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The interactions between an obligate killer pathogen and the microbiota of its hosts

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Interactions between a pathogenic bacteria and the microbiota of its insect host

Marine Cambon



Different levels of complexity in pathogenic infections

- ▶ Infections have been for long considered as **one host/one pathogen** interactions
- ▶ but infections are often **mixtures** of microorganisms:
 - ▶ Multiple infections
 - ▶ Pathogen phenotypic heterogeneity
 - ▶ Host microbiota

Uninfected host



Pathogen



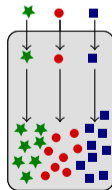
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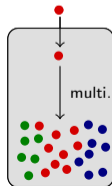
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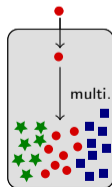
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Why does it matter? Two examples

Interactions with host microbiota can change the infection outcome!

Spodoptera littoralis



Facilitation

- ▶ The pathogen can be **helped by the host microbiota**



(Caccia et al. 2016)

Competition

- ▶ The pathogen can be **cleared by the host microbiota**



(Shao et al. 2017)

Why does it matter? Two examples

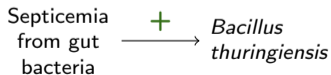
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Septicemia from gut bacteria $\xrightarrow{+}$ *Bacillus thuringiensis*

(Caccia et al. 2016)

Competition

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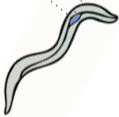
Gut bacteria: *Enterococcus mundtii* $\xrightarrow{-}$ Opportunistic pathogen: *E. faecalis*

(Shao et al. 2017)

Life cycle of the *Steinernema-Xenorhabdus* pair

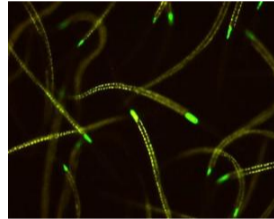
In soils:

- Nematodes disperse in soil
- Carry a symbiotic bacteria:
Xenorhabdus



1

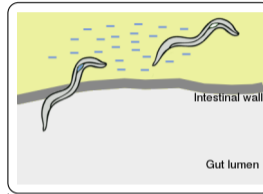
zoom x???



Life cycle of the *Steinernema-Xenorhabdus* pair

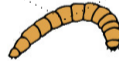
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In insect alive:

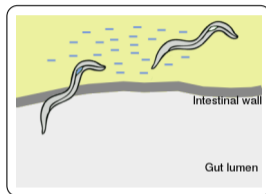
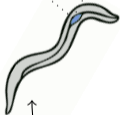
- Nematodes pass through intestinal wall
- Release bacteria in hemocoel
- Bacteria multiply and kill the host



Life cycle of the *Steinernema-Xenorhabdus* pair

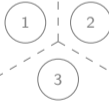
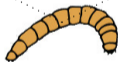
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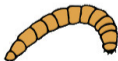
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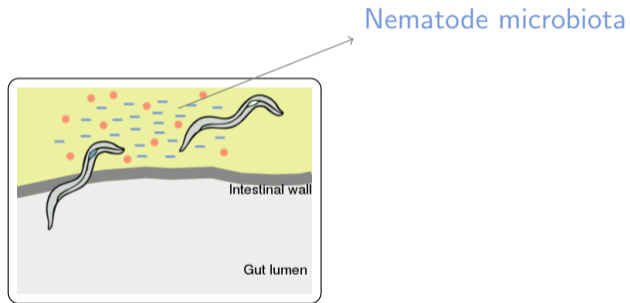


In dead insect:

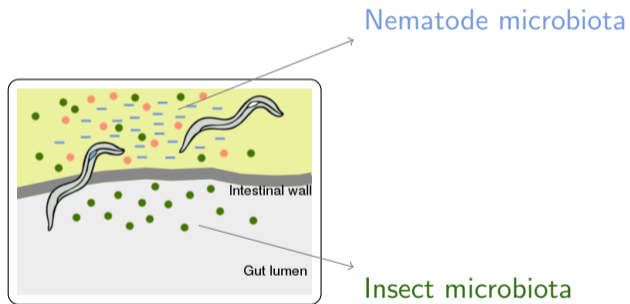
- Bacterial multiplication
- Nematode reproduction



