Identity of parasitoids and their potential for biocontrol of oilseed rape pests in Europe

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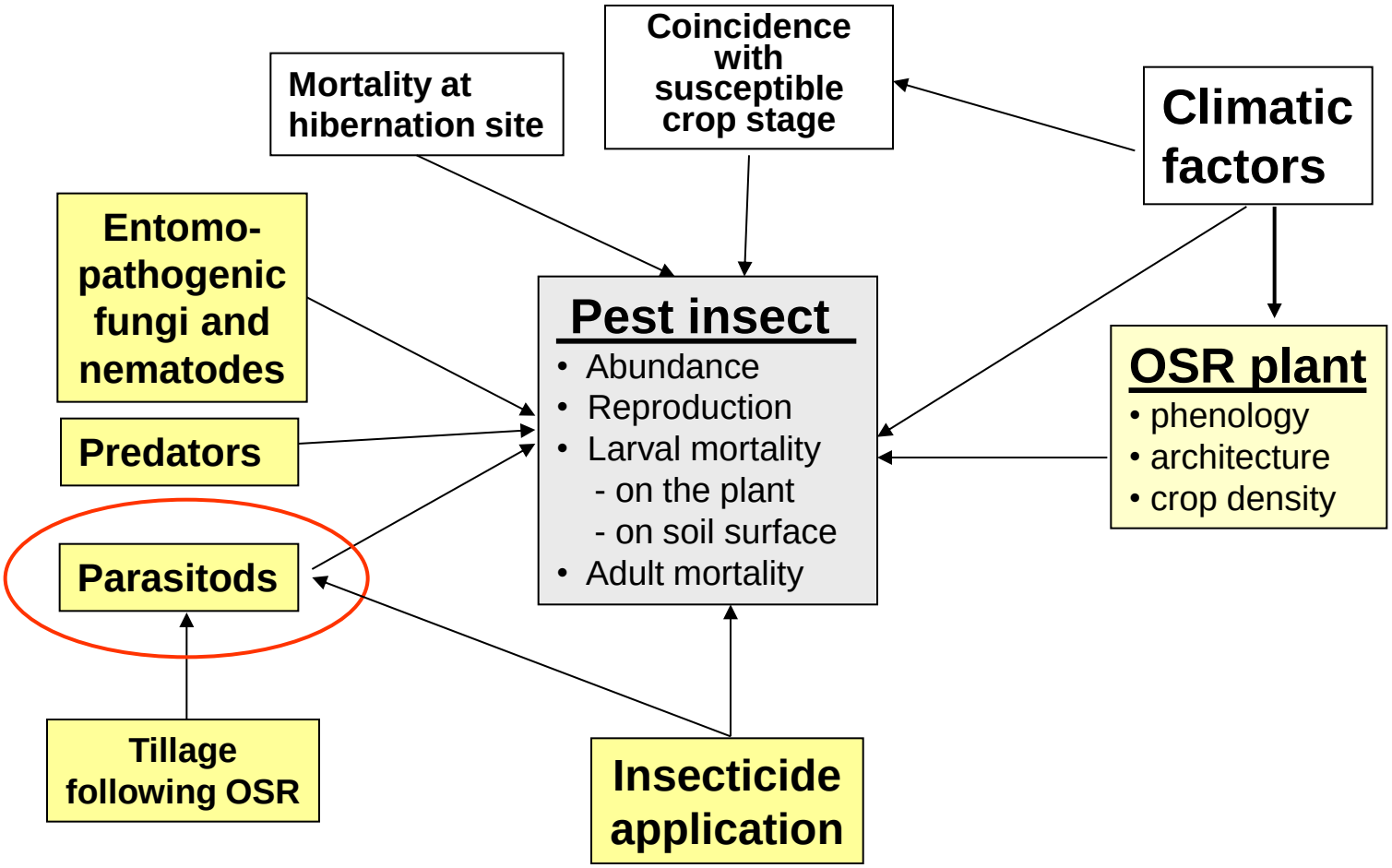
Photo: A. W. Ferguson, UK

