

Department of Ecology



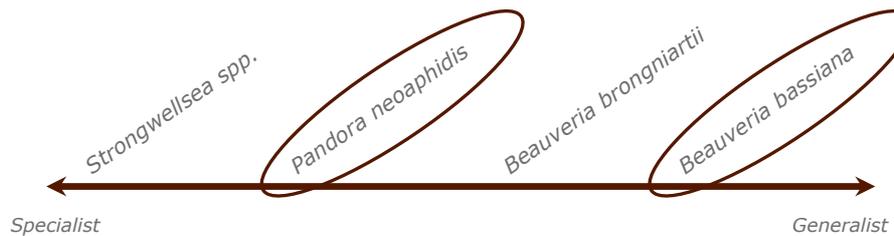
## Entomopathogenic fungi infecting non-pest insects: Implications for ecosystem services Relevance of behavioural ecology

Nicolai V. Meyling and Jørgen Eilenberg



Slide 1

## Fungal infections in insects



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## Direct and indirect effects in ecology

- Host-pathogen interactions
  - direct effects
  - indirect effects
    - Density (trophically) mediated
    - Trait (behaviourally) mediated
  
- Observations in the field (community ecology)
- Laboratory experiments (behavioural ecology)

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## Implications for ecosystem services

Interactions between non-pest and pest populations

- Indirect effects through **shared natural enemies**
  - density mediated

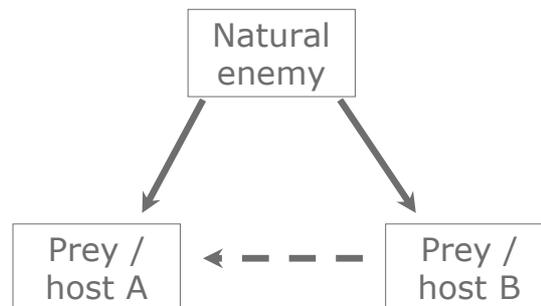
Non-pest insect populations may affect population regulation of pest insects

- **ecosystem service**

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*Implications for ecosystem services*

## Shared natural enemies - indirect effects



### Apparent competition

- outcome similar to competition
- potentially exclusion from community

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Implications for ecosystem services



## Apparent competition and conservation biological control

### Conservation biological control:

*"Modification of the environment or existing practices to protect and enhance specific natural enemies or other organisms to reduce the effects of pests"*

Eilenberg et al. (2001). *BioControl* 46, 387-400

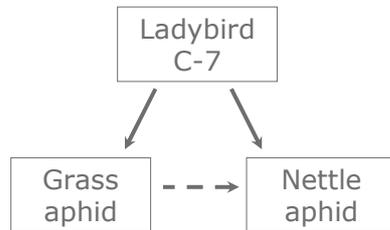
- Shared natural enemies
- Alternative prey / hosts and target pest
- Community ecology

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Implications for ecosystem services



## Experimental evidence of apparent competition - predators



Grass aphids attract ladybirds

- shift to nettle aphids
- population reduction of nettle aphids
- indirect effect of grass aphids on nettle aphids
- apparent competition between aphids

Such indirect effect of one species (grass aphid) on another (nettle aphid) is an aim in conservation biological control

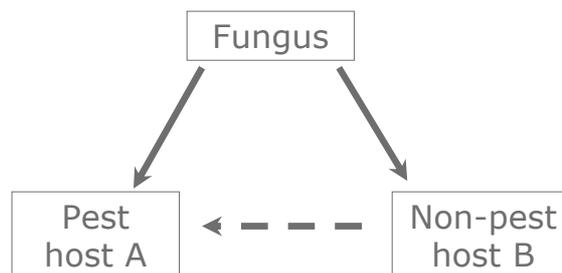
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From: Müller & Godfray (1997). *Journal of Animal Ecology* 66, 57–64

Implications for ecosystem services



## Fungal pathogens shared by insects - potential for indirect effects



- Host range of pathogen
  - food web
- Community context !

