Aphids reroute one of their immune regulators to repress plant immune responses

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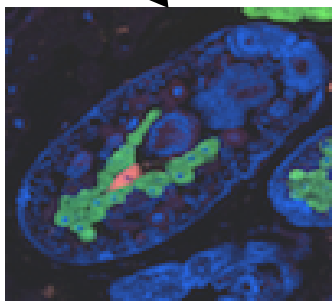
Teams : Insecte Defense/ Plant-Oomycete Interaction

Aphid- Plant interactions

Immune regulators ?

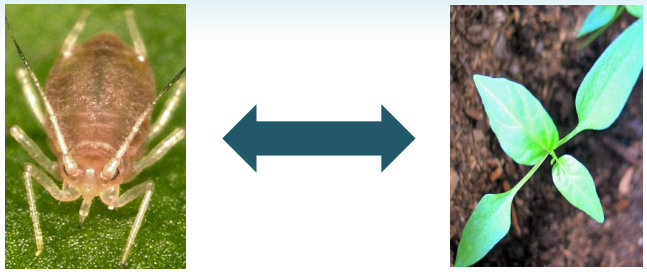
Plants

Parasitoids



Endosymbiosis

Macrophage migration inhibitory factor



Immune regulators ?

➔ **Identification of a multigenie family of cytokines.**

➔ **5 MIF genes in *Acyrthosiphon pisum* and 3 MIF genes in *Myzus persicae***

Pivotal mediator of innate immunity

Human

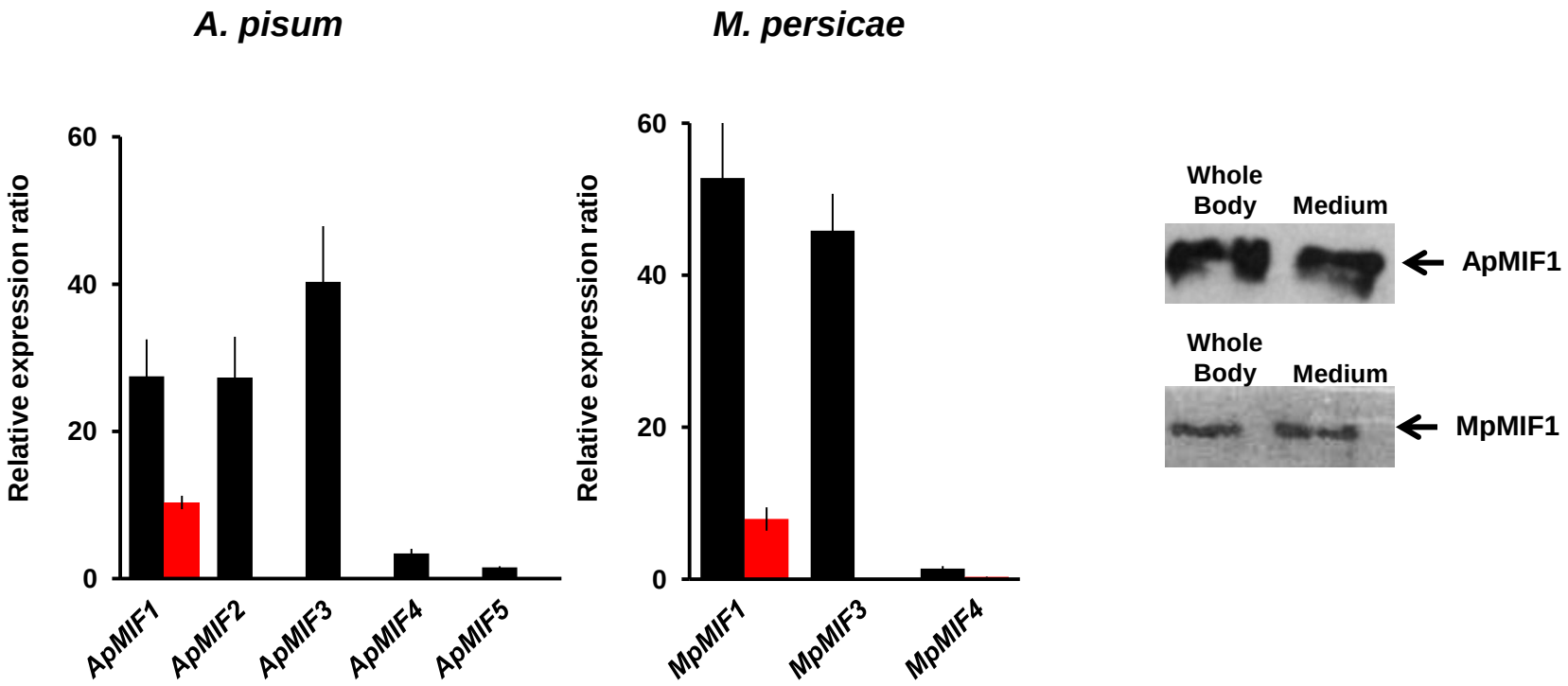
•Induces secretion of pro-inflammatory Cytokines

•Up-regulates cell-proliferation

•Down-regulates p53-dependant apoptosis

Dubreuil et al., 2014, BMC Geno.

MIF expression



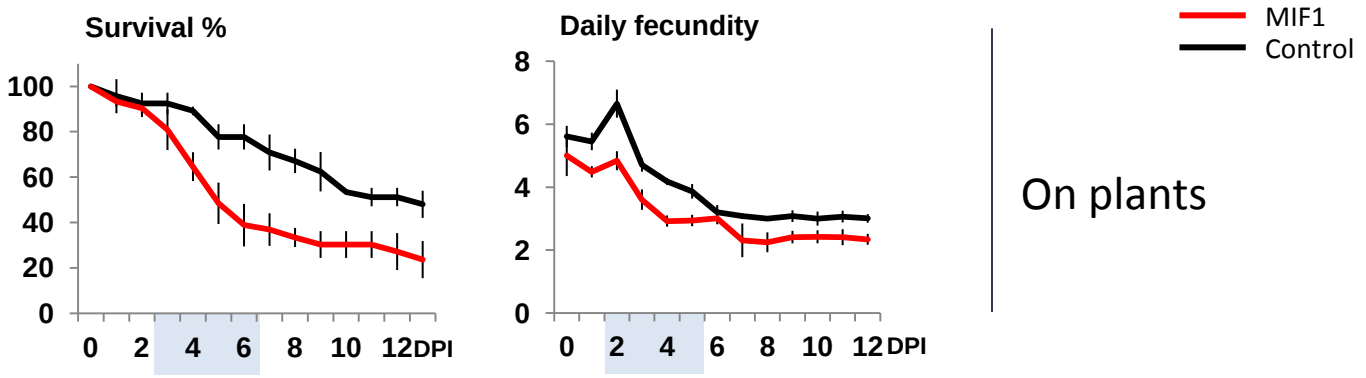
➔ MIF1 genes are also expressed in salivary glands

➔ They are secreted during feeding

Naessens et al., 2015, Curr. Biol

Are aphid MIFs involved in aphid – plant interactions?