Major factors affecting the population dynamics of pest insects on OSR



Outline

1. **Identity and status of hymenopterous parasitoids of OSR pests**
2. **Biology, phenology and behaviour of key parasitoids on OSR**
3. **Percentage parasitism and potential for conservation biocontrol of pests**
4. **Factors affecting parasitoid efficacy**

Management **St**rategies for **E**uropean **R**ape pests

Integrated Pest Management Strategies Incorporating Bio-Control for European Oilseed Rape Pests

(EU project QLK5-CT-2001-01447, 2001 - 2006)

MASTER project partners:

I.H. Williams, A.W. Ferguson (UK),

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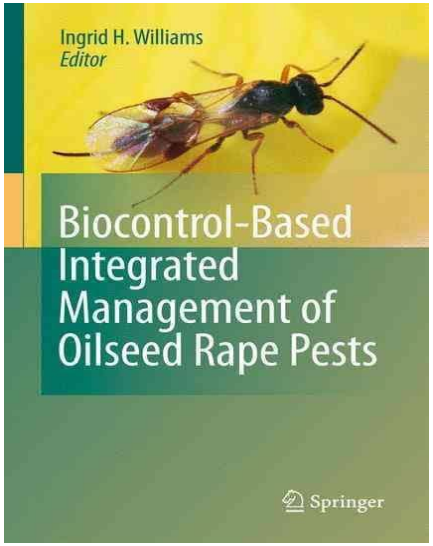

Key larval parasitoids of stem-mining pests and of pollen beetle on oilseed rape in Europe

Target Pest	Key Parasitoids
Cabbage stem flea beetle, *Psylliodes chrysocephala*	*Tersilochus microgaster* (Szépligeti)
Rape stem weevil, *Ceutorhynchus napi*	*Tersilochus fulvipes* (Gravenhorst)
Cabbage stem weevil, *Ceutorhynchus pallidactylus*	*Tersilochus obscurator* Aubert
Pollen beetle, *Meligethes aeneus (syn. Brassicogethes aeneus)*	*Phradis interstitialis* (Thomson) *Phradis morionellus* (Holmgren) *Tersilochus heterocerus* Thomson *Diospilus capito (Nees)*

Life history of parasitoids of stem-mining pests and pollen beetle

Photo: A. W. Ferguson, UK

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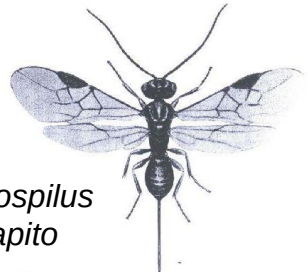
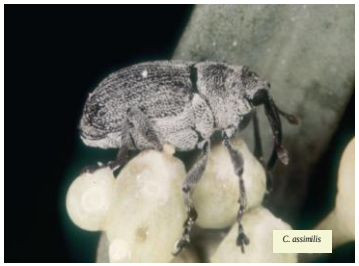


Diospilus capito

Ichneumonidae-Tersilochinae: *T. microgaster* *T. fulvipes* *T. obscurator* *P. interstitialis* *P. morionellus* *T. heterocerus*	**Life history:** • univoltine • solitary larval endoparasitoids • koinobiont • nearly host specific
Braconidae: *Diospilus capito*	**Life history:** • multivoltine • solitary larval endoparasitoid • koinobiont • host specific

Key larval parasitoids of seed weevil and pod midge on oilseed rape in Europe



Target Pest	Key Parasitoids
Cabbage seed weevil, *Ceutorhynchus assimilis* (*syn. C. obstrictus*)	*Trichomalus perfectus* (Walker) *Stenomalina gracilis* (Walker) *Mesopolobus morys* (Walker)
Cabbage pod midge, *Dasineura brassicae*	*Platygaster subuliformis* (Kieffer) *Omphale clypealis* (Thomson)

