DEER KED (*LIPOPTENA CERVI*) DERMATITIS IN HUMANS – AN INCREASING NUISANCE IN FINLAND

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ABSTRACT: The deer ked (*Lipoptena cervi*) is a haematophagous ectoparasite of moose (*Alces alces*) and other cervids that commonly bites humans in Finland. Since the 1970s there has been an increasing number of Finns who suffer from long-lasting and recurrent dermatitis associated with deer ked bites. Forestry workers, hunters, berry and mushroom pickers, and other people who work in or visit forests during late summer and early autumn are especially vulnerable to incidental deer ked infestation and dermatitis. Interestingly, negative effects of deer keds on human activities have not been recently reported in countries other than Finland. Our work indicates that dermatitis caused by deer keds consists of a few to 20-50 red papules which occur mostly on the scalp, neck, and upper back. The papules usually appear 6-24 h after the bites and size varies from a few mm to 1-2 cm. They can persist several weeks and in some people up to 1 year. The rapid range expansion of the deer ked in 1970-1990s seems related to the concurrent increase in moose population density in Finland. It is possible that range expansion of the deer ked will be promoted by high densities of semi-domesticated reindeer (*Rangifer tarandus tarandus*) in northern Finland. As a result, we predict an increase in the distribution of deer keds and the number of people with deer ked dermatitis requiring medical treatment in Finland.

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The moose (*Alces alces*) is the most important game species in Fennoscandia (Lavsund et al. 2003), and its high numbers have been appreciated by recreational hunters. However, the increasing density of moose has also caused frustration among forest-owners and other stakeholders because of the negative impact on forestry and traffic safety (Aarnio and Härkönen 2007). In addition, there has been growing concern about the impact of high densities of moose on the occurrence of dermatitis caused by the deer ked (*Lipoptena cervi*) in Finland (Reunala et al. 2008).

The deer ked is a haematophagous ectoparasite of moose and other cervids and was first documented in the southeastern region of Finland in 1960 (Hackman et al. 1983). At present, it is common in southern and central Finland and its range is gradually expanding northward. In 2007 the first sightings were made close to 66° N within the southern part of the reindeer (*Rangifer tarandus tarandus*) herding area (Kaunisto et al. 2009). The distribution of *L. cervi* also includes central Europe, southeastern Norway, southern Sweden, some parts of Siberia, northern China, and Algeria in northern Africa (Maa 1969); it is an introduced species in the northeastern United States (Bequaert 1942).

Moose are the main host of the deer ked in Finland (Hackman et al. 1983), but it also parasitizes wild forest reindeer (*R. t. fennicus*),

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semi-domesticated reindeer, and white-tailed deer (*Odocoileus virginianus*) (Kaunisto et al. 2009). In central Europe deer keds also use red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), and fallow deer (*Dama dama*) as hosts (Haarløv 1964). A related species, *L. mazamae*, parasitizes white-tailed deer in North America and brocket deer (*Mazama* spp.) in central and South America (Bequaert 1942, 1957).

Females produce one third-instar larva at a time and the larva immediately pupates (Hackman et al. 1983). Ked pupae drop off their hosts onto the snow or ground, for example, at bedding sites and trails of hosts. The number of pupae produced in the life of a female *L. cervi* is unknown. In Finland, the winged adults emerge from pupae in late July-October and seek a new host by flying short distances. Upon finding a suitable host, adult keds shed their wings and commence to suck blood recurrently (Haarløv 1964). In addition, they also bite humans and other hosts but do not reproduce on them (Ivanov 1975, Reunala et al. 1980, 2008). Surprisingly, a ked bite is barely noticeable to humans as it pierces the skin only about 1 mm. The blood meal taken from humans is typically small (Hermosilla et al. 2006).

Forestry workers, hunters, berry and mushroom pickers, and others who work in or visit forests where moose occur are especially vulnerable to incidental deer ked infestation (Reunala et al. 2008). Deer ked attacks are mainly annoying and an inconvenience in having to remove dozens of keds from hair and clothes. However, a recent Finnish case study (Liukkonen et al. 2007) suggests that infestation of deer keds could reduce the recreational value of the hunting experience, especially in western Finland. In addition, 55% of the 1,400 citizens replying to a nationwide questionnaire concerning attitudes about moose management in Finland identified deer keds as an important or very important reason for reducing the moose population (Petäjistö et al. 2005). Their occurrence was the third most important reason for controlling moose numbers after road accidents and forest damage. To our knowledge, there are no recent reports from other countries relative to negative effects on human activities (Ivanov 1975, Alekseev 1985).

