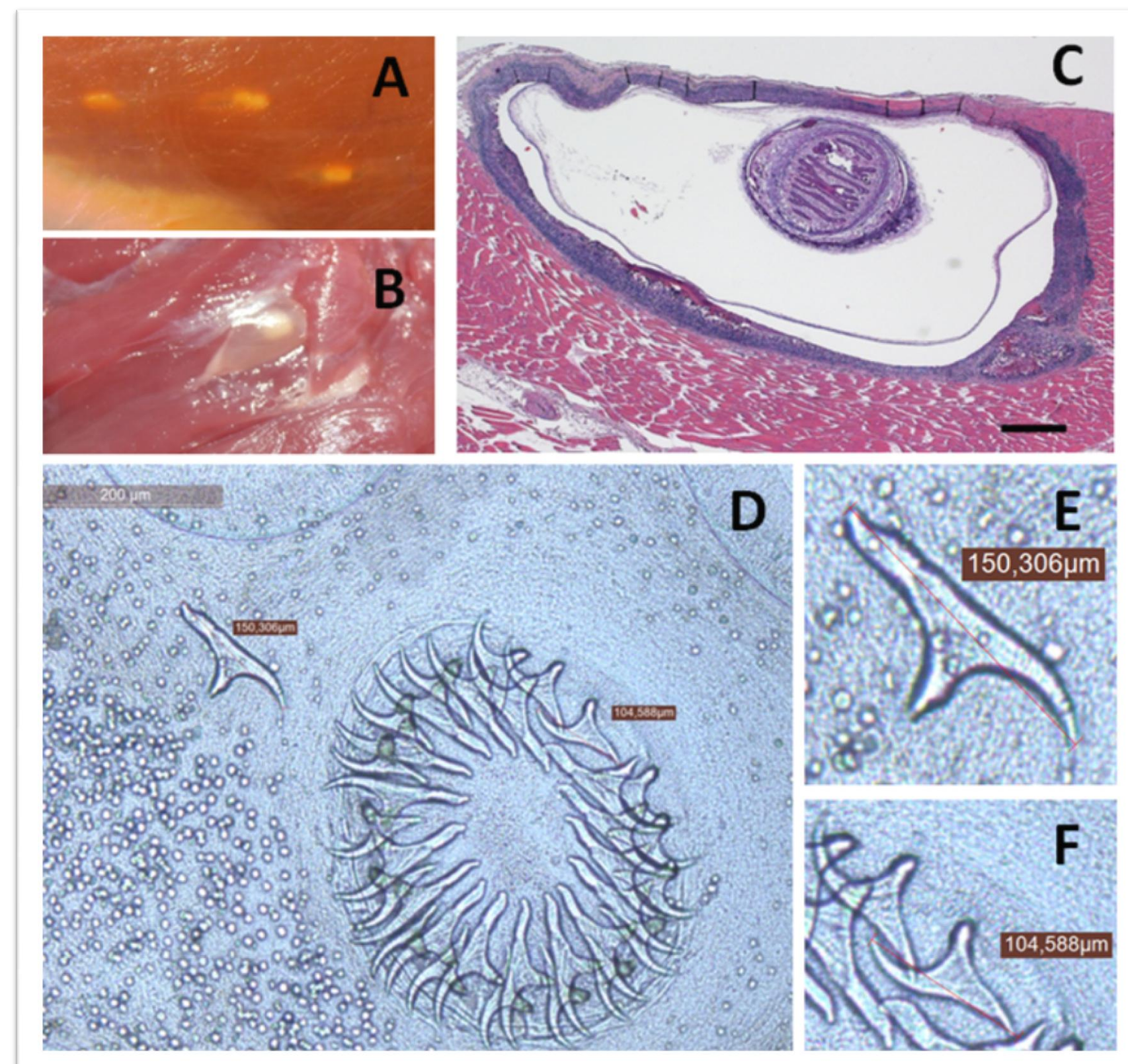


Figure 1: Morphology of cysticerci of *Taenia ovis krabbei* isolated from a roe deer, as they appear by gross morphology (A & B), histology (C) and microscopy of the rostellum (D), showing large (E) and small hooks (F). Scale bar in (C) = 0.5 mm.

Few months later, a grey wolf found dead in Hanstholm wildlife reserve in northern Jutland, around 66 km away from Pajheden forest where the deer was shot. Taeniid worms were recovered from the intestine and examined microscopically (5) (Fig. 2). Molecular analysis was performed on cysts and worms and phylogenetic relationships were inferred employing distance-based Neighbor-Joining analysis of the *cox1* gene (6).

Conclusions:

Taenia ovis krabbei was detected in a roe deer and a grey wolf in northern Jutland, Denmark, for the first time. The source of the infection was unknown but could have been introduced to the area following the invasion of the grey wolf. Invading wolves can support its establishment in new areas by carrying worms of *T. o. krabbei* that cause severe illness to native deer, which later become prey to the wolves.