Life history of parasitoids of cabbage seed weevil and cabbage pod midge

Photo: A. W. Ferguson, UK

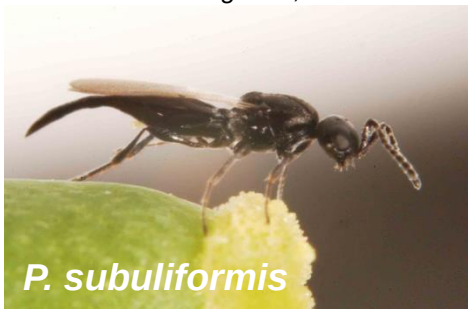


Photo: A. W. Ferguson, UK

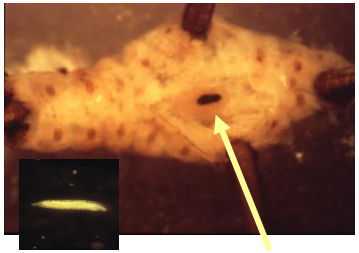
Photo: A. W. Ferguson, UK

Chalcidoidea: Pteromalidae *Trichomalus perfectus* *Mesopolobus morys* *Stenomalina gracilis*	**Life history** • larval ectoparasitoids of seed weevil • solitary • idiobiont • multivoltine
Platygastridae *Platygaster subuliformis*	• egg/larval endoparasitoid of pod midge • solitary • koinobiont • multivoltine
Eulophidae *Omphale clypealis*	• larval endoparasitoid of pod midge • solitary • koinobiont • multivoltine?

Methods of study

1. **Parasitoid activity, phenology and distribution:**
   - emergence traps on previous OSR fields
   - YWT sampling on new crops of OSR

2. **Percentage larval parasitism:**
   - dissection of host larvae under a stereo micrscope
   - rearing of adult parasitoids from host larvae



Parasitoid larva

T. heterocerus egg

3. **Identification of parasitoid species**:
   - rearing out of adult parasitoids from host larvae