Since the 1970s there have been an increasing number of people in Finland who, following deer ked bites, suffer from long-lasting and recurrent dermatitis (Rantanen et al. 1982, Reunala et al. 1980, 2008). In an extreme case, an occupational IgE-mediated allergic condition with symptoms in the nose and eyes resulted (Laukkanen et al. 2005). In this paper we provide a brief overview of typical symptoms of dermatitis associated with deer ked bites, and evaluate the future potential of this condition relative to range expansion by deer keds and population densities of potential host species in Finland.

METHODS

Patients with dermatitis caused by deer keds were diagnosed and studied at the dermatological out-patient clinics at Tampere and Helsinki University Hospitals. The examinations yielded skin biopsies from the bite lesions and skin and blood tests for IgE antibody mediated allergies. The distributions and population estimates for moose, white-tailed deer, roe deer, wild forest reindeer, semi-domesticated reindeer, and fallow deer were evaluated using relevant literature. In addition, harvest statistics of huntable species were collected from the database of the Hunters Central Organization. We assumed that the annual number of harvested animals can be used as an index of population trends (Mysterud et al. 2002, Grøtan et al. 2005).

RESULTS AND DISCUSSION

Our patients usually developed symptoms a few years after their first contact with *L. cervi*. However, sensitization to the bites with accompanied symptoms is highly variable and

can appear in the first season of bites or up to 30 years afterward (Rantanen et al. 1982). Deer ked dermatitis consists of a few to 20-50 red papules occurring mostly on the scalp, neck, and upper back. They usually appear 6-24 h after the bites and their size varies from a few millimeters to 1-2 cm. Papules are accompanied by intense itching since they are easily scratched and often become secondarily infected by staphylococcal bacteria (Rantanen et al. 1982). According to Hackman et al. (1983), some victims show a local wheal and flare reaction within a few minutes of being bitten. Often the papules can persist several weeks and in some people for a year (Reunala et al. 2008).

The histological finding of a papule associated with a recent bite by *L. cervi* is a marked dermal accumulation of lymphocytes and eosinophils. Older lesions can resemble a malignant tumor such as skin lymphoma (Reunala et al. 2008). Immunohistological findings reveal complement deposits in blood vessel walls suggesting that, in addition to cell mediated mechanisms, complement activation also seems to be involved in the pathogenesis of bite lesions (Rantanen et al. 1982).

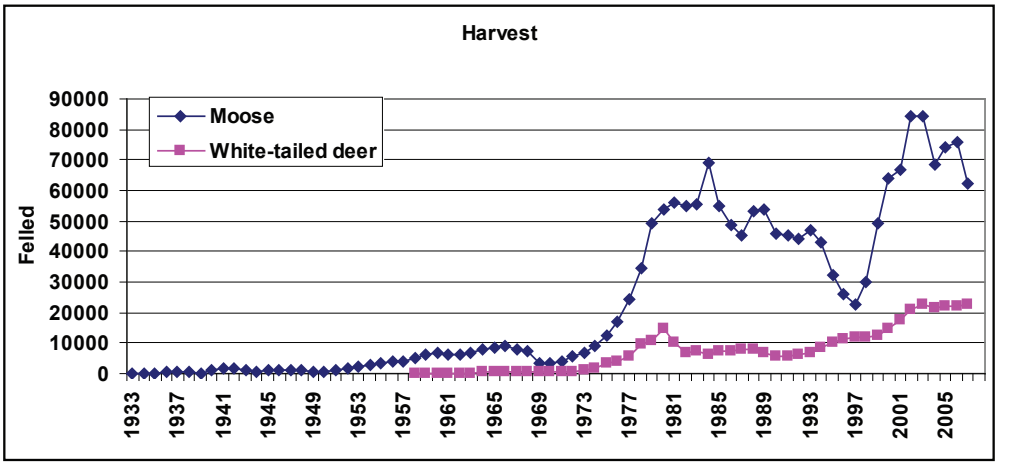
Skin tests were performed with whole-body extract of deer keds to confirm the allergic sensitization. The patients with deer ked dermatitis showed positive immediate and delayed skin test reactions in contrast to non-reactive control subjects (Rantanen et al. 1982). The involvement of immunoglobulin E (IgE) in the pathogenesis of reactions to bites of *L. cervi* was confirmed by Laukkanen et al. (2005). They also identified the IgE-binding allergenic protein by immunoblotting. This was not further characterized but is obviously a saliva protein, possibly similar to those described earlier from mosquito saliva which frequently sensitizes people (Brummer-Korvenkontio et al. 1997).