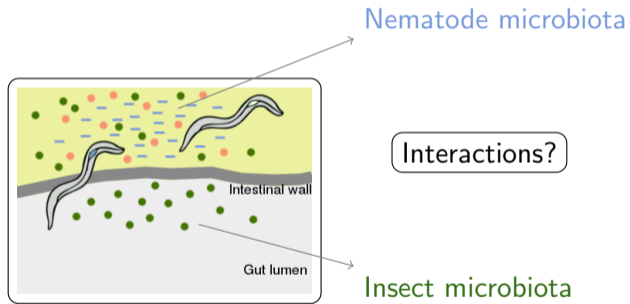
What happens in microbial community in insects cadavers?



What happens in microbial community in insects cadavers?



What happens in microbial community in insects cadavers?



Studying the outcome of these interactions

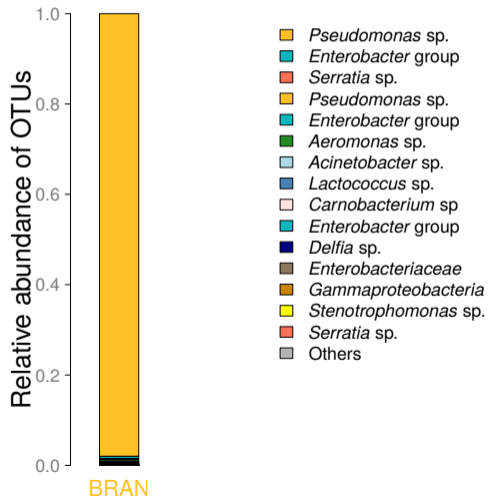
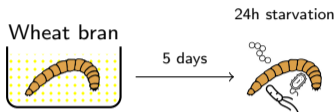
Xenorhabdus produces antibiotics:

A way to dominate the community before transmission?

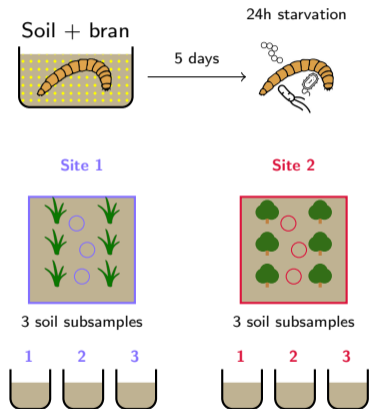
Two steps for a first exploratory approach:

1. **Create an experimental system** to control for the insect characteristics but with a 'natural' microbiota
2. Assess the **impact of the presence of the pathogen** on the bacterial community composition in the host cadaver

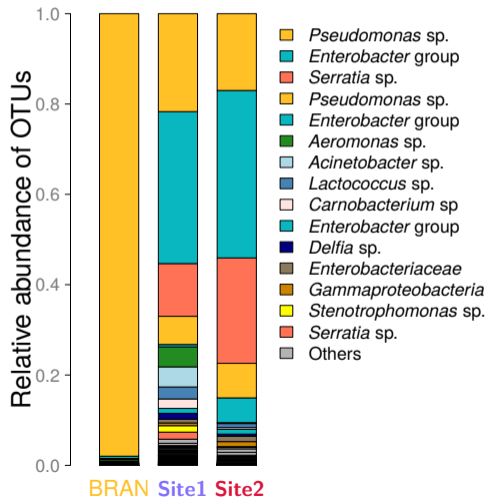
1. Associating lab-reared *Tenebrio molitor* to 'natural' microbiota



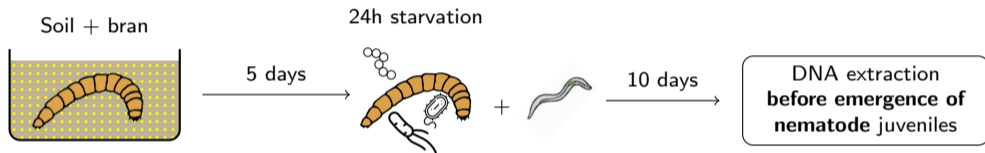
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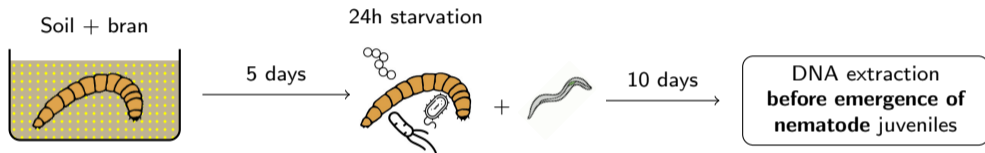
Similar to what is found in insects from natural environment (i.e. Wang and Rozen 2017)