Full-grown host larva

transfer to soil

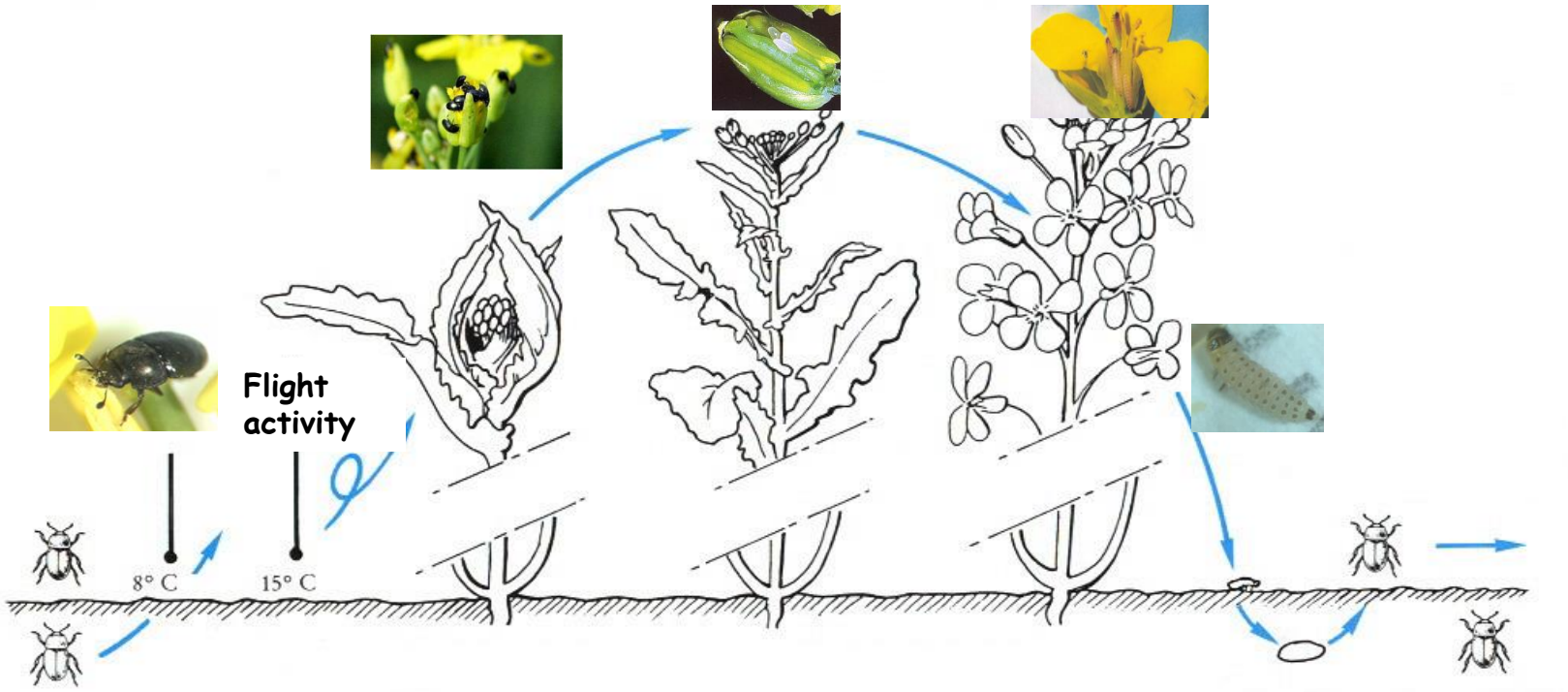
Pupal cocoon of parasitoid

emergence from soil

Female parasitoid

Life cycle of pollen beetle

Winter	March / April	May	June	July	August



Overwintering in soil under leaf litter

Invasion and feeding on buds

Oviposition into buds; larval development in buds and flowers

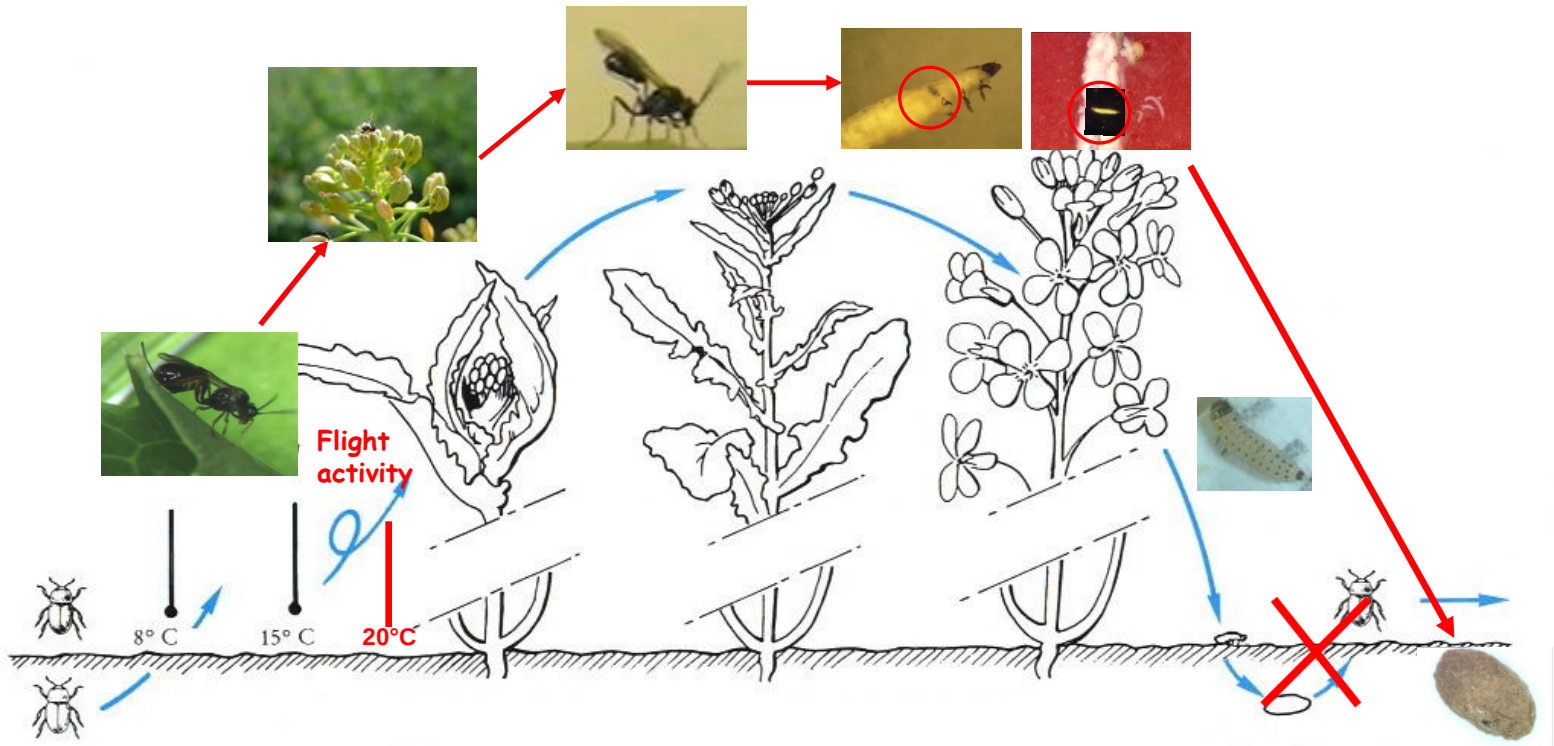
Pupation in soil

Autumn-Winter diapause in litter

Excerpt from CETIOM 1985