➔ **RNAi of MIF1 affects *A. pisum* survival and fecundity on host plants**



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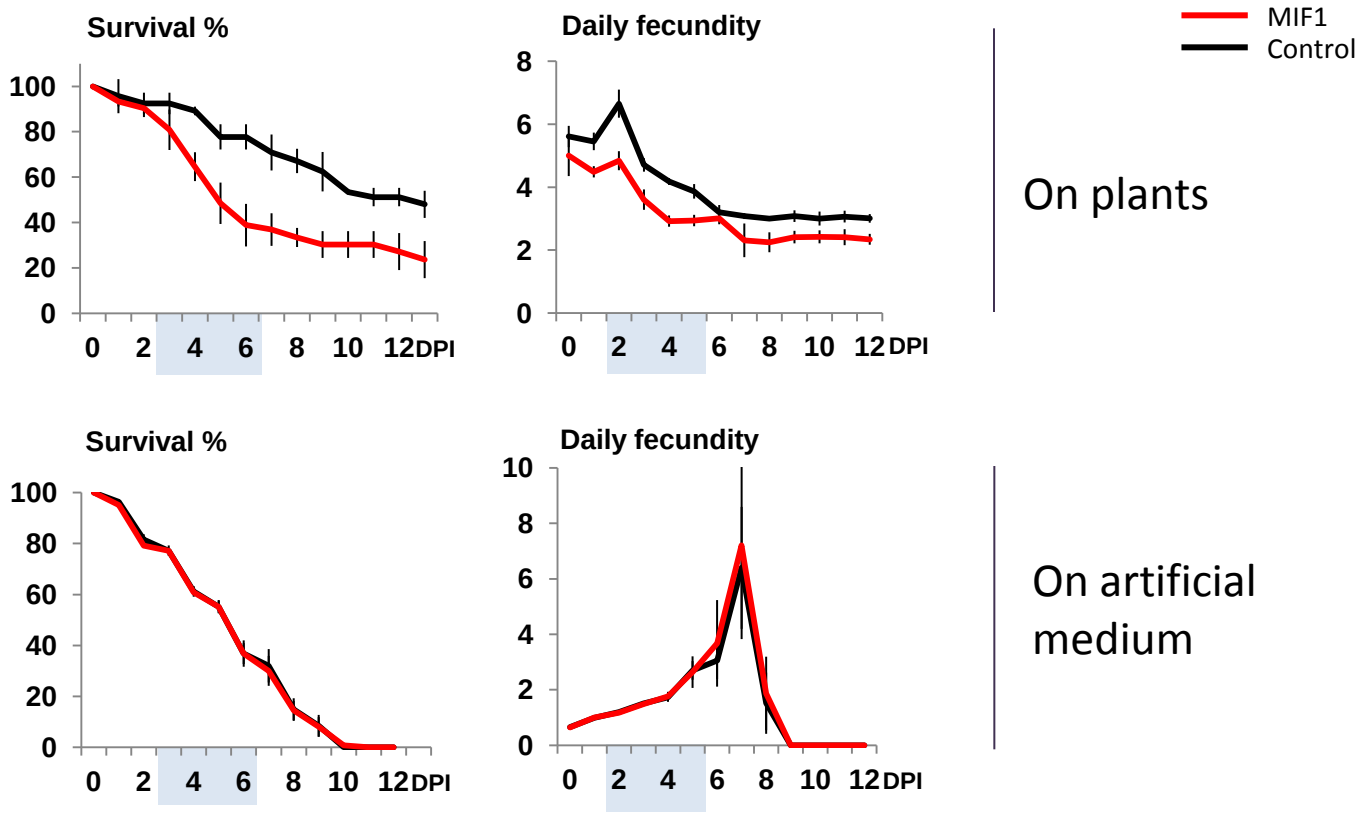
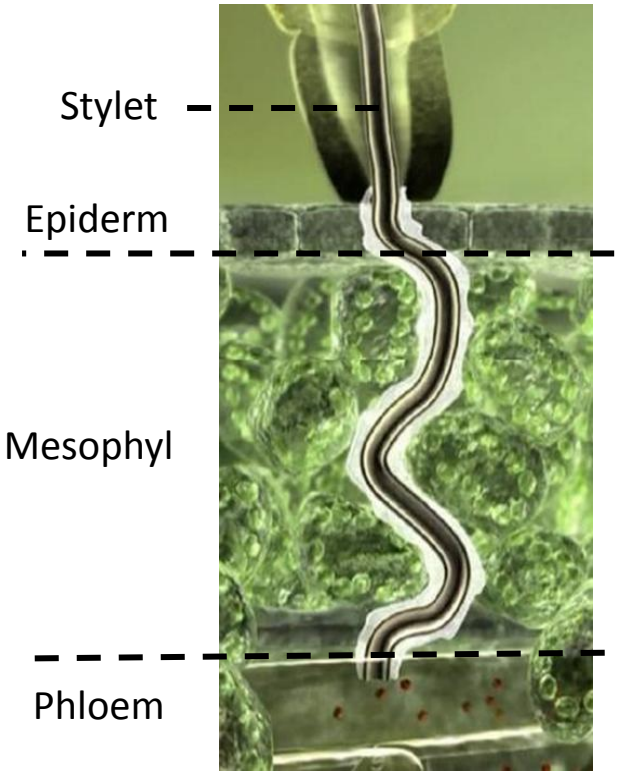


➔ **but not on artificial feeding medium**

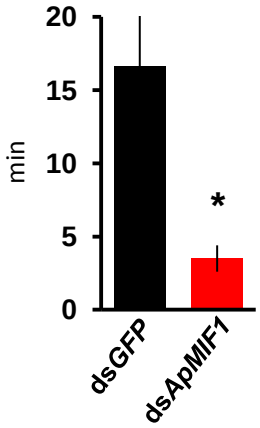
Naessens et al., 2015, Curr. Biol

Are aphid MIFs involved in aphid – plant interactions?

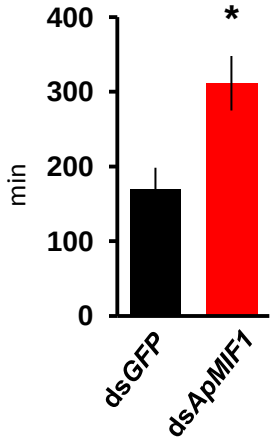
➔**Analysis of feeding behaviour using electropenetrography (EPG)**



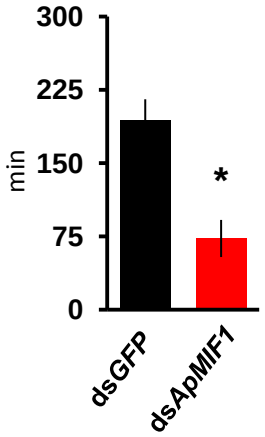
Duration of phloem elements punctures



Time to first ingestion



Duration of phloem ingestion



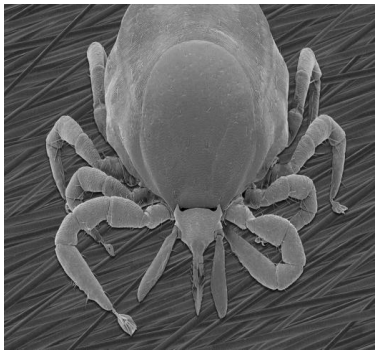
➔ **Expression of MIFs is necessary to exploit the host plant.**

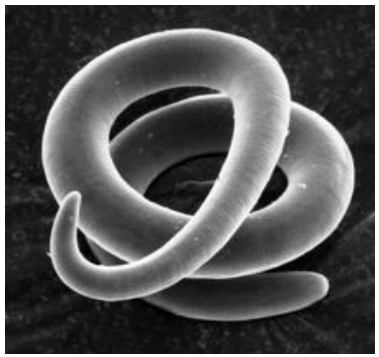
Naessens et al., 2015, Curr. Biol

Are aphid MIFs involved in aphid – plant interactions?