2. Infection of insects by nematode-bacteria couples



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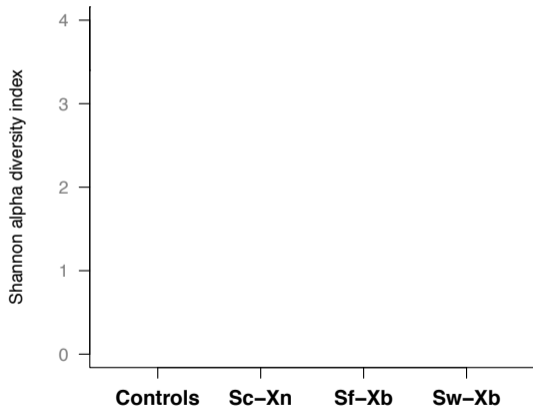
▶  *S. carpocapsae* - *X. nematophila*

▶  *S. weiseri* - *X. bovienii*

▶  *S. feltiae* - *X. bovienii*

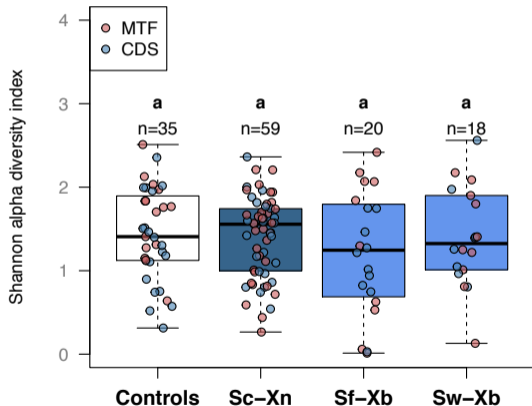
▶  Control

The presence of the pathogen does not reduce alpha diversity



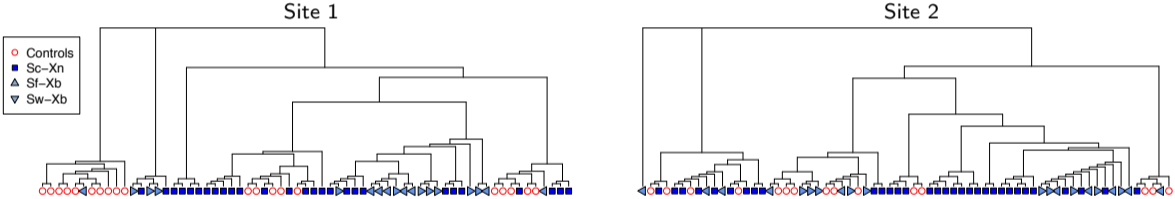
- ▶ If *Xenorhabdus* dominates the community we expect a decrease of alpha diversity...

The presence of the pathogen does not reduce alpha diversity

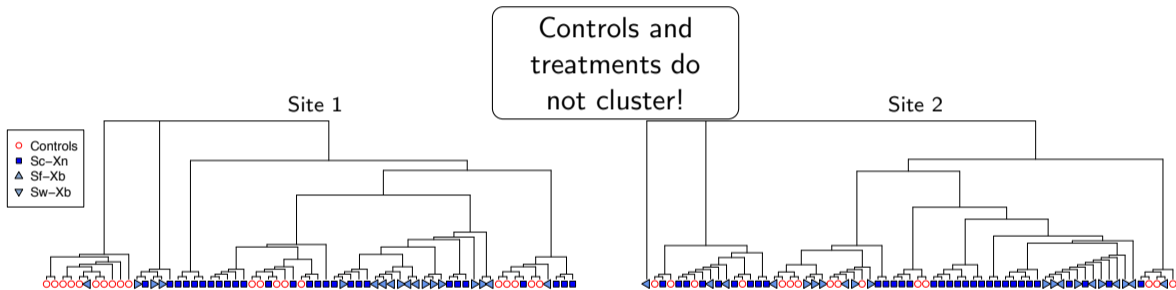


- ▶ If *Xenorhabdus* dominates the community we expect a decrease of alpha diversity...
- ▶ ...but diversity is low even in controls!