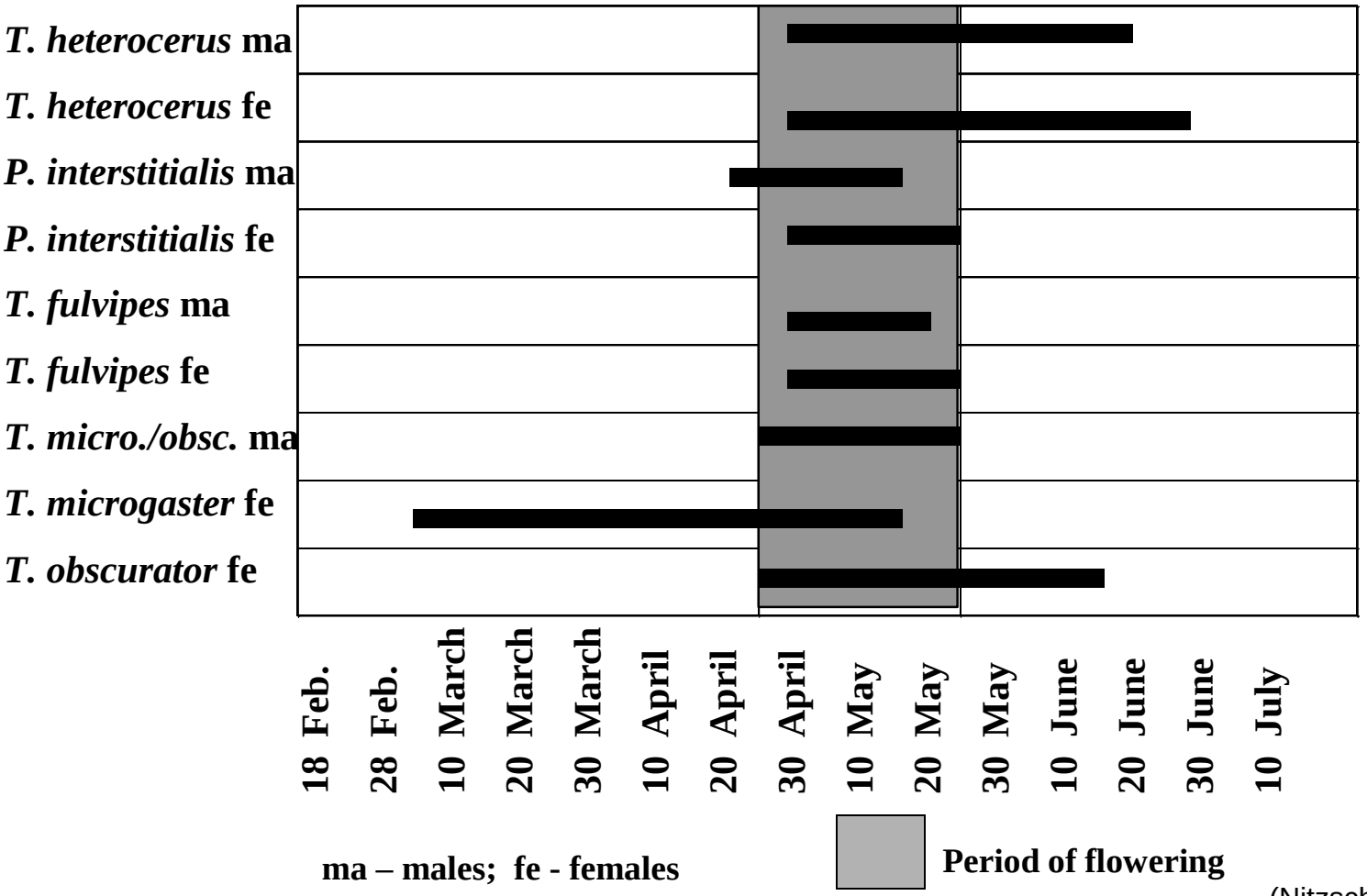
Life cycle of pollen beetle and its univoltine parasitoids

winter	March/April	May	June	July



Pollen beetle:	Overwintering under litter	Feeding on buds	Oviposition into buds, feeding of larvae in buds/flowers	Full-grown larvae (non-parasitized and paras.) dropping to the ground
Parasitoid:		Emergence from previous year OSR field	Crop location and oviposition into PB eggs or larvae	In soil: parasitoid larva kills prepupa of PB, pupates in silken cocoon; adult wasp hibernates