MIFs are known to be secreted by parasites of vertebrates (nematodes, ticks)

- Present in salivary secretions
- Participate in modulation of the vertebrate host immune response





➔ **Aphid MIF1 involved in regulating the plant-aphid interaction?**

Are aphid MIFs involved in aphid – plant interactions?

➔ **Do MIFs interfere with plant defenses?**

Myzus persicae/ Nicotiana benthamiana

Transient expression of **MpMIFs** in tobacco leaves

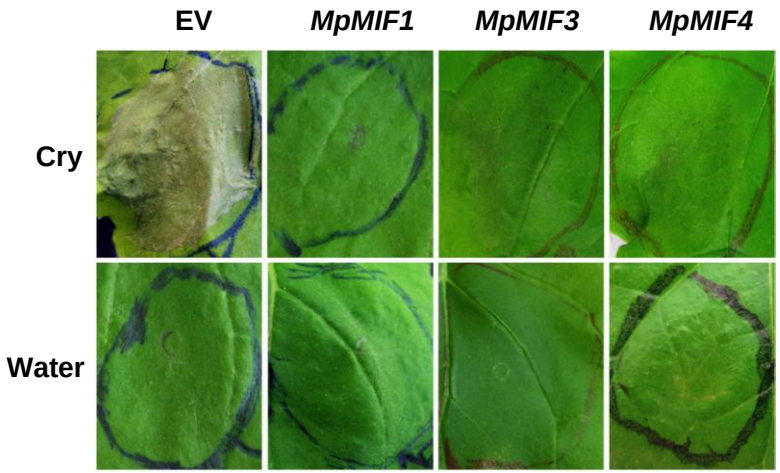
Induction of plant defenses with cryptogein *(Phytophthora cryptogea)*

Analysis of plant defenses

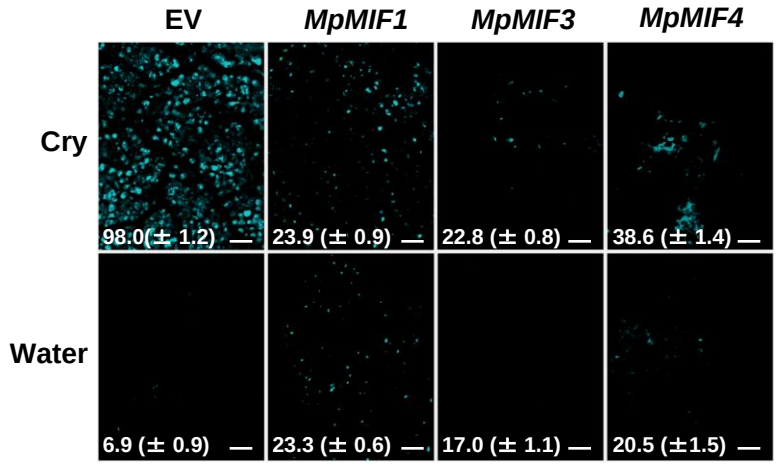
Are aphid MIFs involved in aphid – plant interactions?

➔***Agrobacterium*-mediated transformation**

Hypersensitive cell death



Callose deposition

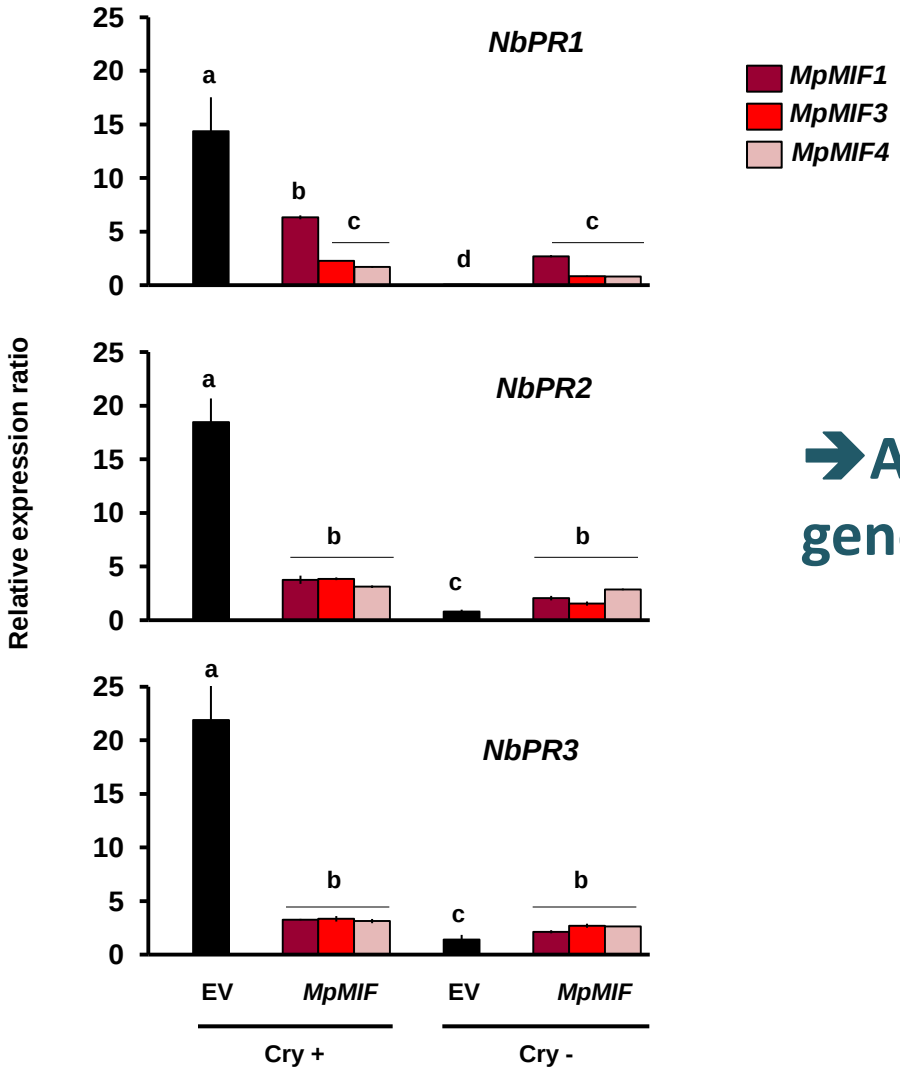


➔**Aphid MIFs reduces HR and callose deposition**

Naessens et al., 2015, Curr. Biol

Are aphid MIFs involved in aphid – plant interactions?