Results:

The characteristic shape and size of the recovered rostellar hooks (Fig. 1 & 2) are typical for either *T. o. krabbei* or *T. o. ovis*, but not for any other *Taenia* spp. By phylogenetic analysis, the roe deer and the wolf isolates were clearly grouped together with other isolates of *T. o. krabbei* from Fennoscandia (Fig. 3). Therefore, the isolated cysts and worms were identified as *T. o. krabbei*.

Discussion:

This is the first report of *T. o. krabbei* in Jutland, Denmark, and a reappearance of the parasite in roe deer in Denmark after more than 60 years (2). This finding is of particular interest to game meat retailers since infected meat is usually not considered fit for human consumption.

Deer infections with *T. o. krabbei* have been reported in the German county that borders Denmark (4). It is possible that similar deer infections were already present but unnoticed in other areas in Denmark. Introducing the infection via deer transport is unexpected, and the suggested method of introducing *T. o. krabbei* to the area is via a definitive host.

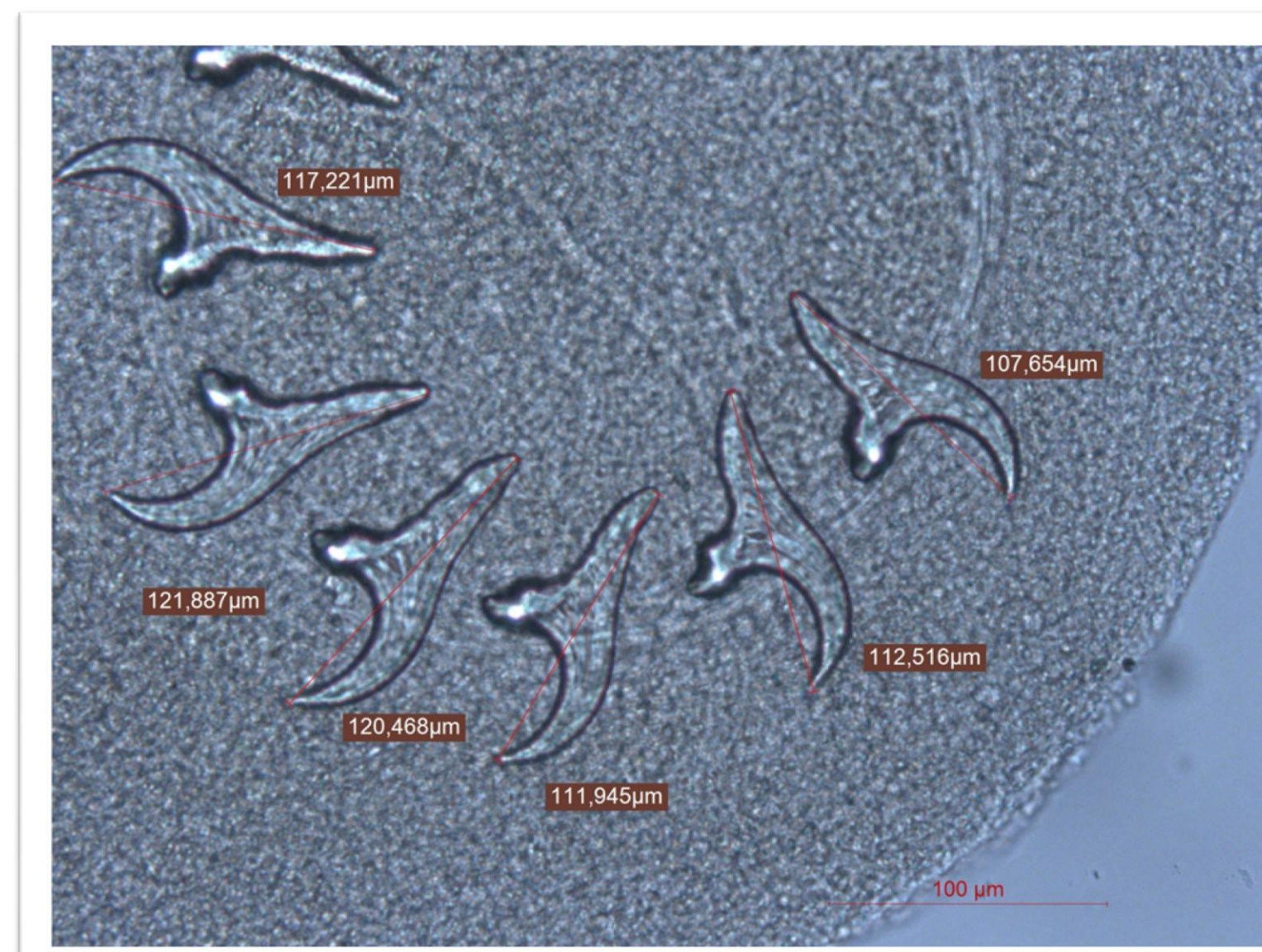


Figure 2: Morphology of rostellar hooks, small hooks, of a *Taenia ovis krabbei* worm isolated from a grey wolf after post mortem analysis. Scale bar = 100 µm.

