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INTERACT
Stories of Arctic Science

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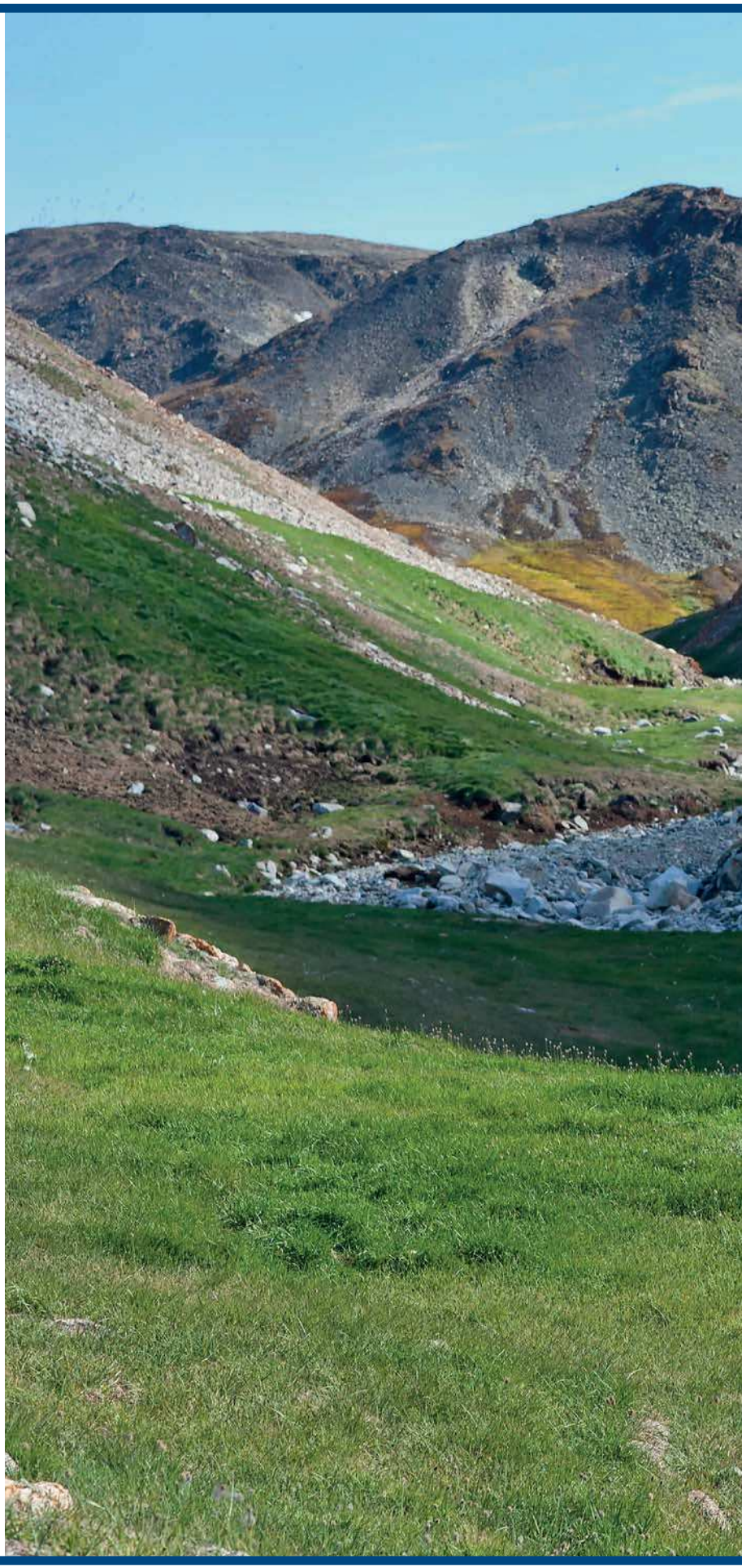
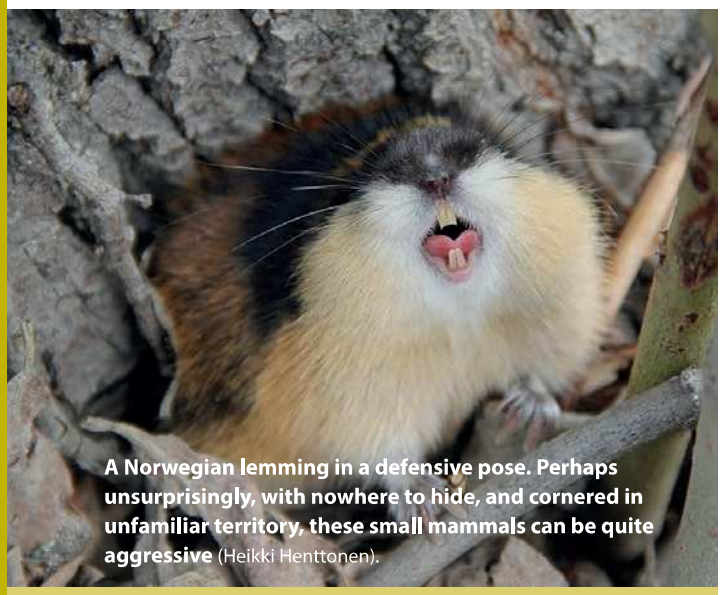


