Research team discovers new microbe in wheat stem sawfly

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Montana State University's College of Agriculture faculty David Weaver observes wheat variations for wheat stem sawfly cutting at a study plot near Amsterdam, Mont., Friday, Sept. 13, 2019. Weaver and associate professor Carl Yeoman are co-authors in a wheat stem sawfly genome study, researching the microbial ecology of the invasive pest. Credit: Adrian Sanchez-Gonzalez

A team of researchers in Montana State University's College of Agriculture has discovered a previously unidentified microbe that lives symbiotically with the wheat stem sawfly, a pest that causes hundreds of millions of dollars in damage to wheat crops each year. The discovery, the result of a years-long project, provides the basis for future research that could be vital to combating losses due to wheat stem sawflies in Montana and beyond.

Carl Yeoman in the Department of Animal and Range Sciences and David Weaver in the Department of Land Resources and Environmental Sciences published a paper in the journal *PeerJ* in August along with a team of colleagues. The paper outlines the discovery of the microbe *Spiroplasma sp. WSS*—its name a nod to the wheat stem sawflies in which it was discovered. The project was inspired by knowledge of similar symbiotic relationships between other insects and microbes inside them.

Yeoman said wheat stem sawflies cause as much as $350 million in damage to wheat crops each year in the Northern Great Plains. The motivation for looking into those symbiotic relationships stemmed from a hypothesis that if the microbes in wheat stem sawflies could be identified and their functions determined, maybe they could be manipulated to work as a management tool for sawflies.

"Many insect species have microbial symbionts, and these relationships are often essential to the survival of both organisms," said Yeoman. "Microbial symbionts have been shown to affect everything from the reproductive success of their insect hosts to their nutrition—allowing them to survive on poor quality diets—and even their ability to defend against pathogens."

So, the team set out to determine what microbes are associated with wheat stem sawflies, and if they could be manipulated to affect the sawfly's ability to damage wheat crops.

Wheat stem sawflies are one of the more widespread wheat pests in western North America, said Weaver, damaging wheat by penetrating the stem to insert their eggs. The larvae then eat tissues lining the stem, inhibiting photosynthesis and causing lodging—weakening the stem to the point where the plant simply falls over in large swaths. The project was supported by the Montana Wheat and Barley Committee, which has long been in search of new ways to manage the pest.

"We've reported 20 percent to 30 percent reductions in seed weight as a result of sawfly feeding," said Weaver. "But if the stem falls and a combine doesn't pick it up, it goes from a 30 percent loss to a 100 percent loss of that stem. It's a pretty big problem, and it really frustrates growers."

Other members of the research team included Curtis Fowler of animal and range sciences; postdoctoral researcher Laura Brutscher and undergraduate Furkan Ibaoglu, who graduated in 2018, of the Department of Microbiology and Immunology; and Kevin Wanner of the Department of Plant Sciences and Plant Pathology, along with researchers from the University of Chicago and the Marine Biological Laboratory in Woods Hole, Mass.

The team began their study by collecting wheat stem sawflies from two locations at the larval and adult stages. They brought those back to their labs and began to examine them, where they observed three types of genomic material in their samples: wheat plant DNA, sawfly DNA and a previously undescribed species of microbe belonging to the genus Spiroplasma.

Based on elements of the microbe's genome in comparison to the sawfly genome—which was fully sequenced through another project Wanner and Weaver worked on—the team inferred that *Spiroplasma sp. WSS* might help sawflies break down sugars they eat and helping them to manufacture other nutrients they don't get from their carbohydrate-heavy diet, including key B vitamins.

"[*Spiroplasma*] plays a role in certain functions the sawfly may not be able to do as well by itself," said Weaver. "These functions are what we're trying to understand, and potentially how these things could be adapted, and the role of the symbiont truncated to be used as a potential management tool."

That method has shown potential in other research: A group of scholars working in China examined a similar system in pea aphids and found that when symbiotic microbes were inhibited with the use of antibiotics—or in another case, using scorpion venom—the fertility of the aphids fell significantly, reducing their population and the risk they posed to pea plants. It is possible that similar approaches could be used with wheat stem sawflies and the newly identified *Spiroplasma* symbiont, Weaver said.

Yeoman and Weaver plan to make future proposals to further their understanding of the role *Spiroplasma sp. WSS* plays in sawflies and other insects.

"We set out to identify the symbiotic microbes of wheat stem sawflies…so that we could begin to determine if these insect-microbial relationships could be exploited as alternate measures to control WSS damage in crops," Yeoman and Weaver concluded in their paper. "The identification of *Spiroplasma sp. WSS* and greater genetic insight into its metabolism provide a critical first step toward our pursuit of a novel biocontrol approach."

More information: Carl J. Yeoman et al. Genome-resolved insights

into a novel Spiroplasma symbiont of the Wheat Stem Sawfly (Cephus cinctus), *PeerJ* (2019). DOI: 10.7717/peerj.7548

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