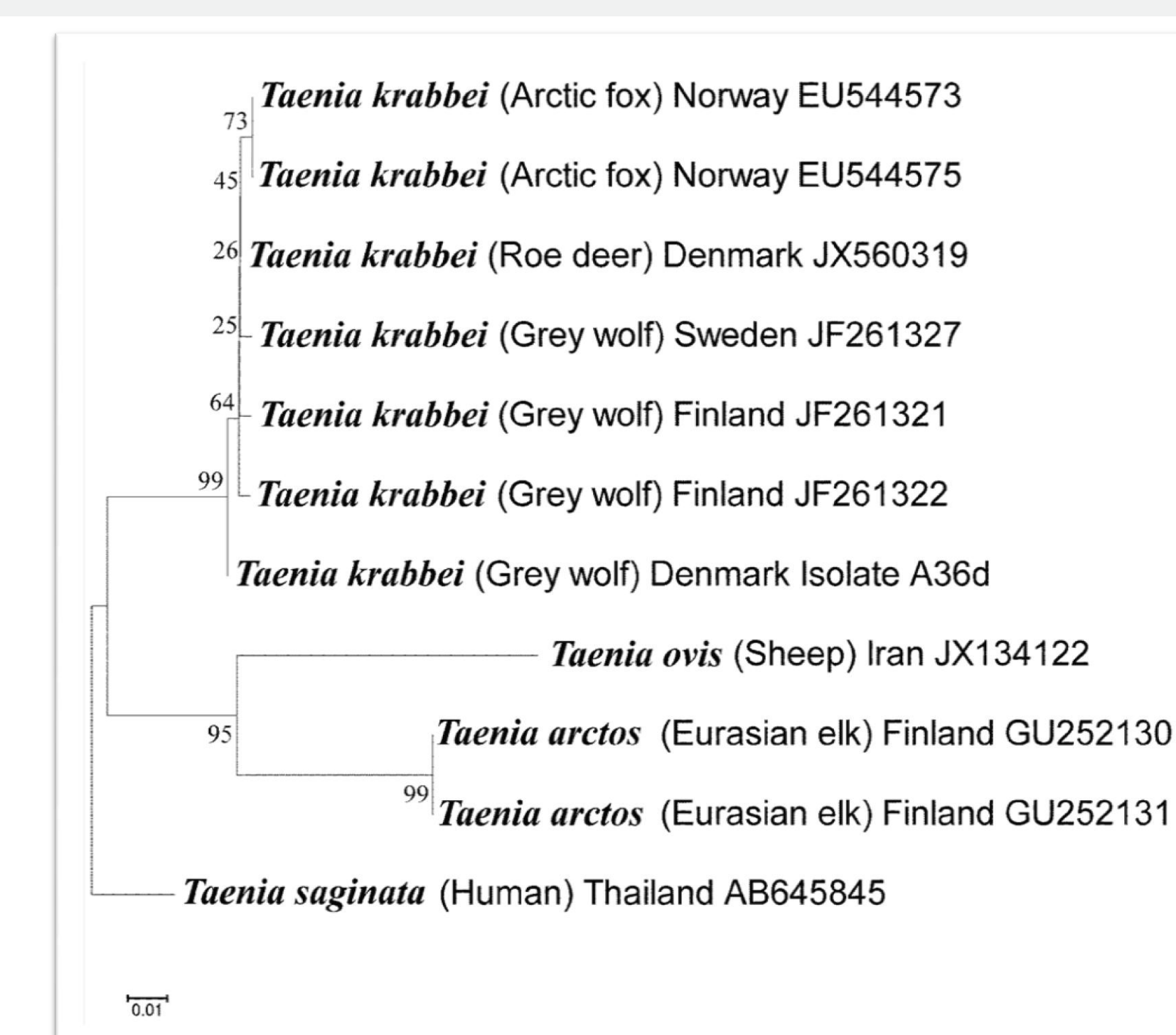


Figure 3: Phylogenetic relationship of *Taenia ovis krabbei* based on *cox-1* sequences, with selected sequences presented with its scientific name, (host), country of origin and GenBank accession number or isolate number. Relationships were inferred using Neighbor-Joining method, with given nodal supports of posterior probability. Scale bar indicates distance.

In mainland Europe, *T. o. krabbei* is considered a parasite of wolves (7 & 8). The unexpected reappearance of a wolf in Denmark after almost two decades could be a mere coincidence, but can also explain, and/or support, the introduction of this parasite during wolf introduction. Domestic dogs, on the other hand, could play a role in transmission of *T. o. krabbei* in that area, but this has yet to be tested.

Invading hosts usually experience a reduction in parasite diversity during invasion (9). However, it would be advantageous for invading wolves to sustain infections with *T. o. krabbei* as long as possible, in order to infect native deer. Infected deer will eventually suffer from severe illness and become exposed to predation by carnivores, for example the wolf. Using this strategy of transmitting *T. o. krabbei* infection to deer, wolves can increase their chance of establishment in a new area.

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