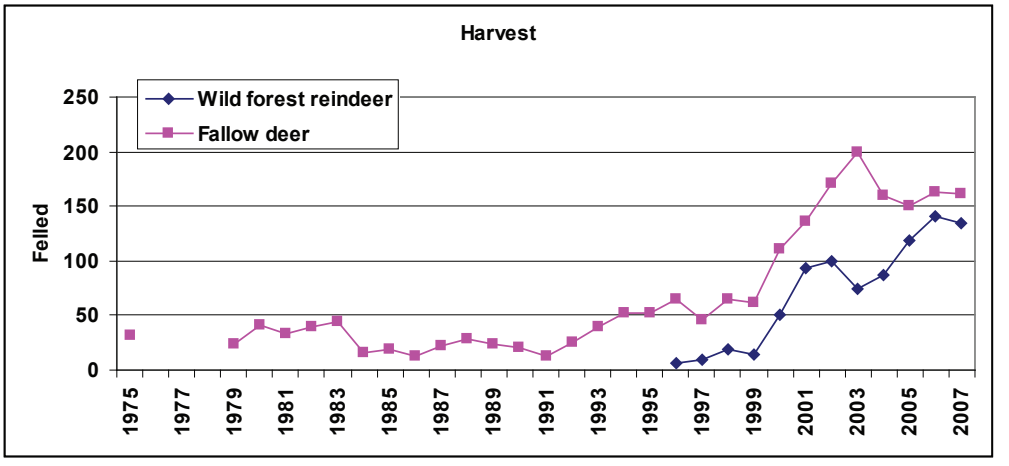
After deer keds were present for about 20 years in eastern Finland, one third of regularly exposed forest workers became sensitized to the bites (Hackman et al. 1983). New bites often cause flare-ups of dermatitis in sensitized victims in the same or subsequent years, and this allergic sensitization persists for years (Rantanen et al. 1982, Reunala et al. 2008). Due to the rapid spread of the deer ked in Finland, increasing numbers of Finns are now exposed annually and many of these subjects will become sensitized in the future (see also Reunala et al. 2008). Unfortunately there is no official register for the number of patients having deer ked dermatitis either at Pirkanmaa Hospital District or any other Hospital Districts in Finland. However, it is well-known that patients with deer ked dermatitis occur throughout Finland (Reunala et al. 2008). The exact number of Finns presenting dermatitis of deer ked origin is not available at present, but is estimated to be several thousands. Unfortunately, there are no effective repellents against deer keds (Ivanov 1975, Alekseev 1985) and the available medical treatment for deer ked dermatitis only provides symptomatic relief. Treatments include antihistamine tablets taken orally to relieve pruritus and corticosteroid creams that are applied to the papules (Karppinen et al. 2002).

