

Vorburger lab: Possible topics for MSc & BSc Projects (updated June 2026)

⇒ We suggest to first have a look at <https://homepages.eawag.ch/~vorburch/research.html> to have the context of these project suggestions.



Projects related to insect host-parasitoid interactions

New: The relative importance of temperature and parasitism in determining the prevalence of a defensive symbiont in aphids.

The bacterial endosymbiont *Hamiltonella defensa* protects black bean aphids (*Aphis fabae*) against their natural enemy *Lysiphlebus fabarum*, a parasitoid wasp. The prevalence of *Hamiltonella* in the aphid population should therefore increase when parasitoids are abundant. However, recent field data have shown that hot days in summer predict the seasonal dynamics of *Hamiltonella* prevalence better than parasitism risk in natural populations of *A. fabae*. This suggests that *Hamiltonella* also improves heat tolerance of their aphid hosts, for which there is some experimental support. But which factor is more important? Field data cannot answer this question, because parasitism risk and temperature are correlated in the field. This correlation can only be broken in the laboratory. We will therefore use replicated experimental populations and manipulate rearing temperature and parasitism risk independently in a factorial design. The outcome will show whether parasitism or temperature is the main determinant of infection with *Hamiltonella* in black bean aphids.

Experiment suitable for a 6-month project (or longer), including work with live insects and work in the molecular lab.

New: Is the host preference of parasitoid wasps shaped by interspecific competition?

Lysiphlebus fabarum is the most important parasitoid of the black bean aphid (*Aphis fabae*). Aphids can resist parasitism by *L. fabarum* when they carry an infection with the heritable bacterial endosymbiont *Hamiltonella defensa*, which strongly increases their resistance. Another parasitoid frequently using *A. fabae* as host is *Binodoxys angelicae*. Unlike *L. fabarum*, *B. angelicae* does not appear to be affected by symbiont-conferred resistance. Recent field data even suggest that *B. angelicae* is found more frequently on *Hamiltonella*-infected aphids. This suggests that *B. angelicae* may be avoiding competition with the more abundant parasitoid *L. fabarum* by preferentially attacking aphids carrying *Hamiltonella*. This project will therefore carry out behavioral experiments to assess host preferences and their fitness consequences in the aphid parasitoid *B. angelicae*.

Project suitable for a 3-6 month project including behavioral experiments with live insects and genetic analyses in the molecular lab.

New: Species-specific host protection by an understudied endosymbiont?

Aphids frequently carry heritable infections with facultative bacterial endosymbionts. In black bean aphids (*Aphis fabae*), the most common facultative symbiont is *Hamiltonella defensa*, which protects them against their most common parasitoid *Lysiphlebus fabarum*. Another facultative symbiont commonly found in *A. fabae* is *Regiella insecticola*. Unlike *H. defensa*, this symbiont is not protective against *L. fabarum*, nor do we know of any other benefits it provides. However, recent field data indicate that *Aphelinus chaonia*, a tiny parasitoid wasp from a different family than *L. fabarum*, is underrepresented in *Regiella*-infected aphids. This correlation suggests that *Regiella* may also be a defensive symbiont, albeit one that is protective specifically against *A. chaonia*. However, correlation is not causation. This project will therefore test experimentally if *Regiella* protects black bean aphids against *A. chaonia*. To this end, we will manipulate the presence/absence of *Regiella* in genetically identical aphids (clones) and expose them to *A. chaonia* to test whether the symbiont makes the aphids more resistant.

Project suitable for a 6-month project (or longer), including field sampling, parasitism assays with live insects and genetic analyses in the molecular lab.

