Plant Nutrient Stealers

CAS/MPG Partner Group on Parasitic Plant Physiology and Ecology

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The stem parasitic plant dodder, *Cuscuta australis*, growing on its host plant soybean (*Glycine max*).

Photos/Images: By courtesy of Prof. WU Jianqiang

Parasitic plants comprise about 1% of the angiosperm plants, and they steal nutrients and other molecules from their hosts. Compared with fully autotrophic plants, parasitic plants are distinct in their physiology, ecology, and evolution. However, still little is known about the evolutionary origins of plant parasitism and the molecular mechanism underlying the parasitic lifestyle. The plants in the genus *Cuscuta* (dodders) are obligate parasitic plants, which draw nutrients and other molecules from the shoots of host plants using a special organ, named haustorium. The genus *Cuscuta* consists of about 150 species that occur in all continents.

The Partner Group on Parasitic Plant Physiology and Ecology was just founded in October 2013, establishing collaboration between the Max Planck Institute for Chemical Ecology (Jena, Germany) and the Kunming Institute of Botany, CAS (Kunming, China). The Partner Group is using molecular biological, analytical chemical, bioinformatic, and ecological approaches to study the stem parasitic plants, *Cuscuta* spp., on the aspects of their distinct physiology, behavior, ecology, and evolution.

Reported by Group Leader WU Jianqiang

Profs. Ian T. Baldwin (left) and WU Jianqiang (right) in 2013. The Partner Group program under their leadership aims to study the unique physiology, ecology, and evolution of the parasitic plants, *Cuscuta* spp.

RESEARCH STATUS AND FUTURE PLANS

The new head of the MPS/CAS Partner Group at the Kunming Institute of Botany (KIB), CAS, Prof. WU Jianqiang used to be a Ph.D. student and a Group Leader in the Department of Molecular Ecology (headed by Prof. Ian T. Baldwin), Max Planck Institute for Chemical Ecology (MPICE). He spent more than ten years (2001-2012) working with Prof. Baldwin on how plants interact with insects, especially in the area of signal transduction. In April 2012, Dr. WU returned to China and started his research group at the KIB. In addition to continuing working on plant-insect interactions, his group is also investigating the molecular mechanism of *Cuscuta* parasitism and its ecology and evolution, in close collaboration with the partners from the MPICE.

1. Foraging behavior of *Cuscuta* seedlings and tendrils

Dodder seedlings are rootless, cotyledonless, and thread-like. After germination, they must find proper hosts within a few days before they die from nutrient deficiency. Adult dodders also extend their tendrils to other parts of the hosts or even neighboring plants to form more connections.

To study how *Cuscuta* seedlings and tendrils locate hosts, an image capture and analysis system has been set up to record and analyze the behavior of dodders, and synthetic chemical cues, genetically modified plants emitting different volatile compounds and light signal systems (providing red and far-red light) will be used to investigate which signals dodders perceive to locate the hosts. Using RNA-seq and bioinformatic analysis, genes involved in host recognition will be identified to gain insight into the molecular mechanism underlying dodder foraging behavior.

2. Using transcriptome analyses to study the physiology of *Cuscuta*

Different organs of *Cuscuta* have been collected at each developmental stages, *i.e*. seedlings, prehaustoria, haustoria, stems, flower buds, flowers, seed capsules and seeds; the extracted RNA samples were used for cDNA library construction, and Illumina RNA-seq was done for obtaining the transcriptomes of these samples. A large and comprehensive transcriptome database, including data from these organs and developmental stages, has been completed for further in-depth analyses.

In the future, the transcriptome of dodder seedlings will be compared with that of Arabidopsis or tomato seedlings to gain insight into the genetic basis for its unique morphological and physiological characteristics. Moreover, the analysis of haustorium transcriptome will be one of the major focuses, since haustorium is the organ that is unique to parasitic plants, in order to reveal

Prof. WU Jianqiang (far right back row) and members of the Partner Group at the Kunming Institute of Botany, CAS.

the mechanism of haustorium development.

3. The molecular mechanism underlying *Cuscuta* defense against insect herbivores

Like all other plants, dodders are also attacked by insects. Phytohormone and transcriptome responses of dodders to aphid and wounding treatment will be analyzed to understand how dodders use hormone signaling and transcriptome changes to cope with insect feeding. Furthermore, large-scale metabolic analyses will be used to identify metabolites that are involved in insect resistance.

Using a recently developed host-mediated RNAi (RNA interference) approach, the function of important candidate genes will be studied. Furthermore, small molecules in host plants can be transported to *Cuscuta* through the haustorium connections and may play a role in insect resistance. Genetically modified host (such as Arabidopsis and tobacco) whose contents of specific metabolites are altered will be used to examine whether host metabolites are translocated to dodders for defense purposes.

Although being newly established, this Partner Group program has begun to reveal the unique physiology, ecology, and evolution of parasitic plants. From 2014 on, scientists from the Partner Group at KIB will visit MPICE for further training in ecology, metabolomics, and genomics and for using the well-established bioinformatic and chemical analysis platforms; scientists from MPICE will also visit KIB to explore further collaboration opportunities. In 2014, a symposium on plant-insect and plant-plant interactions will be held at KIB, and more than eight scientists from MPICE and all members of the Partner Group at the KIB will participate in this symposium. ◀

INFO

MPS/CAS Partner Group on Parasitic Plant Physiology and Ecology

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