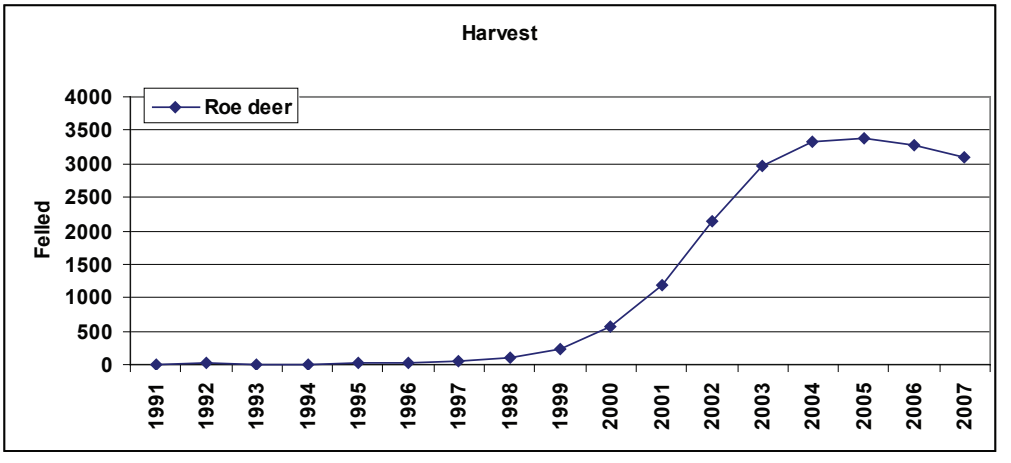
It has been suggested that *L. cervi* might transmit harmful infectious agents such as *Bartonella* spp. (Dehio et al. 2004, Halos et al. 2004, Reeves et al. 2006) which are intracellular, small, gram-negative bacteria transmitted by blood-sucking arthropods; they are considered as emerging pathogens in humans and animals (Chang et al. 2001). However, the potential risk that *L. cervi* could serve as a vector for the transmission of micro-organisms from one host to another is relatively low since the deer ked sheds its wings after finding a potential host, thus making it difficult to change hosts (Reunala et al. 2008). Nevertheless, it is reported that deer keds may transfer directly from another white-tailed deer to newborn fawns (Samuel and Trainer 1972).

The density of moose has increased in

Fig. 1. Harvest of moose in 1933-2007, white-tailed deer in 1958-2007, wild forest reindeer 1996-2007, fallow deer in 1975-2007, and roe deer in 1991-2007 in Finland. Cervid species hunting is license-based and hunters must report felled animals no later than after the end of the hunting season. Roe deer hunting was released 2005 and after that time the harvest reports have been on voluntarily basis (i.e., harvest is assumed to be underestimated after 2005). Harvest statistics were collected from the database of the Hunters Central Organization.







Finland since the 1970s (Torvelainen 2007). The post-harvest moose population was at its highest in 2001 when it was estimated to be 139,000 (4.6 moose/10 km^2 land area); moose harvest data indicate a similar trend (Fig. 1). The white-tailed deer population is more dense in southwestern Finland, whereas the roe deer population is more widely, but sparsely distributed throughout southern and central Finland (Tiainen and Rintala 2008). The post-harvest population of white-tailed deer was estimated as 30,000 in the winter of 2007-2008 and has been increasing steadily (Fig. 1); white-tailed deer are also expanding their distribution. The population of roe deer (15,000 in winter 2004-2005) and other cervids are relatively stable (Hunters Central Organization, unpubl. data). The population of wild forest reindeer was approximately 2,000 in 2007 and is distributed in two subpopulations, one in central Finland and the other in eastern Finland (Bisi and Härkönen 2007). Fallow deer are few in number (~500) and have a restricted distribution in southern Finland and are only marginal hosts for deer keds; relatively few wild forest reindeer and fallow deer are harvested (Fig. 1). Reindeer husbandry occurs north of 66° N in Finland, with approximately 200,000 animals in winter herds (Torvelainen 2007).

We conclude that moose are currently the most important host species for *L. cervi* as moose populations are relatively dense throughout Finland (see Pusenius et al. 2008). Balashov (1996) reported that fluctuations in abundances of deer ked in northwestern Russia were connected to the densities of local moose populations. Similarly, we suggest that the rapid range expansion of *L. cervi* in the 1970-1990s in Finland (see Reunala et al. 2008) coincided well with an increase of the moose population. To our knowledge, this hypothesis of occurrence of *L. cervi* in relation to the spatial and temporal moose densities in Finland has not been tested scientifically. It is also possible that the range expansion of *L. cervi*, especially in northern Finland, will be promoted by high densities of semi-domesticated reindeer. Simultaneously, prevailing indications of climate change may also promote the range expansion and life history of *L. cervi* (L. Härkönen et al., University of Oulu, unpubl. data). In light of the above, we suggest that the number of people with dermatitis caused by *L. cervi* and requiring medical treatment will continue to increase in Finland.

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