DEER KED, AN ECTOPARASITE OF MOOSE IN FINLAND: A BRIEF REVIEW OF ITS BIOLOGY AND INVASION

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ABSTRACT: The deer ked (*Lipoptena cervi*) is an important ectoparasite of moose (*Alces alces*) that has rapidly invaded Finland during the last 50 years, and is currently found in southern parts of Finnish Lapland. We have studied the invasion, behavior, and ecology of this parasitic fly, and in this paper briefly review the effect of climate on the distribution of deer keds and our recent findings from host-choice experiments. The rapid increase of the deer ked is correlated with high moose densities in Finland. We propose that the availability of suitable hosts, not climate, is the primary factor affecting its northward range expansion. Our host-choice experiments indicated that deer keds are attracted by movement and large, dark objects. Our results suggest that this parasite may continue to spread northwards in the near future, and that its potential impact on cervids and human health warrants attention.

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The deer ked (*Lipoptena cervi*) is a blood-sucking ectoparasite of cervids especially moose (*Alces alces*). The deer ked has a fairly extensive area of distribution including Europe, some parts of Siberia, northern China, and Algeria in northern Africa, and it has been introduced into North America (see Maa 1969, Dehio et al. 2004). It is assumed that the deer ked spread to Finland from Russia in the 1960s, and since then, has rapidly spread northward from southeastern Finland (Fig. 1) (Hackman et al. 1983, Reunala et al. 2008). In Central Europe and parts of Scandinavia the deer ked parasitizes red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and, with a low prevalence, white-tailed deer (*Odocoileus virginianus*) (Haarløv 1964). The deer ked is also found in low numbers on wild forest reindeer (*Rangifer tarandus fennicus*) and occasionally on semi-domestic reindeer (*Rangifer tarandus tarandus*) (Kettle and Utsi 1955, Kaunisto et al. 2009). In Finland, the rapid invasion of the deer ked has been associated with the increase of moose density during the last 40 years.

Moose were regarded as almost extinct in Finland during the 1930s and until the Second World War. They were still threatened until the 1950s despite a slow recovery of their population. Due to hunting regulations and changes in Finnish forestry management, the population harvest during the 1970s increased to 50,000 moose, with a maximum annual harvest of 69,000 in the mid 1980s and 85,000 in the early 2000s (Lavsund et al. 2003). Currently, the moose population in Finland has stabilized at about 90,000 (Pusenius et al. 2008). We think that this may be the strongest single factor that enabled the rapid spread and increase of the deer ked. Despite high

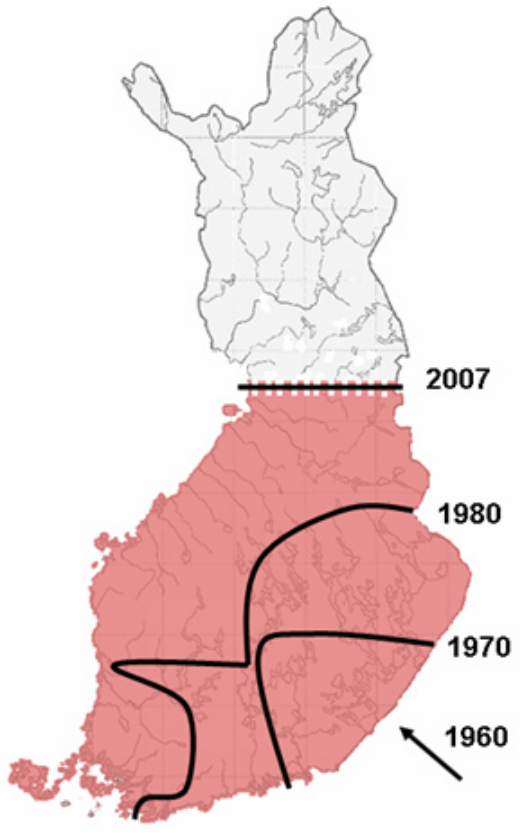

Fig. 1. The current distribution of the deer ked (*Lipoptena cervi*) in Finland according to the distribution records courtesy of the Zoological Museum of the University of Oulu. Sporadic observations occur 50-100 km above the current distribution area. In 50 years the deer ked expanded its range almost 1,000 km northward. The earliest records were from the southeastern corner of Finland in 1960, suggesting spread from the Russian side (Hackman 1977). The distribution in 1970 is based on a report by Hackman (1977), whereas the distribution in 1980 is based on Hackman et al. (1983).

local abundances of the deer ked in Finland and high relative abundances in central and eastern Europe, our current knowledge of its biology is limited.