Is rodent-borne Ljungan virus responsible for mortality in migrating Norwegian lemmings *(Lemmus lemmus)*?

Heidi C. Hauffe, Cristina Fevola, Chiara Rossi, Annapaola Rizzoli, Jukka Niemimaa & Heikki Henttonen



A Norwegian lemming in a defensive pose. Perhaps unsurprisingly, with nowhere to hide, and cornered in unfamiliar territory, these small mammals can be quite aggressive (Heikki Henttonen).

In 1998, a new virus was isolated in wild populations of bank voles (Myodes glareolus) *in Sweden. The suspected pathogen was named the "Ljungan virus" (LV), after the river near the site of its discovery. Later, it was also detected in voles in the United States and Denmark, and more recently in the UK and Italy.*

Interest in LV stems from reports that this virus may be associated with human fetal death and malformations. Some authors maintain that LV should be considered a potential zoonotic agent *(i.e. a pathogen carried by wild animals that can infect and cause disease in humans), while others are distinctly more skeptical. Recent optimization and testing of a* serological technique *using LV-positive rodent samples show that humans can apparently be infected with LV, or an LV-type virus, but its ability to cause symptoms has not been definitively proven, and species-specificity has not been investigated.*

Trapping site near the Kilpisjärvi Biological Station. As the snow drifts melt, the lemmings must move quickly to find new cover and sources of food (Heidi C. Hauffe).

AIMS OF THE PROJECT

Since the bank vole and other rodents could act as reservoirs of LV, knowledge of LV's geographical and host range is necessary to assess its potential importance as a human pathogen and to identify possible zoonotic reservoirs. On the other hand, because LV is one of the only rodent-borne viruses that causes pathologies in the rodent itself, this virus may also have an effect on rodent ecology. Consequently, knowledge of the presence and effect of LV among wild mammal species is also crucial for estimating its potential role as a rodent pathogen.

As part of the EU FP7 project EDENext (www.edenext.eu), tissue samples are currently being collected by us from rodents across the EU, and ongoing molecular and serological studies suggest that LV has a wide geographical and host distribution, including species that live in close contact with humans (e.g. house mice). However, at the time of the INTERACT Transnational access Call in 2010, the role of LV in lemmings and in lemming cycles had not been examined. Norwegian lemmings (*Lemmus lemmus*) are typical rodents of the alpine mountain regions of Fennoscandia (Norway, Sweden and Finland), and their numbers show extreme fluctuations. When the snow melts in the spring, lemmings must move to find new habitat; these movements become longer distance "migrations" at high densities (Henttonen and Kaikusalo 1993). In contrast, autumn migration is density dependent, and due mainly to social factors. Migrating lemmings can easily be spotted running in all directions, and during particularly high peaks thousands of corpses litter the landscape and roads. At these very high densities, migrating lemmings can be seen for several months.

One factor that may affect the survival of these individuals at such high densities is pathogens. Therefore, since LV was known to have a greater effect on stressed individuals, and migrating lemmings are under considerable stress, this project aimed at studying whether LV is responsible for the high death rate of lemmings during these dispersal events.