➔ **Genes defenses expression**

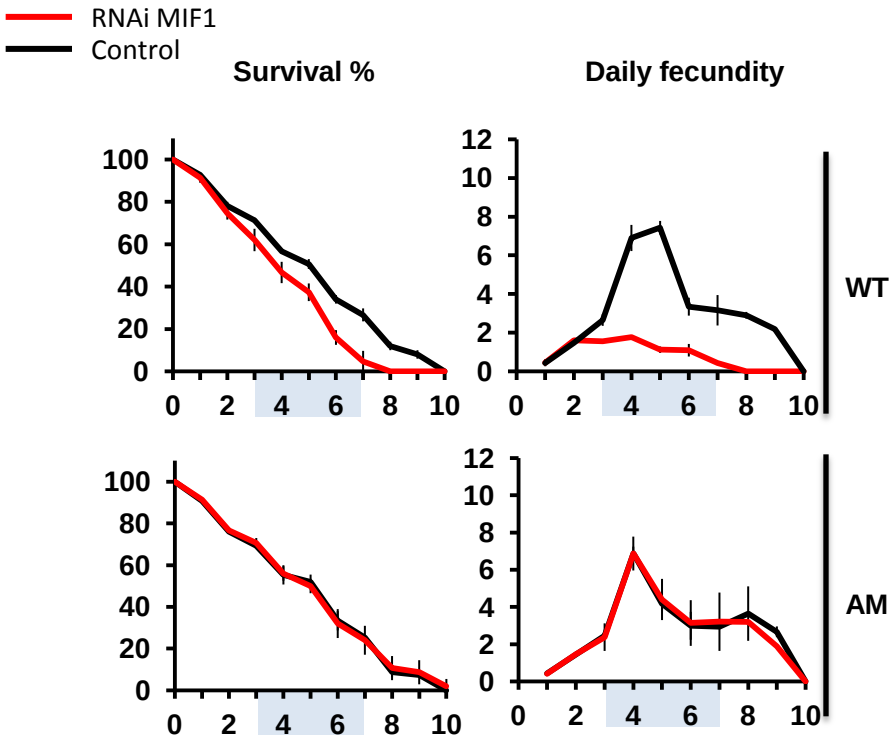


➔**Aphid MIFs reduces genes defenses expression**

Naessens et al., 2015, Curr. Biol

Are aphid MIFs involved in aphid – plant interactions?

➔ **Confirmation of the role of MIF1 in *M. persicae***



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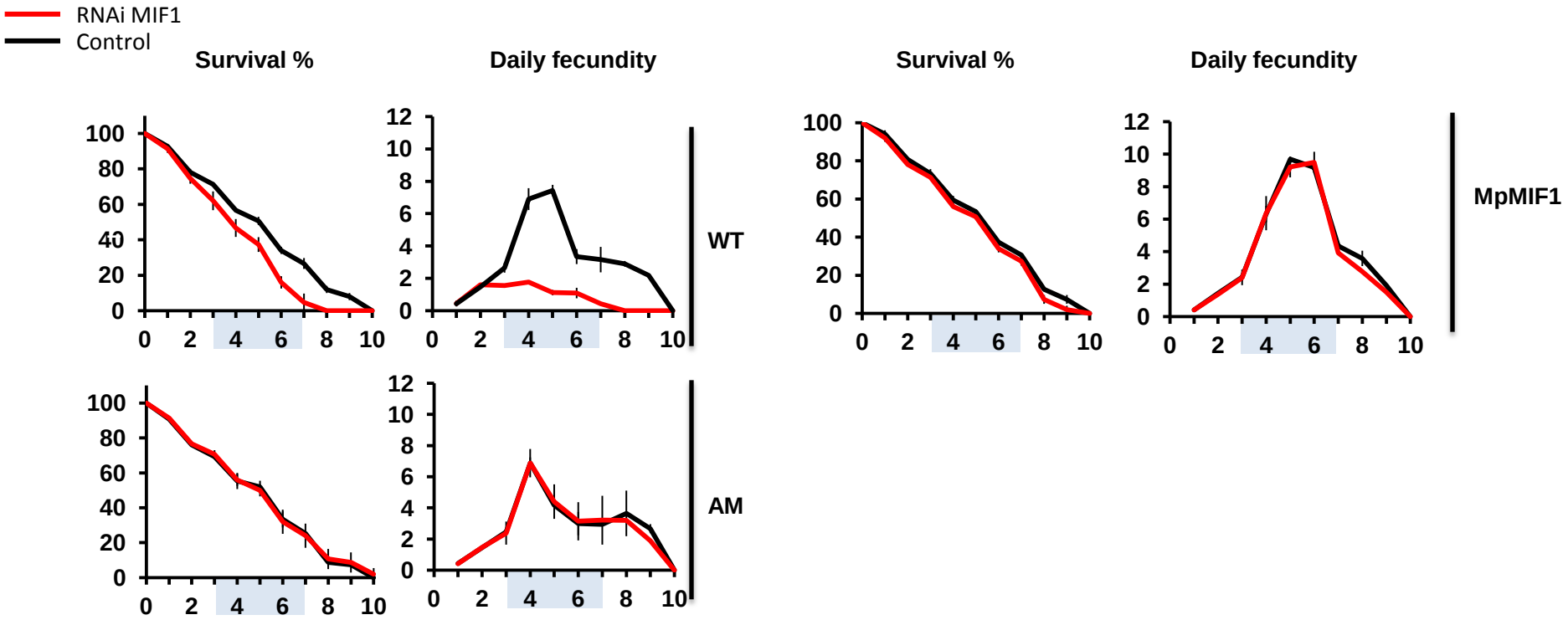

➔ **MpMIF1 expressed in plant complement Aphid RNAi phenotype**

Naessens et al., 2015, Curr. Biol

Are aphid MIFs involved in aphid – plant interactions?

