Emergence of fungal plant diseases linked to ecological speciation

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A new commentary on the nature of pathogens is raising startling new questions about the role that fundamental science research on evolution plays in the understanding of emerging disease.

Ecological speciation, and specifically speciation that occurs when a subset of a population shifts onto a novel host, is one of the main routes for the emergence of new fungal diseases in plants, argue the authors of a new paper published online in *Trends in Ecology &* Evolution (*TREE*).

Linking emerging diseases with ecological speciation has important implications for understanding the biological mechanisms of disease and for designing more efficient and sustainable control programs, say Tatiana Giraud and Pierre Gladieux, both researchers at Universite Paris-Sud, and Sergey Gavrilets, associate director for scientific activities at the National Institute for Mathematical and Biological Synthesis and a professor at the University of Tennessee-Knoxville.

While much attention has been given toward extrinsic factors that might contribute to emerging fungal diseases, such as climate change or worldwide trade, the authors contend, intrinsic genetic changes in the pathogen itself should also be considered.

The authors point out that certain life-history features of fungal plant pathogens make them prone to rapid ecological speciation by host shifts, including strong disruptive selection caused by hosts, a large number of spores produced by pathogens, mating within hosts, a small number of

genes underlying the specificity of host-pathogen interactions, and frequent asexual reproduction with rare occurrences of sexual recombination.

Fungi account for 30 percent of emerging infectious diseases in plants. These fungal diseases can radically alter natural ecosystems as well as food and agricultural production. Examples include the chestnut blight fungus, which eliminated nearly 100 percent of native chestnut trees throughout eastern American forests during the last century, and, more currently, the Phytophthora cinnamomi fungus threatening native forests throughout Australia. Other fungal pathogens have been responsible for the epidemic leading to the Irish potato famine in the 1840s and, more currently, the stem rust disease of wheat, first identified in Uganda in 1998 and now threatening North Africa, the Middle East and Asia.

The paper's conclusions were recently cited as a part of evidence provided by the journal's editor to the House of Commons Science and Technology Committee on The Impact of Spending Cuts on Science and Scientific Research. "It's a good example of how research on an apparently esoteric area of science - speciation - can unexpectedly produce insights that potentially have social and economic importance," says Paul Craze, *TREE*'s acting editor.

"New ways of understanding the emergence of novel disease organisms are being developed by applying ideas from fundamental research on the factors influencing the origin of species (speciation)," Craze wrote in his testimony for the evidentiary sessions held in February 2010. "This has only been possible due to the large body of basic, theoretical knowledge that has been developed on speciation; it is almost impossible to imagine how a specific application to disease organisms could have been used to drive research in this area."

The conclusions could be applied to other pathogens, including

nematodes, bacteria and viruses because they share many traits with fungal plant pathogens that could cause ecological speciation by host shifts.

"If we are to fully understand emerging diseases, we recommend thinking differently about life-history traits to tailor models based on specificities of pathogens," the authors write.

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