Fungi can change quickly, pass along infectious ability

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Studies done with this fungus have challenged existing beliefs about how quickly fungi can change their genetic makeup and become infectious. (Photo courtesy of Oregon State University)

Fungi have significant potential for "horizontal" gene transfer, a new study has shown, similar to the mechanisms that allow bacteria to evolve so quickly, become resistant to antibiotics and cause other serious problems.

This discovery, to be published Thursday in the journal *Nature*, suggests that fungi have the capacity to rapidly change the make-up of their genomes and become infectious to plants and possibly animals, including humans.

They are not nearly as confined to the more gradual processes of conventional evolution as had been believed, scientists say. And this raises issues not only for crop agriculture but also human health, because fungi are much closer on the "evolutionary tree" to humans than bacteria, and consequently fungal diseases are much more difficult to treat.

The genetic mechanisms fungi use to do this are different than those often used by bacteria, but the end result can be fairly similar. The evolution of virulence in fungal strains that was once believed to be slow has now been shown to occur quickly, and may force a renewed perspective on how fungi can behave, change and transfer infectious abilities.

"Prior to this we've believed that fungi were generally confined to vertical gene transfer or conventional inheritance, a slower type of genetic change based on the interplay of DNA mutation, recombination and the effects of selection," said Michael Freitag, an assistant professor of biochemistry and biophysics at Oregon State University.

"But in this study we found fungi able to transfer an infectious capability to a different strain in a single generation," he said. "We've probably underestimated this phenomenon, and it indicates that fungal strains may become pathogenic faster than we used to think possible."

Researchers from the Center for Genome Research and Biocomputing at OSU collaborated on this study with a large international group of scientists, including principal investigators from The Broad Institute in Massachusetts, the University of Amsterdam, and the USDA Agricultural Research Service at the University of Minnesota.

Bacteria use "horizontal" genetic transfer through chromosomes and DNA plasmids to change quickly, which is one reason that antibiotic

resistance can often develop. This capability was believed to be possible, but rare, in fungi. In the new study, based on a genome-wide analysis of three Fusarium species, it was shown experimentally that complete chromosomes were being transferred between different fungal strains, along with the ability to cause infection. Various Fusarium fungi can infect both plants and humans.

In humans, fungal infections are less common than those caused by bacteria, but can be stubborn and difficult to treat - in part, because fungi are far more closely related to animals, including humans, than are bacteria. That limits the types of medical treatments that can be used against them. Fungal infections are also a serious problem in people with compromised immune systems, including AIDS patients, and can be fatal.

According to Freitag, this new understanding of fungal genetics and evolution is great news.

For one thing, it may help researchers to better understand the types of fungal strains that are most apt to develop resistance to fungicides, and help crop scientists develop approaches to minimize that problem.

Fungal diseases are a major problem in crop agriculture, and billions of dollars are spent around the world every year to combat new and emerging fungal pathogens in plants, animals and humans.

On a more basic level, this study provides evidence that the "tree of life," with one trunk and many branches, is outdated. It should be replaced by a "network of life" in which many horizontal connections occur between different species.

Provided by Oregon State University