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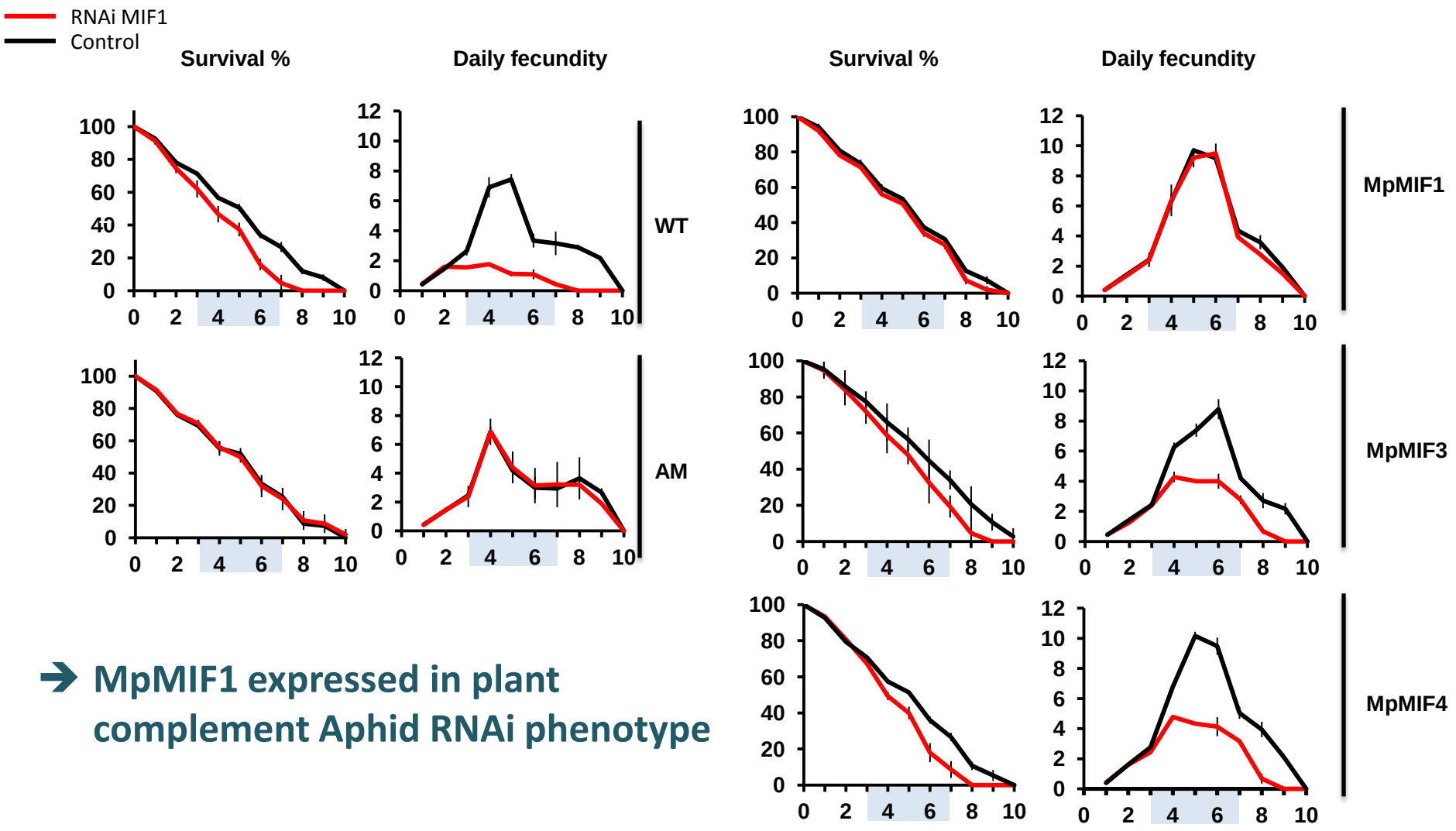


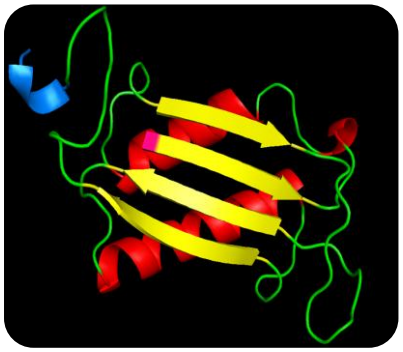
➔ **MpMIF1 expressed in plant complement Aphid RNAi phenotype**

Naessens et al., 2015, Curr. Biol

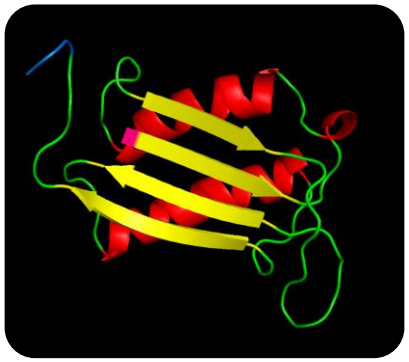
Role of plant MIFs in the aphid-plant interactions?

3 MIF genes in *Arabidopsis thaliana (AtMDL1, AtMDL2, AtMDL3)*

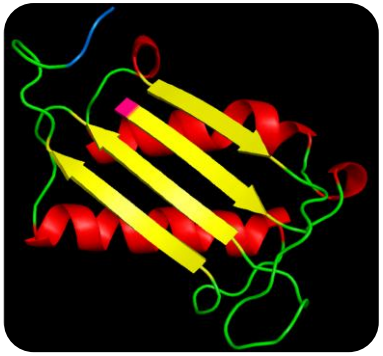
Predicted protein structures



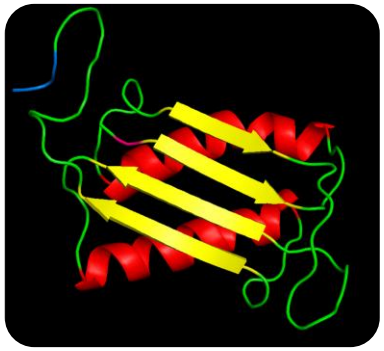
MIF1



AtMDL1



AtMDL2



AtMDL3

- 80% structure identity with MpMIF1
- No functional studies to date
- Mutants lines availables

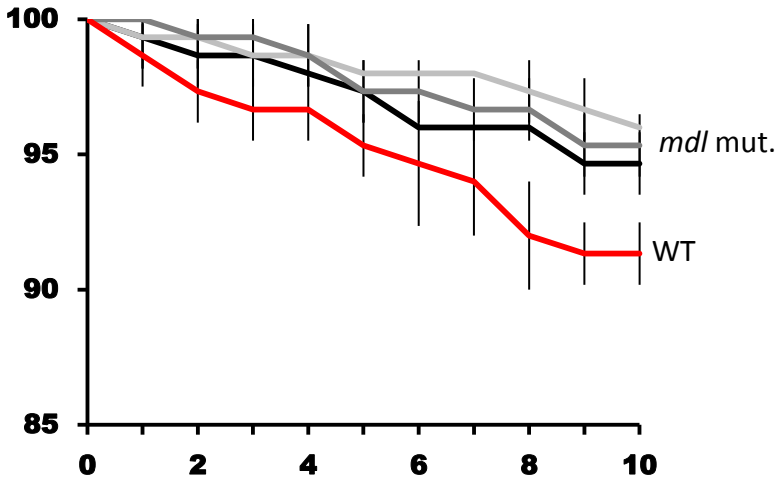
➔ **Role of AtMDL in interaction ?**

Panstruga et al., 2015, BMC Ev. Biol.

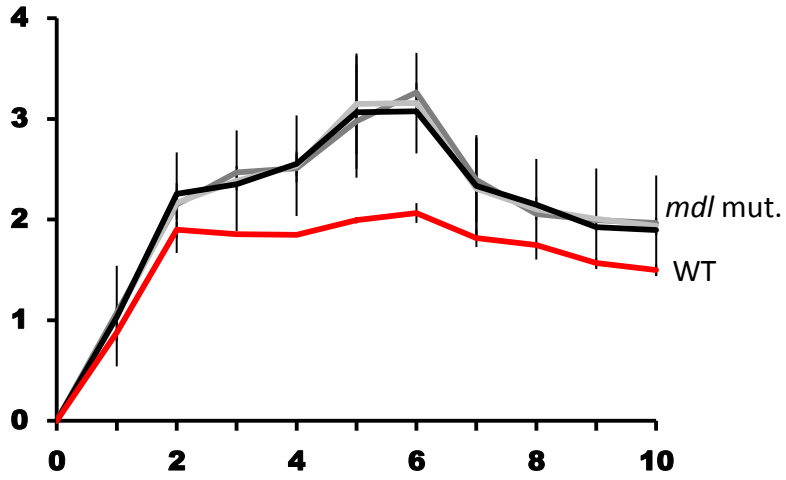
Role of AtMDL in interaction ?

