New study defines life cycle of a destructive plant pathogen 142 years after its discovery

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Found in more than 60 countries, cruciferous clubroot disease is one of the most destructive plant diseases, causing so-called tumors on the roots of Brassicaceae crops and resulting in huge yield losses annually. The

causal agent of this disease, *Plasmodiophora brassicae*, was first discovered by Russian biologist M. S. Woronin in 1878. Despite this early discovery, the life history of the pathogen remains a mystery.

"Although *P. brassicae* has been identified as the causal agent of cruciferous clubroot disease for 142 years, much earlier than the discovery of most plant pathogens, we were astonished that the full life cycle of this pathogen remained unclear when we started our investigation on this plant disease in 2015," said Lijang Liu, a scientist based at the University of Saskatchewan and the Chinese Academy of Agricultural Sciences. "The limited knowledge of *P. brassicae* biology greatly hinders the progress of studies on the cruciferous clubroot disease, which drove us to conduct this research."

The life history of the pathogen is very complex, comprising many different life forms. Liu and colleagues clarified the life history of *P. brassicae* in the root tissues of host Arabidopsis in a recently published article.

"Using confocal and electron microscopic imaging, we provide compelling evidence to support the proposed life cycle of *P. brassicae*, making it more convincing and acceptable to the community," explained Liu. "Notably, and most surprisingly, we discovered the existence of a sexual life stage of *P. brassicae*, starting from the fusion of two secondary zoospores within the infected epidermal cells."

Their other major findings include defining the development of zoosporangia and secondary zoospores and the sexual behavior between secondary zoospores in root epidermal cells and elucidating the growth and development of secondary plasmodia in root cortical cells, as well as the resultant physiological disturbances to host cortical cells.

"This research provides a fundamental understanding of the pathogen's

biology as well as its cellular interactions with host plants. The knowledge gained from this investigation may further illuminate cellular mechanisms underlying host resistance and susceptibility and offers insights into the management practices against clubroot disease," said Liu. "Our article will help readers understand how such a lower eukaryotic microorganism performs a complex and sophisticated life history, giving a rise to a 'tumor' disease on plant roots."

Their article also highlights microscopic techniques coupled with live microbial fluorescence staining, which can be widely used in studying host-pathogen interactions.

More information: Lijiang Liu et al, Refining the Life Cycle of Plasmodiophora brassicae, *Phytopathology* (2020). DOI: 10.1094/PHYTO-02-20-0029-R

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