New: Gene-flow of a pest insect (*Aphis fabae*) along a latitudinal gradient

The black bean aphid, *Aphis fabae*, is an important agricultural pest. It occurs all across Europe and shows interesting latitudinal clines in its reproductive mode (cyclical parthenogenesis in the north, obligate parthenogenesis in the south) and in its association with bacterial endosymbionts that provide resistance against parasitoid wasps. To understand how these clines form and what role potential dispersal barriers like the Alps play in their maintenance, we require an estimate of gene flow across latitudes in *A. fabae*. To estimate infection rates with bacterial symbionts, we have sampled black bean aphids along a > 3000 km long N-S transect across Europe in 2023. These samples are now available for analysis with genetic markers to estimate latitudinal gene flow in black bean aphids. Suitable for a 6-12 month project, in collaboration with a postdoc (Cameron Hudson) and a PhD student (Dominic Stalder).

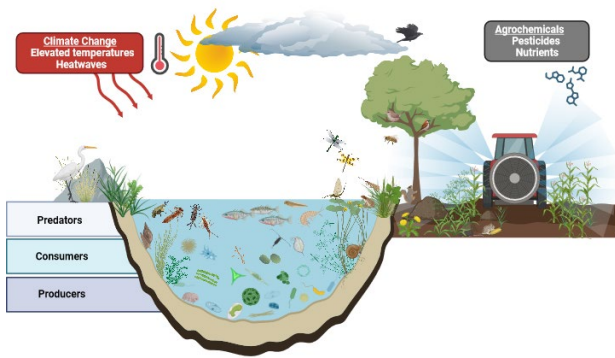
Strain diversity of the defensive symbiont *Hamiltonella defensa* in close relatives of *Aphis fabae*

Hamiltonella defensa is a heritable bacterial endosymbiont of aphids that increases aphid resistance to parasitoid wasps. To describe the genomic basis of this remarkable trait, we aim to compare a large number of different *H. defensa* strains. In our main study species, *Aphis fabae*, strain diversity of *H. defensa* is very limited, but we expect to find more strains by screening additional species of *Aphis* that are closely related to *A. fabae*. This project would include fieldwork, laboratory husbandry of insects, as well as molecular genetic analyses. Suitable for a 6-12 month project.

The specificity of chemical mimicry in aphid parasitoids of the genus *Lysiphlebus*

Aphid parasitoids of the genus *Lysiphlebus* are specialized on ant-tended aphid species. These aphids engage in a symbiosis with ants, which provide protection against predators and parasitoids in exchange for honeydew from the aphids. To exploit such aphids despite their protection by ants, *Lysiphlebus* parasitoids have evolved chemical mimicry. The chemical profile of the hydrocarbons coating their cuticula closely matches that of the aphids, 'fooling' ants into 'believing' they are aphids and leaving them unmolested (Liepert & Dettner, 1996, J Chem Ecol). However, it is still unknown how precise this mimicry needs to be to be functional. As a first attempt to answer this question, the student will exchange *Lysiphlebus* parasitoids between different ant-tended aphid species, to test whether parasitoids remain undetected by ants even against a 'background' consisting of different aphid species. Field experiment suitable for a 3-month project.

Projects related to aquatic ecology and biodiversity



Climate Change and Freshwater Biodiversity (CCFB):

Multiple stressor effects of climate change and other stressors on aquatic food webs

Global climate change brings on rising temperatures and more frequent and extreme weather events, such as heatwaves and warm spells. These will have both immediate and lasting impacts on freshwater ecosystems. There is still a limited understanding of how these ecosystems will respond to higher mean temperatures and temperature extremes, particularly when unpredictable interactions with other stressors occur. These stressors include agricultural inputs such as pesticides, nutrients or fine sediment, as well as structural habitat degradation. To study multiple stressor effects on aquatic food webs, we use various types of mesocosms as experimental units (ponds and flumes), comprising semi-natural communities of differing complexity. The overall project goal is to deepen our knowledge on how multiple stressors in the context of global warming affect freshwater communities as well as ecosystem processes and function. Since studies that examine the underlying mechanisms of multiple stressor effects are scarce and often lack environmental realism, full-factorial experimental designs in the field will be used to disentangle interaction effects.

Field and laboratory work suitable for a 3 to 12-month project, depending on participation in planned field experiments and/or laboratory work. This project would take place in collaboration with Dr. Markus Hermann (Research Scientist and Program Coordinator of the CCFP project).