• *Macrolophus* spp. (Heteroptera : Miridae)
  ▫ Small predatory bugs (+/- 3mm)
• Palearctic species
  ▫ Widely used in European greenhouses
  ▫ Biological control of aphids, whiteflies, thrips, spider mites on eggplants, tomatoes,…

• Two commercially distributed species:
  ▫ *M. pygmaeus* and *M. caliginosus*
• Morphologically very similar

*M. pygmaeus* often sold as "*M. caliginosus*" by biocontrol companies (Perdikis *et al.*, 2003, Martinez-Cascales *et al.*, 2006, Machtelinckx *et al.*, 2009)

• Facultative phytophagous predators
  ▫ In times of prey scarcity: feeding on plants
• Piercing-sucking mouthparts

• Our objective:
  ▫ Endosymbiotic community in *M. caliginosus* and *M. pygmaeus*
  ▫ Symbiosis :'living together of two dissimilar organisms' (De Bary, 1879)
  ▫ Most important and best known arthropod endosymbiont: *Wolbachia*
**Wolbachia**

- Obligate intracellular alpha-proteobacterium with an exceptionally wide host range within the arthropods
- Approximately 66% of all insects infected (Hilgenboecker et al., 2008)
- Possible influence on the fecundity (Vavre et al., 1999)
- In rare cases: obligate for its arthropod host (Dedeine et al., 2001)

**Parthenogenesis**

Infected females produce female offspring of unfertilized eggs in haplo-diploids (thelytoky via gamete duplication) (Stouthamer et al., 1990)

**Wolbachia**

Manipulates the reproduction of its arthropod host
- **Feminization**
  - Infected genetic males convert into females (prevention of the androgenic gland formation) (Rousset et al., 1992)

**Male killing**

- *Wolbachia* bacteria kill male progeny during embryogenesis while female progeny survives (Stevens et al., 2002)
Cytoplasmic incompatibility

- Probably most common effect of *Wolbachia* (Stouthamer et al., 1999)
- Cross between an infected male and an uninfected female or a female infected with another *Wolbachia*-strain results in embryonic mortality

Effect of *Wolbachia* in *M. pygmaeus*?

- *Macrolophus pygmaeus* is infected with *Wolbachia* (Machtelinckx et al., 2009)
- An infected strain was cured by adding tetracycline to an artificial diet based on egg yolk

Crossing experiments

- Infected males with infected females [I-♂ x I-♀]
- Uninfected males with uninfected females [U-♂ x U-♀]
- Infected males with uninfected females [I-♂ x U-♀]
- Uninfected males with infected females [U-♂ x I-♀]

*Wolbachia* causes cytoplasmic incompatibility in *M. pygmaeus* (only 8 out of 702 eggs hatched)
Other endosymbionts?

- Besides *Wolbachia*: increasing number of endosymbionts found in arthropods (Duron et al., 2008)
  
  *Rickettsia* (MK, P)
  
  *Arsenophonus* ("Son-killer")

*Cardinium* (CI, P, F)

*Spiroplasma* (MK)

Conclusion

- *Wolbachia* induces strong CI in *M. pygmaeus*
  - May have vital implications for the commercial production of *Macrolophus* sp. and their use in biological control
  - Suppression of the population growth by interaction of populations with a different infection status

Future research

- Reproductive effect of endosymbionts in *M. caliginosus*
- Infection status of wild *Macrolophus* spp.
  - Same endosymbiotic community?
  - Bidirectional incompatibility?

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- Thank you for your attention!