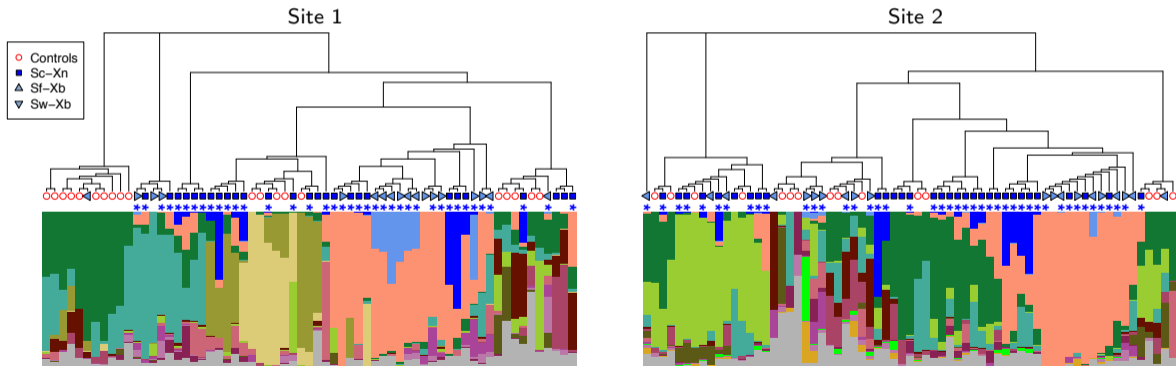
Community is usually dominated by one or two OTUs