In the boreal areas of Finland, adult deer keds emerge synchronously and seek hosts from late summer to the end of autumn (Hackman 1977). Almost immediately after finding a suitable host, usually moose, both males and females drop their wings and begin to suck blood from the host (Hackman et al. 1983). The adults spend their entire lives on the same host. Deer ked larvae develop inside the blood-sucking female that produces one pupa at a time; thus, the female gives birth to a single pupa. At birth, the whitish pupa turns dark during the rapid chitinization and drops to the ground vegetation layer or snow where over-wintering and development takes place (see review in Haarløv 1964).

Our research group has experimentally investigated whether the distribution of the deer ked is affected by climate and if it could potentially spread northward in Finnish Lapland from its current range in the most southerly areas of reindeer husbandry (Fig. 1). Our results show that, although pupal hatching success decreases strongly with latitude, the deer ked has the potential to spread further north and reach the northern areas of Scandinavia up to the Arctic circle. Even in the high Arctic regions, some deer ked pupae could develop successfully (Härkönen et al. 2009). In spring the pupae may survive at temperatures of -15° C and higher, but do not survive short periods of -20° C or below. Even during extremely severe winter conditions, pupae may survive under the snow where temperatures are greatly moderated. Thus, winter climate may not be the critical factor that regulates distribution of deer keds. We suggest that the northward spread of the deer ked will depend on the availability of suitable hosts for reproduction. Even without new potential host species such as reindeer, the deer ked may be capable of expanding its range further north by depending only on moose, its major Finnish host. This assumption is based on the fact that moose are notably numerous in the southern part of Finnish Lapland (Pusenius et al. 2008).

Dispersal of the deer ked has been rapid in Finland and its distribution has expanded, and related problems have increased for humans and domestic animals (e.g., horses and semi-domesticated reindeer). Controlled

experimental infections demonstrated that deer keds can lower the physical condition of semi-domesticated reindeer and cause short-term histological, physiological, and behavioral changes (S. Kynkäänniemi et al., Finnish Food Safety Authority, unpubl. data). The effects of deer keds on moose are unknown, but deer keds can be extremely numerous on host moose and during the flying period. For example, up to 17,000 deer keds have been reported on a single moose (T. Paakkonen et al., University of Joensuu, unpubl. data). Deer keds also cause major inconvenience, nuisance, and possible health threats for humans. Although it has not been reported to reproduce after feeding on humans, their bites can cause serious health problems and symptoms, including chronic deer ked dermatitis (Rantanen et al. 1982, Reunala et al. 2008) and occupational allergic rhinoconjunctivitis (Laukkanen et al. 2005). It may also act as a vector for other diseases (Ivanov 1974, Rantanen et al. 1982, Dehio et al. 2004).

Our host-choice experiments (Kortet et al. 2009) have revealed that the deer ked may use relatively simple cues for host choice (Alekseev 1985). They are attracted by movement and to large sized, dark colored objects. Studying host choice in the natural environment is challenging, but we have managed to explore this topic using volunteer human subjects. Because this parasite also causes harm to humans (Rantanen et al. 1982, Reunala et al. 2008), more studies are needed to determine how attacks can be avoided, for example, by type and color of clothing.

Based on our recent studies, the colder and shorter growing season in northern Finland may not constrain deer ked invasion. In northern Finland, the densities of suitable (i.e., moose) and potential host species (i.e., semi-domesticated reindeer) are relatively high. As a result, the deer ked will likely continue spreading its range into new areas. Continued research of the deer ked is warranted because of its potential negative impacts on wild and semi-domesticated cervids and human health.

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REFERENCES

Alekseev, E. A. 1985. Initial experience with individual human protection from attack by the deer louse fly *Lipoptena cervi*. Medicinskaa Parazitologia (Mosk.) 6: 56-57.