WHERE DID WE WORK?

The year 2011 was a particularly fortuitous year to study this phenomenon, since a strong cycle (with a high lemming density) was predicted. Therefore, we visited the Kilpisjärvi Biological Station (•12) in Finnish Lapland to participate in the annual trapping of small mammals during the peak of the

A Norwegian lemming *(Lemmus lemmus)*, intent on finding new habitat (Helena C. Olandi).

A Norwegian lemming *(Lemmus lemmus)* resting among the tangled twigs of the forest floor during his exhausting quest to find food and shelter after the snow melt (Annapaola Rizzoli).

lemming migration in May 2011 in order to collect samples for screening LV. We chose the Kilpisjärvi Biological Station because annual trapping of small mammals has been carried out there for many decades; therefore, we were confident that we would successfully trap enough individuals for our study.

WHAT DID WE DO?

Over the six days of trapping at the station, we trapped over 100 lemmings: 72 of these individuals were dissected, and liver samples were couriered on dry ice to the Fondazione E. Mach in Italy for molecular screening of LV (i.e. we used genetic methods to detect whether LV was present in liver tissue). In addition, lemming samples collected at Kilpisjärvi from June and September 2011 were added to the screening, as well as samples from other small mammal species from another long-term trapping area at Pallasjärvi trapped in the same year.

WHAT DID WE FIND?

Our laboratory analyses showed that only two out of 122 Norwegian lemmings at Kilpisjärvi were positive for LV, both of these trapped after the spring migration in the summer and autumn of 2011. Therefore, it seems unlikely that LV is responsible for the mortality of lemmings at high densities. However, our investigations are ongoing, and we are currently screening lemmings caught before the peak and found dead during the peak to make sure we have the full story. Interestingly, however, we also found that LV infects most vole species in the rodent community, including the bank vole (5 out of 21 LV-positive); the field vole (*Microtus agrestis*: 4 of 29 LV-positive); the northern red-backed vole (*Myodes rutilus*: 2 of 15 LV-positive); and the grey-sided vole (*M. rufocanus*; 1 of 23 LV-positive), as well as another lemming species (wood lemming, *Myopus schistocolor*: 3 of 12 LV-positive), confirming our wider studies that the bank vole is probably the main reservoir of LV. Also, for the first time, we detected LV in the tundra vole (*M. oeconomus*: 1 of 6 LV-positive).

WHY ARE THE RESULTS IMPORTANT?

Although the role of LV in lemming cycles seems improbable, the samples collected during this field trip have added to our knowledge of the geographical and host distribution of LV. The samples will also be used for further studies on the virus, including estimates of genetic variability, which are essential for the future development of a vaccine, should this prove necessary.

THE ADVENTURE

The opportunity to work at the Kilpisjärvi Biological Station could not have come at a better time for consolidating our collaboration with experienced Finnish researchers and ensuring completion of a critical joint project only possible where there are Arctic rodent populations. The Station was exceptionally clean and well-organized, and the efficient and enthusiastic staff made sure we lost no time in settling in, so that we were out trapping on the very first day. On a personal level, to experience first hand the extraordinary beauty and biodiversity at the "top of the world" was a dream of a lifetime.

Further information

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Greene McDonald, A. 2009. Ljungan virus: an emerging zoonosis? Clinical Microbiology Newsletter 31:177-82.
Henttonen, H. and Kaikusalo, A. 1993. Lemming movements. In: Stenseth, N.C. and Ims, R.A. (eds), The Biology of Lemmings. Academic Press for the Linnean Society of London, pp 157-186.
Niklasson, B., Nyholm, E., Feinstein, R.E. and others 2006. Diabetes and myocarditis in voles and lemmings at cyclic peak densities-induced by Ljungan virus? Oecologia 150: 1-7.
Samsioe, A., Papadogiannakis, N., Hultman, T. and others 2009. Ljungan virus present in intrauterine fetal death diagnosed by both immunohistochemistry and PCR. Birth Defects Research (Part A) 85:227-9. Catalogued as manuscript EDENext272.