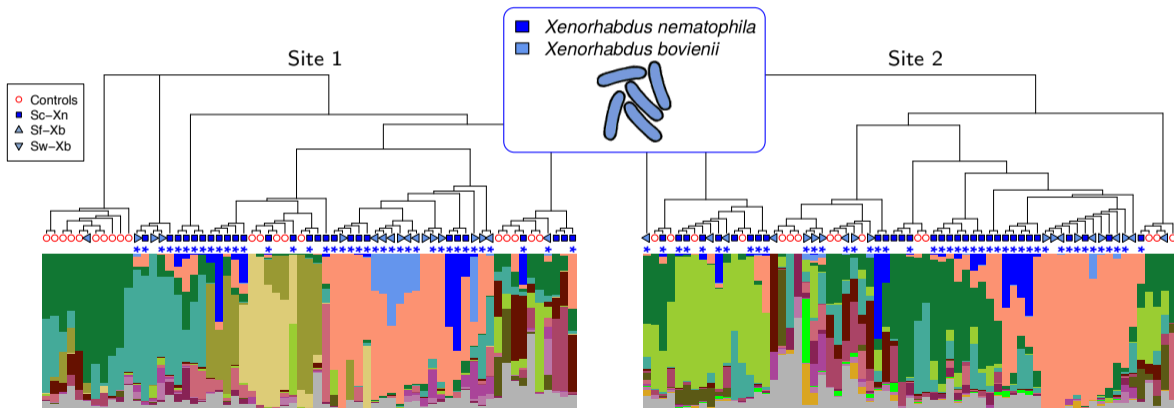
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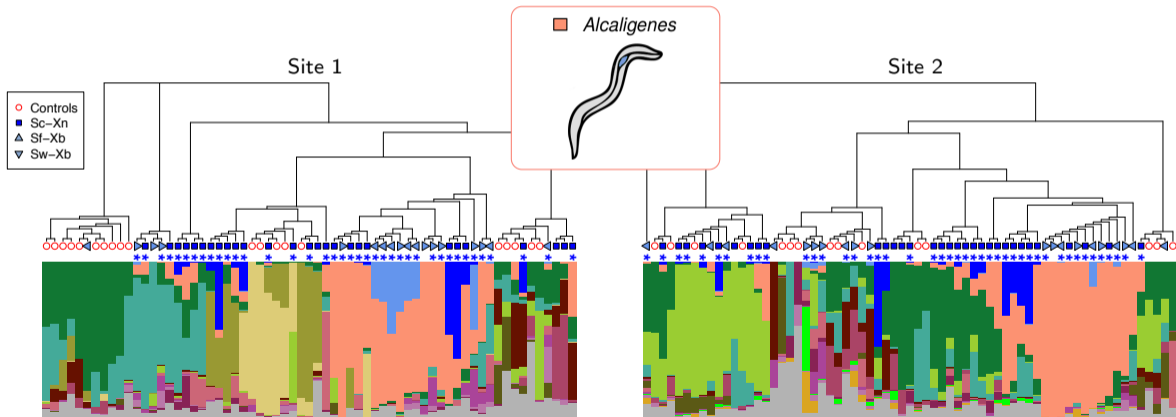
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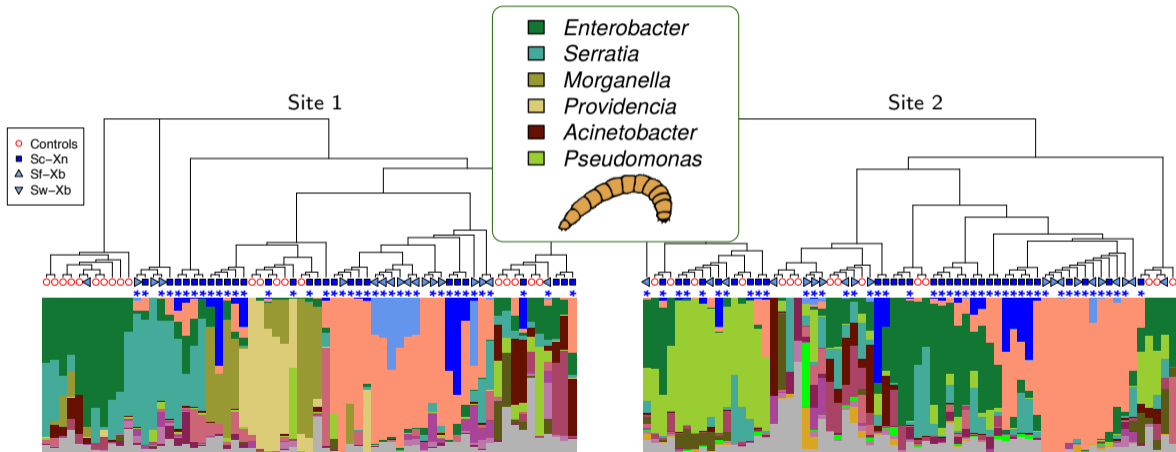
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A complex community before reassociation between the pathogen and its vector

Before reassociation with the vector for transmission:

- ▶ *Xenorhabdus* is usually not dominant in the community

Ongoing qPCR and network analysis

A complex community before reassociation between the pathogen and its vector

Before reassociation with the vector for transmission:

- ▶ *Xenorhabdus* is usually not dominant in the community
- ▶ Some other bacteria from the host microbiota or brought by the vector can be dominant

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- ▶ The identity of the dominant bacteria is variable between individuals and site

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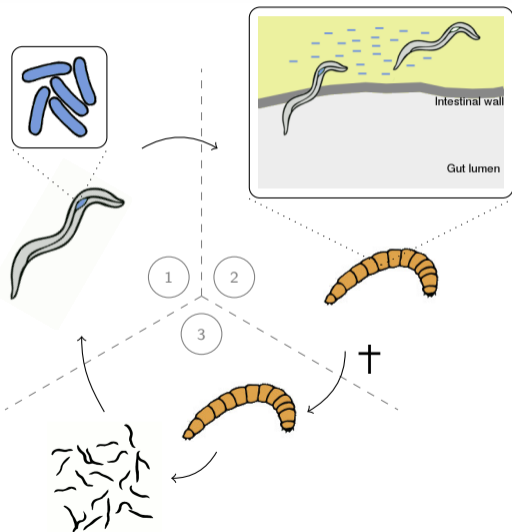
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Possible competition/facilitation?

Ongoing qPCR and network analysis

What consequences for *Xenorhabdus* transmission?



- ▶ Do nematodes reproduce when *Xenorhabdus* is not the dominant bacteria?
- ▶ If so, do they reassociate with *Xenorhabdus*?

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