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Implications for ecosystem services



## Host-pathogen food web: Aphid pathogenic fungi

Indirect effects may structure communities

Aphid community in English meadow

- host plant specificity
- no resource competition

3 guilds of enemies: predators, parasitoids and pathogens

Construction of quantitative food web

- potential for apparent competition
- hypothesis of structuring forces
- experimental tests

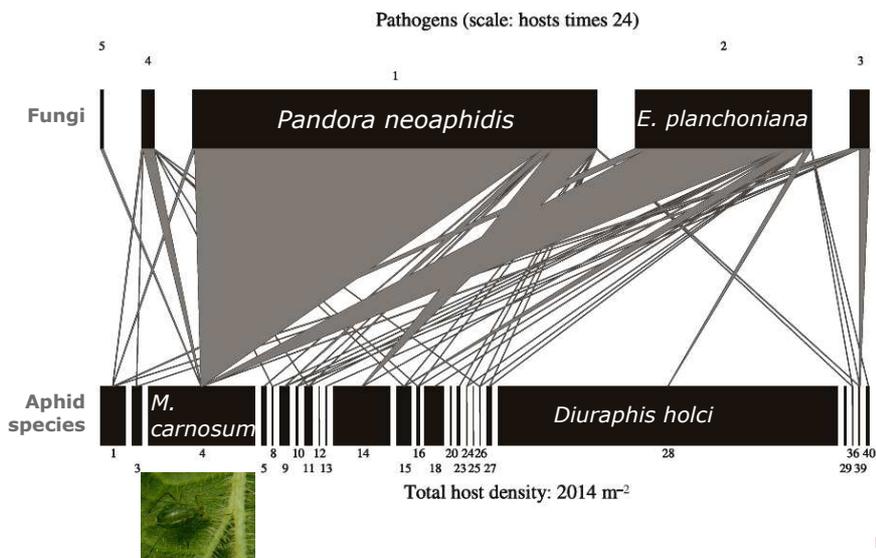
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van Veen, Müller, Pell, Godfray (2008). *Journal of Animal Ecology* 77, 191–200

Implications for ecosystem services



## Host-pathogen food web: Aphid pathogenic fungi



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van Veen, Müller, Pell, Godfray (2008). *Journal of Animal Ecology* 77, 191–200

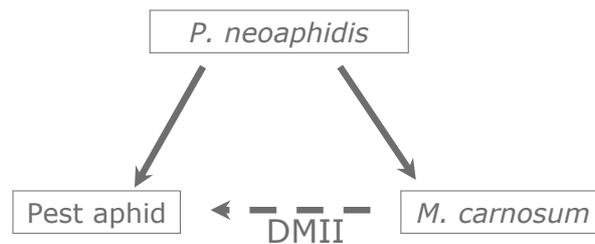
Implications for ecosystem services



### Host-pathogen food web: Aphid pathogenic fungi

Nettle aphids source of *P. neoaphidis*

- *P. neoaphidis* shared with other host species
- potential for apparent competition
- target for conservation biological control



Specificity of genotypes?

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Implications for ecosystem services



### Host-pathogen food web: *Beauveria* spp.

*Beauveria* spp. may be shared by many host species in a community

- Most host species are non-pests
  - potential for many indirect interactions
  - potential for conservation biological control

Example: *Beauveria* infections in non-pest insects

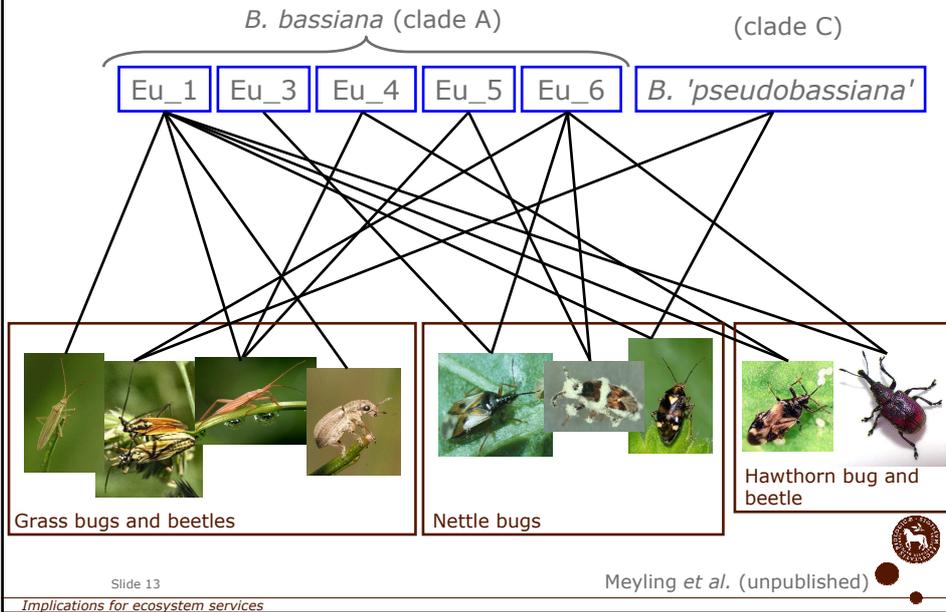
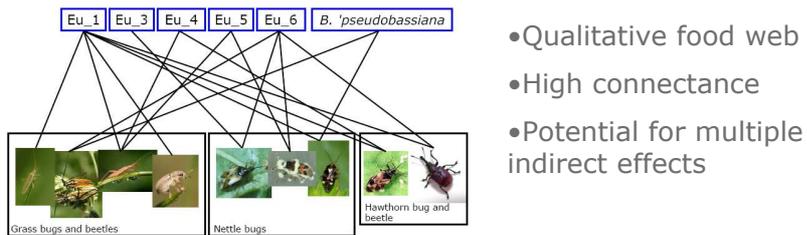
- Single locality !
- Local insect community
- Host plants in hedgerow



