



When science fiction meets science fact

POSSIBLE THREATS FROM THE DEFROSTING PERMAFROST

BY MARIE ROSENTHAL, MS

Laboratories freeze organisms to preserve them for long periods. Nature preserves them in the permafrost of the Arctic. As temperatures rise and the permafrost melts, animals and people could be exposed to new organisms—either ones that they have never encountered before or that are quite different from the modern versions of these pathogens.

And make no mistake, the permafrost is melting: In the past 70 years, temperature monitoring in the Western Canadian Arctic has seen

an almost 3°C (5.4°F) increase—observed, not projected, explained **Emily Jenkins**, PhD, DVM, a professor in the Department of Veterinary Microbiology at the University of Saskatchewan, in Saskatoon. Scientists predict 6% to 24% of Alaska's permafrost will melt by 2100.

The possibility that infections could arise from exposure to defrosting organisms does not come from the pages of a 1950s sci-fi comic book but from scientific research. So far, several ancient viruses,

including *Pithovirus sibericum* and *Mollivirus sibericum*, both isolated from the same 30,000-year-old permafrost sample (*Proc Natl Acad Sci U S A* 2015;112[38]:E5327-35), as well as roundworms that are 46,000 years old, have been found. In addition, scientists reconstructed the 1918 H1N1 pandemic influenza variant that caused the Spanish flu from bodies that had been interred in the tundra (bit.ly/3EqGzgD-IDSE).

What parasites, bacteria, fungi or viruses might lurk in the remains of

an extinct prehistoric person or in the carcasses of long-dead animals?

"Nature's deep freeze of permafrost is certainly something that works well to conserve carcasses of animals, as well as human bodies," Dr. Jenkins said during IDWeek 2024. "[The permafrost is] cryoprotectant of these pathogens. To know what might be in our future, we need to look to the past at what's in nature's deep freeze."

As the permafrost thaws, cubic tons of organic material "about which we know very little" are being exposed. Although the probability is small that the next pandemic pathogen will spontaneously emerge from the permafrost, "if it does, it could have high consequences," said Dr. Jenkins, who is also the head of the Zoonotic Parasite Research Unit, graduate chair of the Department of Veterinary Microbiology and colead of the USask One Health Signature Area.

In 2019, the Volkswagen Foundation sponsored an event in Hanover, Germany, where experts discussed the likelihood that a pandemic pathogen might emerge from melting permafrost (nap.nationalacademies.org/catalog/25887/). The consensus was the probability was fairly low, but not zero. Since that conference, several papers documenting spontaneous and intentional reconstruction of pathogens out of permafrost have been published. Although that does not necessarily change the odds for pandemic potential, experts can't just look to warm climates for potential threats; they

need to consider the North, too, according to **Jay C. Butler**, MD, the deputy director of Infectious Diseases at the CDC. (Dr. Butler spoke in place of **Anders Koch**, MD, PhD, of the Statens Serum Institut Faculty, in Greenland, who could not attend the meeting.)

In 2016, before the Hanover conference, a heat wave in the Yamal Peninsula in Siberia thawed reindeer carcasses from animals that died 75 years ago. Seventy-two people became ill from anthrax, and one boy died. More than 2,300 reindeer, integral to the life of the ethnic Nenets people of Siberia, also died.

"In the early 20th century, anthrax was devastating to these animals and impacted humans as well," Dr. Butler said, but a veterinary vaccination program stopped the outbreaks in 1941. Within five years of ending that program, during an exceptionally warm summer, the reindeer thawed, and people and animals were exposed. The Russians reinstituted the vaccination program.

"The North is warming faster than other parts of the world—some [estimate] four times faster in fact," Dr. Butler said. "And that is impacting the people, the animals, the plants as well as the pathogens in that area."

Shifting Disease Patterns Also a Problem

Typically, when people think of the occurrence of emerging or reemerging infections, they look to warmer climates. "We've got this potential for the emergence of frozen microbes from the thawing



4 QUESTIONS TO CONSIDER:

Will these ancient pathogens mismatch our current host immunity?

Will our current countermeasures be effective?

How rapidly would previously isolated pathogens that may have burned out in a remote community spread globally?

What are the ethics of "de-extinction"?

permafrost, but I think it is also important to recognize that particularly for people in northern latitudes, there is the likely impact of northward migration of vectors, reservoirs and pathogens," Dr. Jenkins said.

Wildlife will be incredibly important in this scenario because they contribute to 11 of the 17