mdl mutants → Aphids fitness

Survival %



Daily fecundity



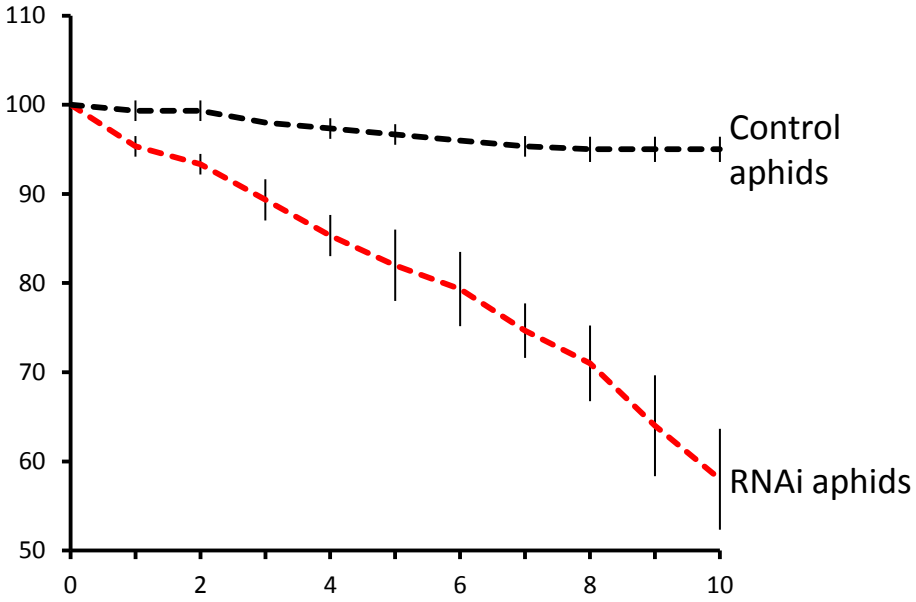
➔ **The 3 mutants have an increased susceptibility to aphid infection**

Effect of mdl mutant on aphid RNAi phenotype?

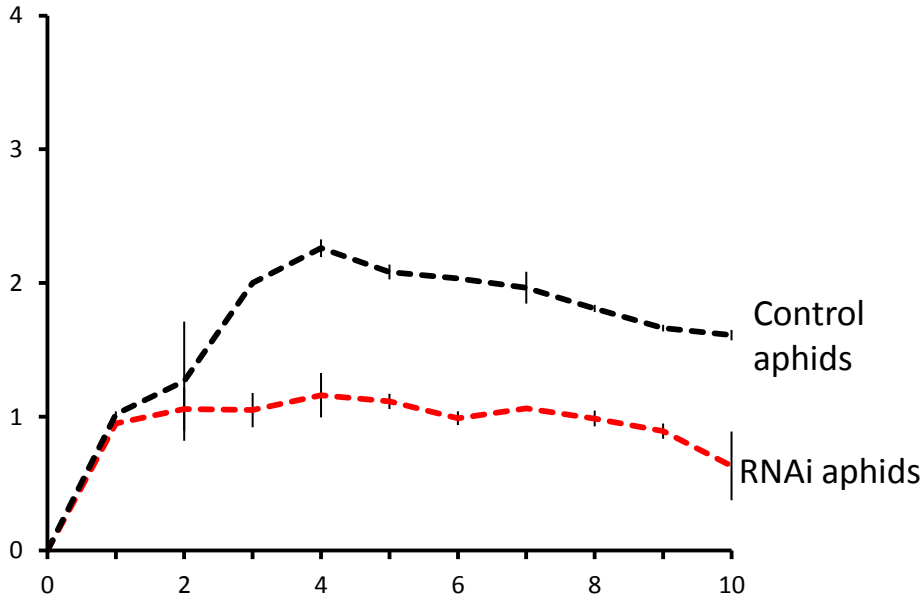
→ Aphids fitness

WT plants

Survival %



Daily fecundity

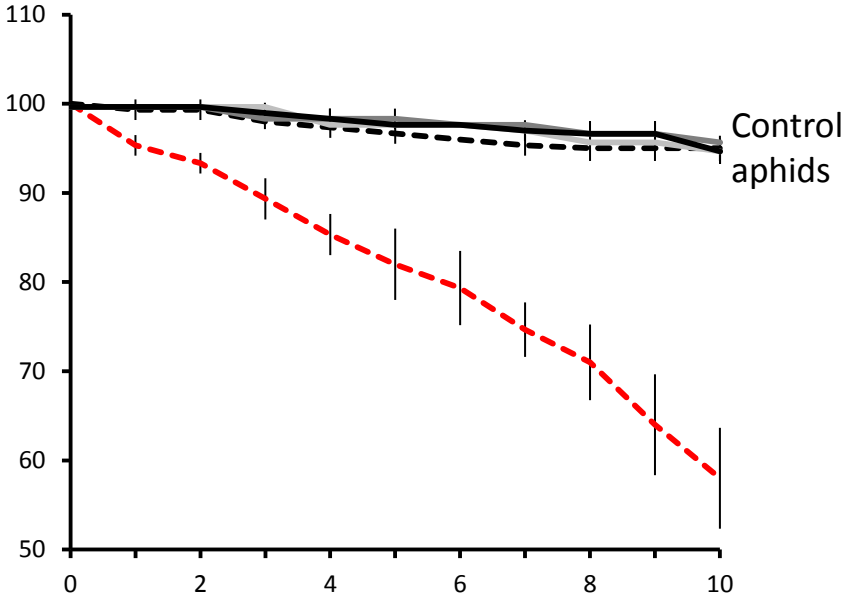


Effect of mdl mutant on aphid RNAi phenotype?

