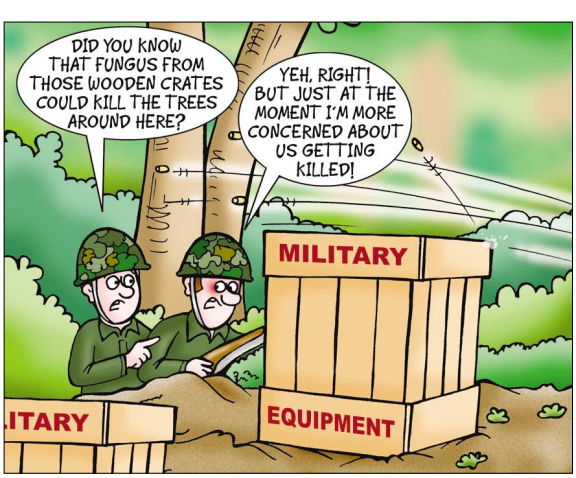
Trees become casualties of war

Now that the European Centre for Disease Prevention and Control (ECDC) is up and running in Stockholm, the new agency might like to consider a scenario that is apparently not on its agenda at the moment—the spread of pathogenic microorganisms as a consequence of warfare. Recent work in Italy and the USA has provided the best documented evidence, using modern molecular methods, for such transmission. Although this study concerned a plant rather than human pathogen, the case highlights an easily overlooked "collateral" consequence of armed conflict.

Historically, there are countless examples of communicable disease outbreaks triggered by invading armies and by the disordered social conditions created by warfare. Hans Zinsser gave the title "On the relative unimportance of generals" to one chapter in his classic *Rats, lice and history*. He did so because viruses and other pathogens have on many occasions had a greater influence than the machinations of generals on the course and outcome of military campaigns. Typhus and dysentery, for example, were Napoleon's chief opponents during his retreat from Moscow in 1812. "The homeward march became a rout", Zinsser wrote. "Diseases, especially typhus, spread through all the cities and villages of the surrounding country."

The new evidence implicates US forces in the introduction of a fungal parasite from North America into trees in Europe during World War II. The evidence is convincing—and disturbing—because it indicates that decades can elapse between the dissemination of a pathogen during times of armed conflict and the detection of its deleterious effects. Could there be as-yet undiscovered sequelae of the many battles that took place in Europe during the 20th century?

On several occasions over the past 150 years, pathogens of trees have been inadvertently carried far and wide in infected wood or saplings. Nowadays, these dangers are minimised by regulations and by monitoring agencies. From time to time, however, anomalies come to light. A few years ago, Paulo Gonthier and colleagues at the University of Turin in Italy were investigating the death of stone pine trees (*Pinus pinea*) in the forest of the Presidential Estate of Castelporziano near Rome. They found that the root pathogen *Heterobasidion annosum* was consistently associated with the dead and dying pines.



Gonthier's group managed to establish several pure cultures of the fungus from fertile fruiting bodies. Following DNA extraction and amplification by PCR using *H annosum*-specific primers, they discovered a mitochondrial insertion that was known to be absent from Europe but had been reported previously in North America. This finding prompted a more intensive scrutiny—sequencing of portions of the insertion and of three additional loci from seven Castelporziano and 97 *Heterobasidion* spp isolates of worldwide distribution. This sequencing was conducted in conjunction with co-workers at the University of Tuscia in Italy and the University of California at Berkeley, USA.

The outcome, reported in *Mycological Research* (2004; **108:** 467), was a clear separation between European and North American populations. But the Castelporziano isolates always clustered with *H annosum* populations infecting US pines. This and associated studies supported the hypothesis that the *Heterobasidion* spp population at Castelporziano originated from eastern North America.

But how? The Presidential Estate's forest, composed of exclusively native Italian trees and other plants, has been closed to the public for centuries. It was, however, occupied by regiments of the US 5th Army during World War II. This fact leads Gonthier and his colleagues to suggest that the fungus was introduced through crates, pallets, and other military equipment made of untreated timber from infected trees in the USA. "The short-range spread of *Heterobasidion* spp via infected wood posts has been previously documented", they write, "but this fungus is generally thought as an unlikely exotic pathogen because of the lack of resting propagules, the short life span of its airborne basidiospores, and its inability to grow in the soil."

Unlikely maybe. But the precise molecular findings presented in this paper turn otherwise purely circumstantial evidence about infected military hardware into a highly convincing case. It's a scenario for the ECDC to ponder.

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