Phenology of tersilochine parasitoids on crops of oilseed rape in relation to the time of flowering



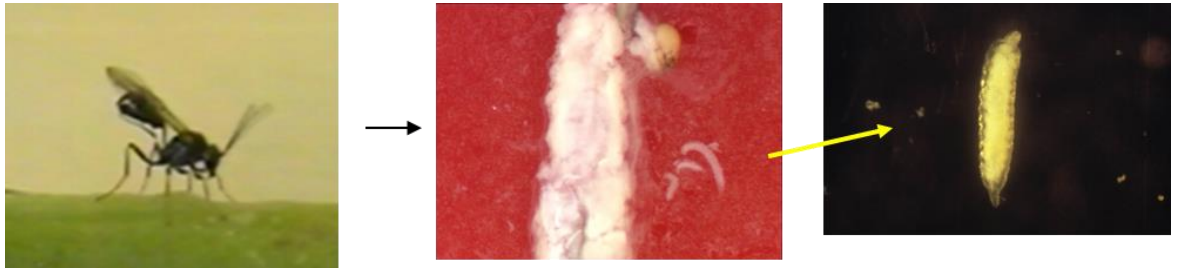
(Nitzsche, 1998)

Parasitisation behaviour of *T. obscurator* (video by U. Wyss)

Cabbage stem weevil
larvae are mining
in petioles and stems

Tersilochus obscurator

• for parasitisation, females lay single eggs through the stem tissue into host larvae