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Implications for ecosystem services



**Host-pathogen food web: *Beauveria* spp.****Host-pathogen food web: *Beauveria* spp.**

Quantitative data?

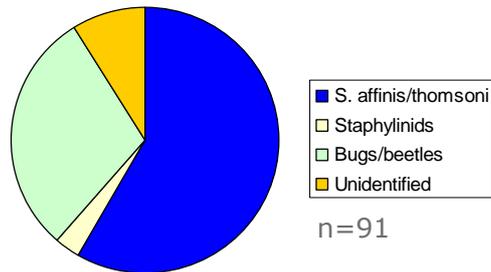
Sampling approach?

Molecular characterisation

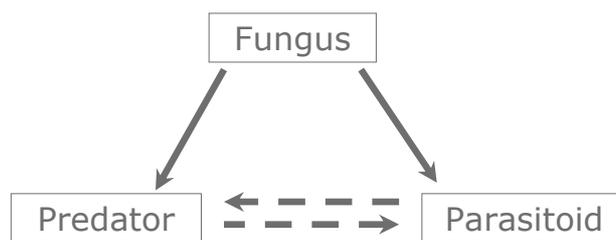
## *Beauveria* spp. in nettle insects: quantitative approach



**Mycosed cadaver**  
*Scolopostethus* sp.



## Non-pest insects are not just herbivores...



- Predators and parasitoids are also non-pests
- Natural enemies of natural enemies!



## Fungal infections in predator populations

Non-target effect assesments

- natural infections
- infections after field application
- susceptibility in laboratory

Low or no susceptibility

Low prevalence (generally)

- Steenberg et al. (1995) observed prevalence of **67 %** of *B. bassiana* in staphyllinid *Anotylus rugosus* (n=563)

Vestergaard and Eilenberg (2000). *IOBC/WPRS* 23 (2), 181-185  
 Steenberg et al., (1995). *Entomophaga* 40, 77-85  
 Riedel & Steenberg (1998). *BioControl* 43, 175-188



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Implications for ecosystem services

## Natural infections of predators in an agroecosystem



- Soil surface between rows of white cabbage
- 3 transects (fixed area)
- Collection of mycosed cadavers
- Host identification to functional group



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N.V. Meyling, unpublished data



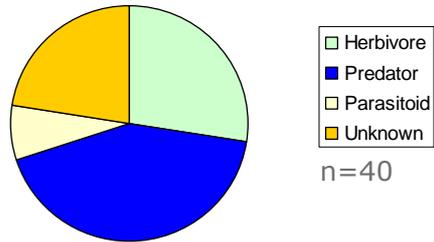
Implications for ecosystem services

## Natural infections of predators in an agroecosystem



*B. bassiana* infected staphylinid beetle

- Regulation of predator populations ?
- Trophic and behavioural interactions

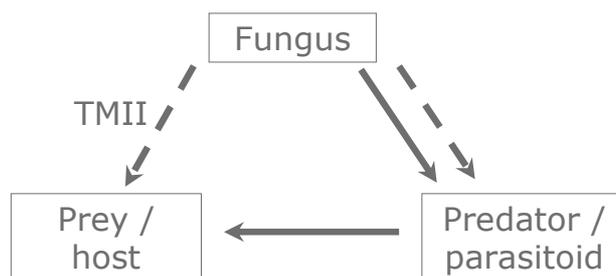


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N.V. Meyling, unpublished data

Implications for ecosystem services

## Trait mediated indirect interactions



Do fungi affect predator behaviour ?

