Life Sciences

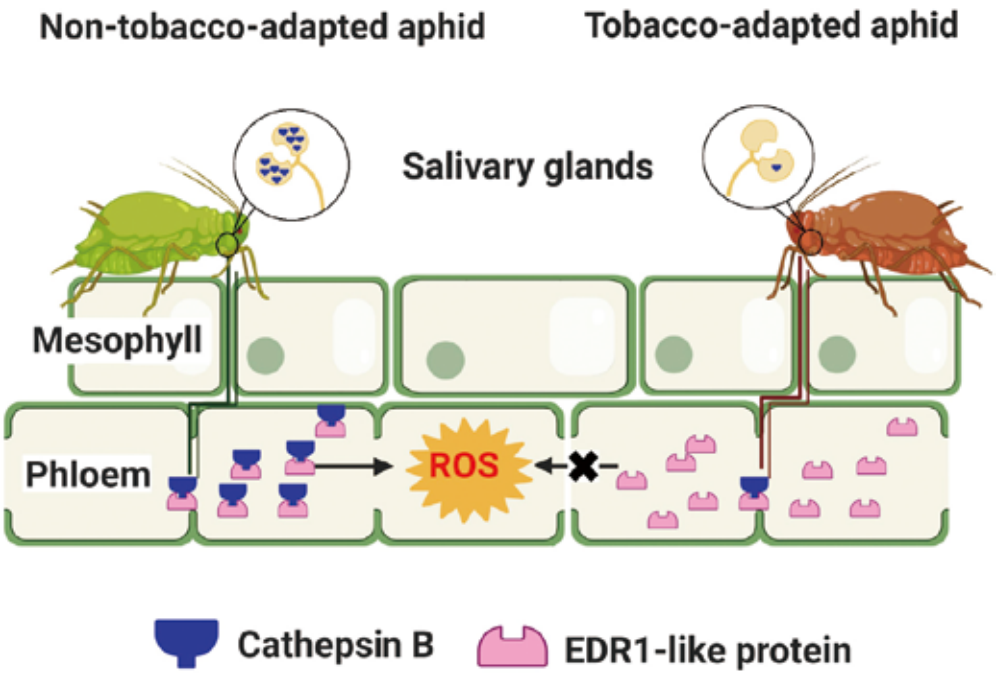
An Aphid-secreted Salivary Protease Activates Plant Defense in Phloem

Scientists from the CAS Institute of Zoology (IOZ) and CAS center for Excellence in Biotic Interactions have discovered that tobacco plants can recognize a potential elicitor protein cathepsin B3 (CathB3) in aphid saliva, and suppress aphid feeding by triggering ROS accumulation in phloem. This study was recently online published in *Current Biology*.

The green peach aphid *Myzus persicae*, an extremely important insect pest of many crops worldwide, has been reported to colonize hundreds of plant species, including members of 40 different families. *M. persicae* includes a variety of host plant-associated lineages, which differ in fecundity and survival rate when reared on specific host plant species. The tobacco-adapted (TA) *M. persicae* lineage performs well when feeding on tobacco plants, whereas non-tobacco-adapted (NTA) aphid lineages perform poorly. The molecular mechanisms underlying different host plant-associated lineages of *M. persicae* manipulate the chemical induced defenses of host plants are generally poorly understood.

"Since *M. persicae* lineages differ in their feeding efficiency and population fitness on tobacco plants, it is reasonable to speculate that some types of salivary component-triggered plant resistance could be lineage-specific," said SUN Yucheng, one of the corresponding authors of this research article.

To figure this out, a research team, jointly led by GE Feng and SUN Yucheng, screened the differentially expressed genes using transcriptome analysis, as well



The non-tobacco-adapted (NTA) aphid can only shortly suck the phloem due to the host plant defenses that is triggered by the abundant bindings of 'elicitor' proteins (blue) with the 'sensor' proteins (pink), while the tobacco-adapted (TA) aphid performs well when feeding on tobacco by releasing less elicitor proteins into plant tissue during feeding. (Image by IOZ)

as identified saliva-localized proteins by profiling the salivary proteome of the TA vs. NTA *M. persicae* lineages.

They found a conserved cysteine protease, namely *CathB3*, constitutively up-regulated in the salivary glands of a natural NTA *M. persicae* lineage, as compared with a TA lineage. More importantly, *CathB3* of *M. persicae* could be secreted into host plants. When *CathB3* was silenced, NTA aphids had quicker access to phloem and exhibited longer phloem feeding duration, which subsequently increased aphid growth rate and survival rate on tobacco plants. The transient expression of the full-length *CathB3* sequence in tobacco plants also confirmed that *CathB3* could suppress the phloem feeding of TA aphids, suggesting that aphid *CathB3* triggered an effective plant defense response against aphids, and attenuated the phloem feeding of NTA aphids.

They also found that *CathB3* specifically interacts with the plant EDR1-like protein, a Raf-like MAPKKK, through its propeptide domain. NtEDR1-like protein was mainly expressed in vascular tissues. To evaluate the function of EDR1-like in aphid feeding behavior, *NtEDR1-RNAi* lines with attenuated (*irEDR1*) and up-regulated (*35S::EDR1*) EDR1-like expression were generated. Aphids that fed on *35S::EDR1* plants exhibited the shortest phloem feeding duration whereas aphids that fed on *irEDR1* plants exhibited the longest phloem feeding duration, suggesting that EDR1-like mediated an effective defense of tobacco plant against aphids and reduced aphids' feeding efficiency. The RNA-seq analysis of tobacco plants revealed that EDR1-like protein was necessary for the activation of phloem ROS by plants.

During long-term co-evolution, some TA aphid lineages have developed improved phloem feeding efficiency, and have improved their fitness by releasing less *CathB3* into plant tissue during feeding, as illustrated.

These findings reveal a novel function for a cathepsin-type protease in aphid saliva that elicits effective host plant defenses, and may be useful for the development of pest control strategies that are specific for piercing-sucking insects.

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Reference

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