Insect-Bacteria-Plant Interactions: Microbiomes of Russian wheat aphid contain bacteria that increase virulence to wheat

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Phytobiomes, December 2018
Phytobiomes are complex systems

Phytobiome:
• Interactions of the environment and living organisms that influence or are influenced by plants

Bacteria associated with the Colorado potato beetle manipulate plant defenses to facilitate larval feeding.

S-H Chung et al. 2013 PNAS; 2017 Sci Reps, etc
Do microbes facilitate Russian wheat aphid virulence to plants?
Aphids use stylets to probe/feed:   
https://vimeo.com/54269766
By Kimberly Falk
Does the Russian wheat aphid saliva contain virulence effectors?

RWA Saliva Proteome

- < 1% aphid proteins
- No ‘typical’ aphid effectors
- RWA genome does not contain ‘typical’ aphid effector genes

- > 99% bacterial proteins!!!

Luna et al., 2018
Do aphid stylets harbor bacteria?

Luna et al. unpubl.
What is the role of RWA bacterial-associates in interactions with plants?

Do bacteria associated with Russian wheat aphids enhance aphid virulence to plants?

Luna et al. 2018, Phytobiomes
Aphids abducted at birth harbor fewer bacteria

Mass reared clean aphids = less bacteria

Luna et al. 2018
‘Clean’ aphids cause less damage to wheat than ‘Dirty’ aphids!

Clean aphids = less chlorosis

Luna et al. 2018
Dirty aphid microbiome: more diverse and more

*Enterobacteriaceae* and *Moraxellaceae*

- *Buchnera* dominates
- Co-fed aphid microbiome more diverse & enriched in *Enterobacteriaceae* and *Moraxellaceae*
Isolated bacteria common to aphids, saliva (diets) and infested leaves

Enterobacteriaceae

Moraxellaceae

Luna et al., 2018
Are RWA associated bacteria virulent to wheat?

- Bacteria do not cause disease symptoms (water-soaking, chlorosis, etc) or the HR when infiltrated into wheat leaves.

Luna et al. 2018
Genome sequence of six RWA-associated bacteria: *E. Iniecta* harbors genes important for host interactions

*Erwinia iniecta*: 4,854,730 bp

Whole Genome: Bacteria-host interactions
- Reduced virulence: 61%
- Loss of pathogenicity: 5%
- Unaffected pathogenicity: 18%
- Mixed outcome: 6%
- Increased virulence (Hyperirulence): 2%
- Effector (plant avirulence determinant): 2%
- Lethal: 0%
- Chemistry Target: 6%
Erwinia iniecta genome encodes secretion systems

H₀: Bacteria associated with RWA deliver effectors to plant cells to enhance aphid virulence

--Have RWA evolved to rely on bacteria for virulence?
--Do bacterial effectors induce plant SA responses, resulting in suppression of JA responses?
How do bacteria facilitate aphid virulence?

- \( H_0 \): **Bacteria** associated with Russian wheat **aphid** manipulate **plant** defenses to enhance aphid **virulence**

Clean aphids induce less SA than dirty.

Trend: less JA induction at 48 h.
Phytobiome knowledge can guide management strategies

- Should breeding programs target the bacteria rather than the insect?
- Can the leaf microbiomes be altered to protect plants from aphid feeding?
- If RWA evolved to rely on bacteria for virulence, can we identify novel resistances that detect/disrupt that process?
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