# Evolution mystery: Spider venom and bacteria share same toxin

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It's a case of evolutionary detective work. Biology researchers at Lewis & Clark College and the University of Arizona have found evidence for an ancient transfer of a toxin between ancestors of two very dissimilar organisms--spiders and a bacterium. But the mystery remains as how the toxin passed between the two organisms. Their research is published this month in the journal Bioinformatics in an article titled "Lateral gene transfer of a dermonecrotic toxin between spiders and bacteria."

"We are piecing together an historical puzzle with evidence from living descendants of an ancient ancestor," said Greta Binford, assistant professor of biology at Lewis & Clark. Her coresearcher on the project is Matthew Cordes, assistant professor of biochemistry and molecular biophysics at the University of Arizona. The toxin is uniquely found in the venom cocktail of brown or violin spiders, including the brown recluse, and in some Corynebacteria. The toxin from the spider's venom can kill flesh at the bite site; the bacterium causes various illnesses in farm animals.

"Our research was inspired by the fact that we have a group of spiders with a unique toxin, and that toxin also happens to exist outside the animal kingdom in this particular bacterium," she added. "A pattern like this raises the possibility of lateral gene transfer as a explanation." Lateral gene transfer refers to the movement of genes between the genomes of unrelated organisms. This contrasts with vertical transfer of genes from parent to offspring.

Cordes and Binford found a common structural motif at the end of both toxic proteins that is not found in any other proteins. Evidence for common ancestry (homology) of the toxins had previously been noted, but this uniquely shared structural bit is best explained by these toxins being more closely related to each other than they are to any other known protein.

"That one structural detail--which resembles a plug or cork at the end of a barrel-shaped enzyme--is evidence that the spider and bacterium share a relatively recent common ancestor," Cordes said. "Aside from being an example of lateral transfer between very distantly related organisms, this study is an unusual example of using structural motifs in proteins to answer questions about common ancestry when gene sequences are too different to be clear about these relationships."

"We're still left with the question of whether this venom enzyme hopped species from the spider to the bacteria, or the other way around. Either way, the presence of this medically-relevant toxin in one of these groups of organisms is likely the result of transfer from the other lineage," Binford said. "Understanding the importance of this structural motif in the toxic activity may help with developing treatments that minimize the effects of bites of brown recluse and their relatives. If this motif is central to protein function, treatments designed for the spider bites may also work for treating problems caused by the corynebacterial toxin," she added.

Source: Lewis & Clark College