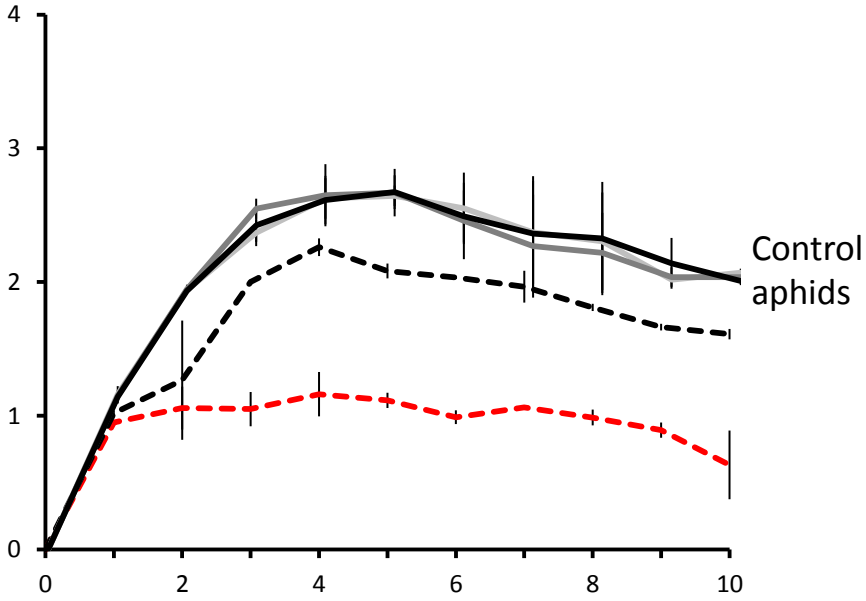
→ Aphids fitness

mdl plants

Survival %



Daily fecundity



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mdl plants

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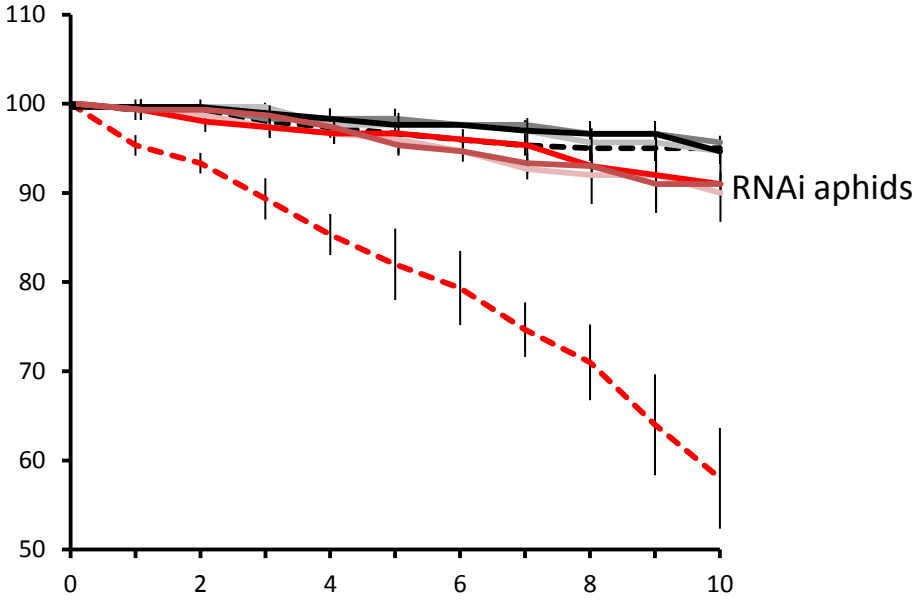
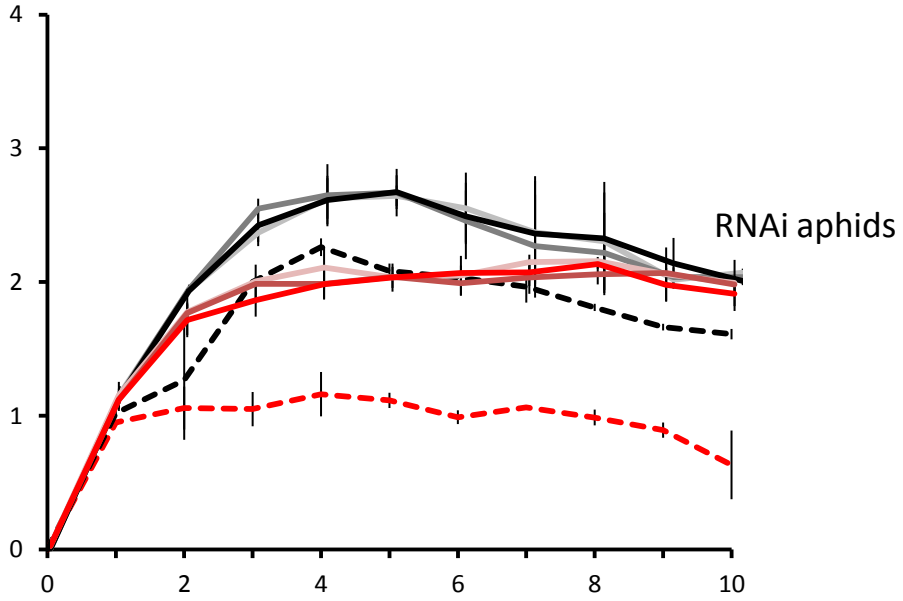


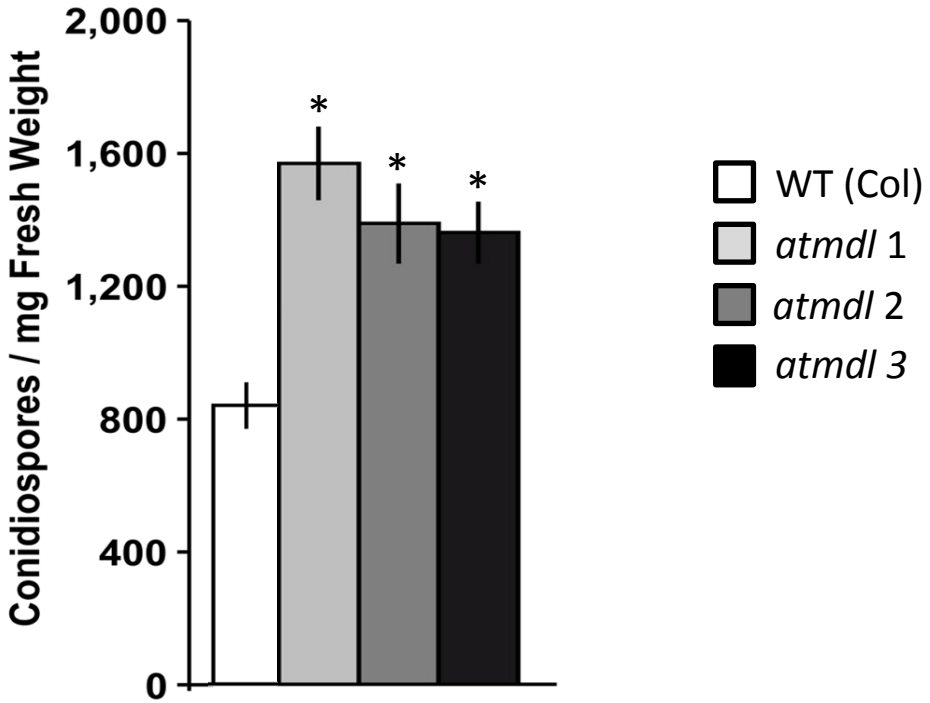
Daily fecundity



➔ **Absence of MDL in plants, complements absence of MIF1.**

Role of AtMDL in Oomycete interaction ?