Dehio, C., U. Sauder, and R. Hiestand. 2004. Isolation of *Bartonella schoenbuchensis* from *Lipoptena cervi*, a blood-sucking arthropod causing deer ked dermatitis. Journal of Clinical Microbiology 42: 5320-5323.

Haarløv, N. 1964. Life cycle and distribution pattern of *Lipoptena Cervi* (L.) (Dipt., Hippobosc.) on Danish deer. Oikos 15: 93-129.

Hackman, W. 1977. Hirven täikärpänen ja sen levittäytyminen Suomeen. (A parasitic lousefly of moose and its spread in Finland). Luonnon Tutkija 81: 75-77 (in Finnish).

_____, T. Rantanen, and P. Vuojolahti. 1983. Immigration of *Lipoptena cervi* (Diptera, Hippoboscidae) in Finland, with notes on its biology and medical significance. Notulae Entomologicae 63: 53-59.

Härkönen, L., S. Härkönen, A. Kaitala, S. Kaunisto, R. Kortet, S. Laaksonen, and H. Ylönen. 2009. Predicting range expansion of an ectoparasite – the effect of summer temperatures on deer ked (Lipoptena cervi, Diptera: Hippoboscidae) performance along a latitudinal gradient. Ecography, in press.

Ivanov, V. I. 1975. Anthropophilia of deer

blood sucker *Lipoptena cervi* L. (Diptera, Hibboboscidae). Medicinskaa Parazitologia (Mosk.) 44: 491-495.

KAUNISTO, S., R. KORTET, L. HÄRKÖNEN, S. HÄRKÖNEN, H. YLÖNEN, and S. LAAKSONEN. 2009. New bedding site examination-based method to analyse deer ked (*Lipoptena cervi*) infection in cervids. Parasitology Research 104: 919-925.

KETTLE, D. S., and M. N. P. UTSI. 1955. *Hypoderma diana* (Diptera, Oestridae) and *Lipoptena cervi* (Diptera, Hippoboscidae) as parasites of reindeer (*Rangifer tarandus*) in Scotland with notes on the second stage larva of *Hypoderma Diana*. Parasitology 45: 116-120.

KORTET, R., L. HÄRKÖNEN, P. HOKKANEN, S. HÄRKÖNEN, A. KAITALA, S. KAUNISTO, S. LAAKSONEN, J. KEKÄLÄINEN, and H. YLÖNEN. 2009. Experiments on the ectoparasitic deer ked that often attacks humans; preferences for body parts, colour and temperature. Bulletin of Entomological Research, in press.

LAUKKANEN, A., P. RUOPPI, and S. MÄKINEN-KILJUNEN. 2005. Deer ked-induced occupational allergic rhinoconjunctivitis. Annals of Allergy, Asthma and Immunology 94: 604-608.

LAVSUND, S., T. NYGRÉN, and E. J. SOLBERG. 2003. Status of moose populations and challenges to moose management in Fennoscandia. Alces 39: 109-130.

MAA, T. C. 1969. A revised checklist and concise host index of Hippoboscidae (Diptera). Pacific Insects Monographs 20: 261-299.

PUSENIUS, J., M. PESONEN, R. TYKKYLÄINEN, M. WALLÉN, and A. HUITTINEN. 2008. Hirvikannan koko ja vasatuotto 2006. (Moose population size and calf production in 2006). Pages 7-14 *in* M. Wikman, editor. Riistakannat 2007: riistaseurantojen tulokset (Game populations 2007: results of game monitoring). Riista- ja kalatalouden tutkimuslaitoksen selvityksiä 5/2008. (In Finnish).

RANTANEN, T., T. REUNALA, P. VUOJOLAHTI, and W. HACKMAN. 1982. Persistent pruritic papules from deer ked bites. Acta Dermatol Venereologica 62: 307-311.

REUNALA, T., M. LAINE, M. VORNANEN, and S. HÄRKÖNEN. 2008. Hirvikärpäsihottuma - maanlaajuinen riesa. (Deer ked dermatitis – a country wide nuisance). Duodecim 124: 1607-1613. (In Finnish).