

Immune gene expression in sympatric and allopatric stickleback-tapeworm combinations

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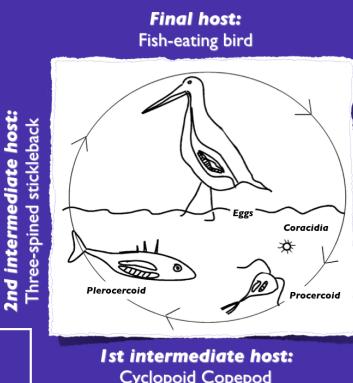
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Schistocephalus solidus is a parasitic tapeworm with a complex life cycle. A special characteristic of *S. solidus* is its extremely high specificity to its secondary host, the three-spined stickleback (*Gasterosteus aculeatus*), where it realizes its complete growth. This implies close co-adaptation and makes the stickleback-*S. solidus* system a very suitable model for experimental studies on reciprocal adaptation in host-parasite interactions^{1,2}.

We used lab-bred fish infected with worms from two different co-evolved populations (a Norwegian and a German one) to investigate the specificity of the host immune response at the gene expression level.



Schistocephalus solidus life cycle³

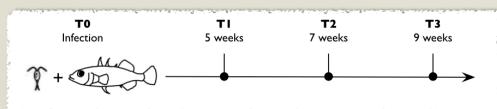


Experimental design

We used a fully crossed design to produce sympatric and allopatric combinations of three-spined stickleback infected with *S. solidus*.

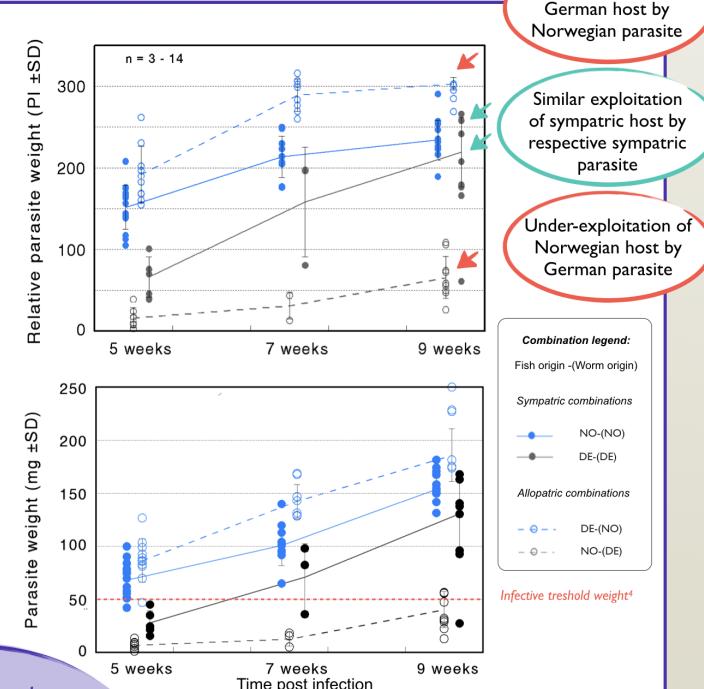
Host origin	German	Norwegian	Control (un-infected fish)
German	DE-(DE)	DE-(NO)	DE-CTL
Norwegian	NO-(DE)	NO-(NO)	NO-CTL

The fish were dissected **5, 7 and 9 weeks post infection**. Parasite and relevant **immunological tissue** samples (headkidney and spleen) were harvested for expression studies.



Phenotypic evidence for local adaptation

Sympatric combinations: potential optimal virulence
Allopatric combinations: potential maladaptation



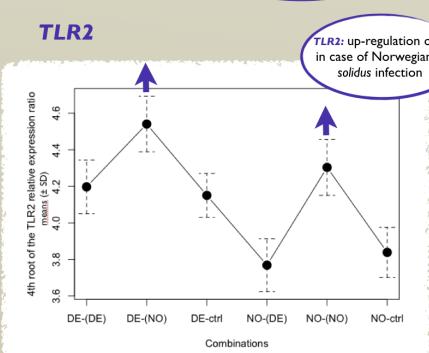
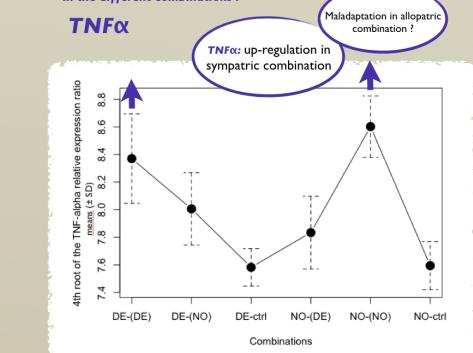
Gene expression analysis and preliminary results:

The gene expression of **8 immune relevant genes** has been analyzed by **Real-Time quantitative PCR** and calculation of relative expression ratios.

Gene name / abbreviation	Function	Immune pathway
Interleukin 1 Beta <i>IL-1β</i>	Cytokine	Innate immunity (Th1)
Tumor Necrosis Factor alpha <i>TNFα</i>	Cytokine	Innate immunity (Th1)
Transforming Growth Factor Beta 1 <i>TGF-β1</i>	Cytokine	Innate immunity (Th2)
Macrophage Migration Inhibitory Factor <i>MIIF</i>	Lymphokine	Innate immunity
Toll-Like-Receptor 2 <i>TLR2</i>	Antigen recognition	Innate immunity
Superoxide Dismutase 2 <i>SOD2</i>	Antioxidant	Innate immunity
Major Histocompatibility complex class II Beta <i>MHC class II β</i>	Antigen recognition	Adaptive immunity
Immunoglobulin M <i>IgM</i>	Antibody	Adaptive immunity

Mean expression of two immune genes (*TNFα* & *TLR2*) in the different combinations :

Preliminary analyses of gene expressions show local adaptation in fish-worm pairs and divergent evolution for host resistance and parasite virulence in the two studied populations.



¹ Barber & Scharsack, 2009, Parasitology

² Hammerschmidt & Kurtz, 2009, Advances in Parasitology

³ Milinski, 2006, Integrative & Comparative Biology

⁴ Tierney & Crompton, 1992, The Journal of Parasitology

⁵ Pfaffl et al., 2001, Nucleic Acids Research

Acknowledgements

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