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Relevance of behavioural ecology

## Fungal pathogens of predators - evidence from behavioural ecology

### Fungi constitute a significant mortality risk

- Mortality risk is density-dependent
- Selection for avoidance mechanisms
- 'Behavioural resistance'
- Observations of predator behaviour

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Relevance of behavioural ecology



## Avoidance of *B. bassiana* on phylloplanes

*Anthocoris nemorum*

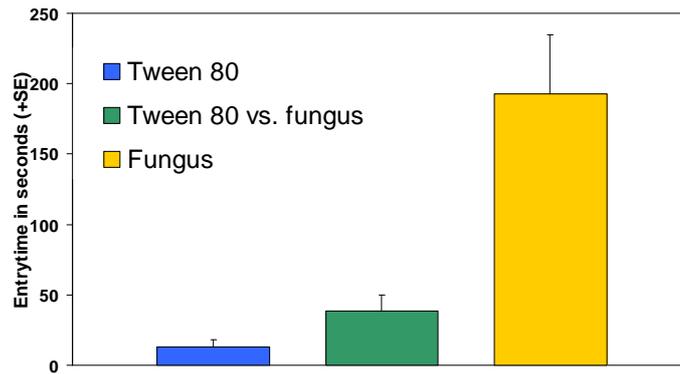
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Meyling and Pell (2006). *Ecological Entomology* 31, 162–171

Relevance of behavioural ecology



## Detection of entomopathogenic fungi on phylloplanes - entry onto leaves

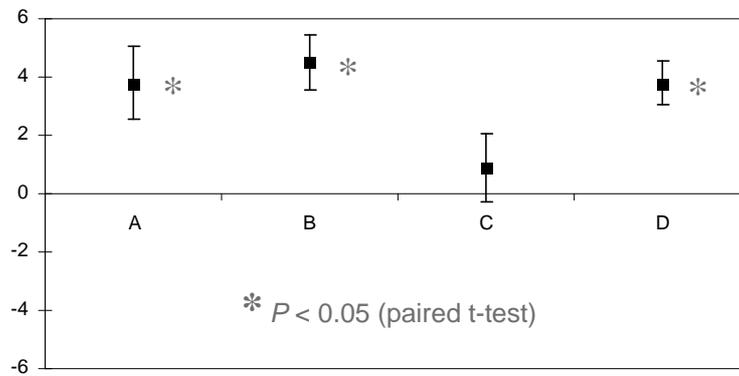
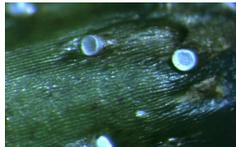


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Meyling and Pell (2006). *Ecological Entomology* 31, 162-171

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## Oviposition on leaves with *B. bassiana*

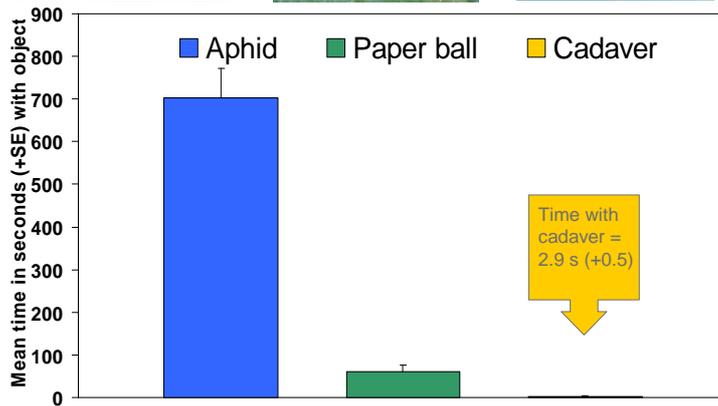


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Meyling and Pell (2006). *Ecological Entomology* 31, 162-171

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## Avoidance of sporulating cadavers



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Meyling and Pell (2006). *Ecological Entomology* 31, 162-171

Relevance of behavioural ecology

## 7-spot Ladybird: Avoidance of *B. bassiana*



Photo: H.E. Roy

**Foraging:** Avoids *B. bassiana*

- on leaves
- on soil



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Photo: E. Ormond

**Overwintering site selection:**

- Selects microhabitat further from sporulating cadaver than from dead conspecific

E. Ormond (unpublished, in prep.)

Relevance of behavioural ecology

## Ecological significance of pathogen avoidance

Fungal pathogens affect behaviour of predators

- direct effects
- trait mediated indirect effects?

Predator natural history

- active hunting vs. sit-and-wait
- over-wintering of adults

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Relevance of behavioural ecology



## Spider pathogenic fungi in agroecosystems



Web building spiders with *Gibellula* spp. infections

- ecological significance?
- host range?

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N.V. Meyling (unpublished)



## Thanks

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