→ Oomycete (*Hpa*) fitness

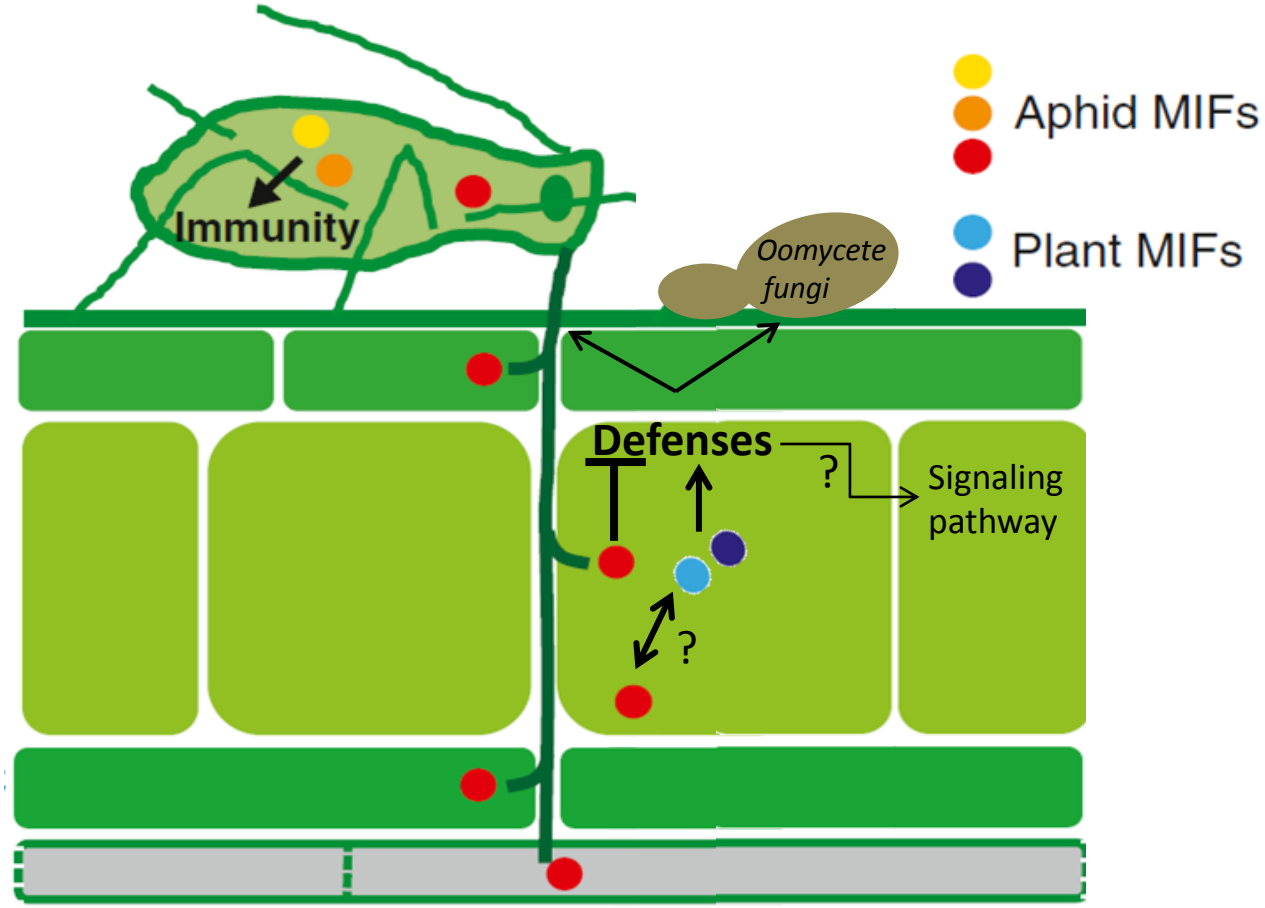


➔ **The mutants have an increased susceptibility to oomycete infection**

Conclusion

➔ **Aphid MIFs reduces plant immune systeme**

➔ **Plants MDLs are involved in plant-parasite responses (aphid, oomycete)**

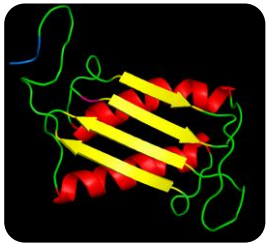


Conclusion

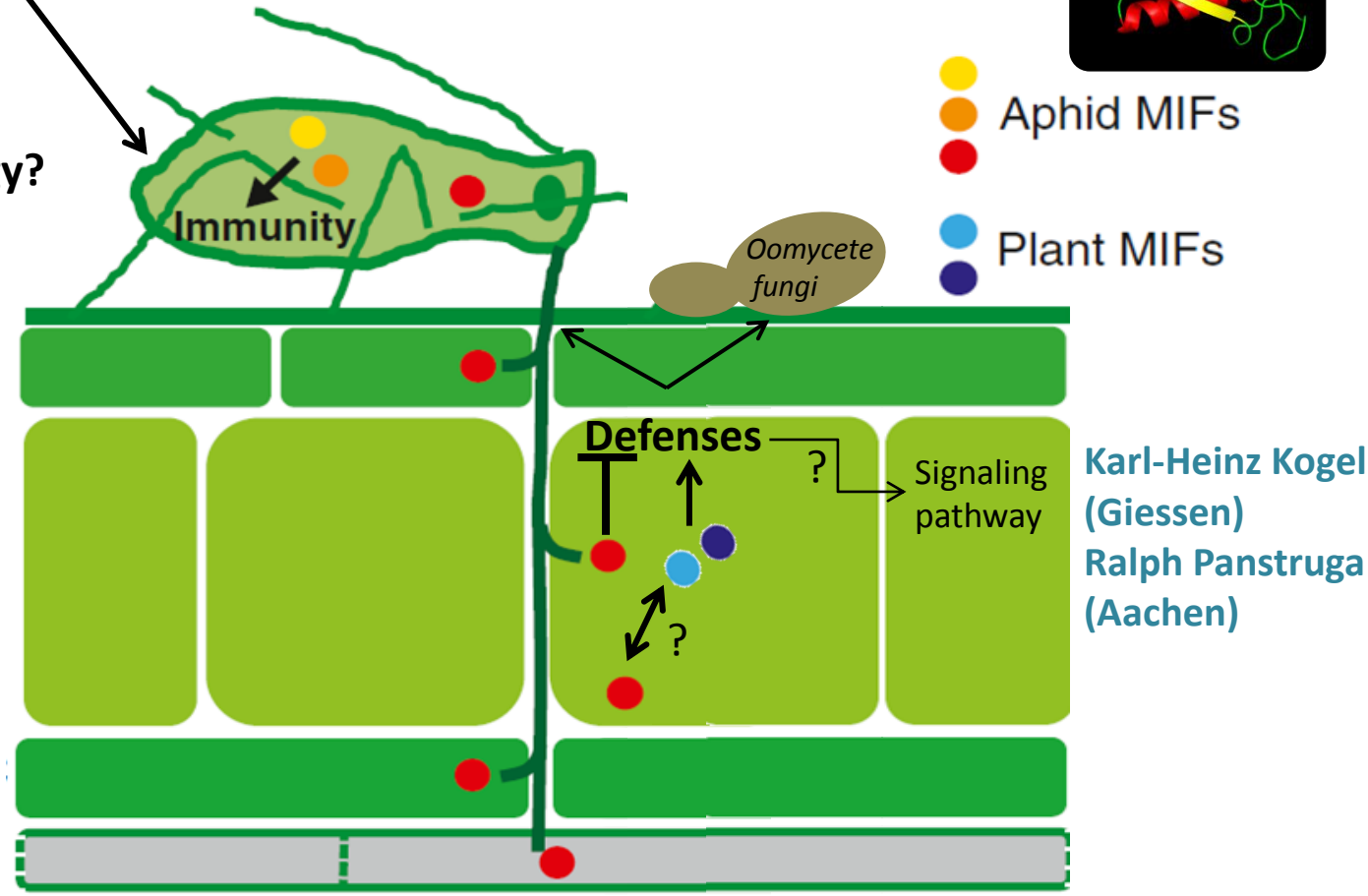
Jürgen Bernhagen
(Munich)

Structure-Function Analysis

Claire Michelet
(Sophia)



Function homology?



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Thank you for your attention