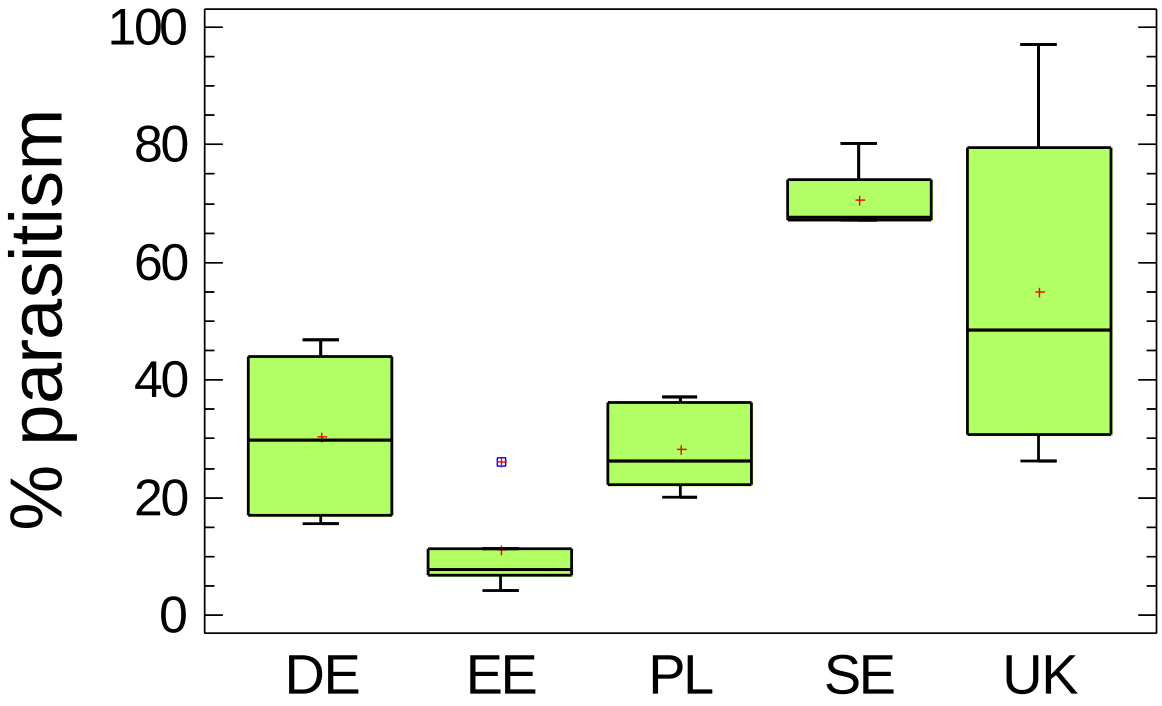


Percentage parasitism of insect pests on oilseed rape

(data collected from crops of OSR around Göttingen, 1993-2016)

Pest	Parasitoid	Range of parasitism rate
Rape stem weevil (*Ceutorhynchus napi*) 	*Tersilochus fulvipes* 	**0 - 21 %**
Cabbage stem weevil (*Ceutorhynchus pallidactylus*) 	*Tersilochus obscurator* 	**20 – 50 %**
Pollen beetle (*Meligethes aeneus*) 	*Phradis interstitialis*  *Phradis morionellus* *Tersilochus heterocerus*	**45 - 83 %**
Seed pod weevil (*Ceutorhynchus assimilis*) 	*Mesopolobus morys*  *Stenomalina gracilis* *Trichomalus perfectus*	**30 – 70 %**
Stem flea beetle (*Psylliodes chrysocephala)* 	*Tersilochus microgaster* 	**up to 44 %**

Percentage larval parasitism of *M. aeneus* in IPM OSR plots in EU countries (2003 – 2005)



Levels of parasitism ranging between

4 – 26% in EE

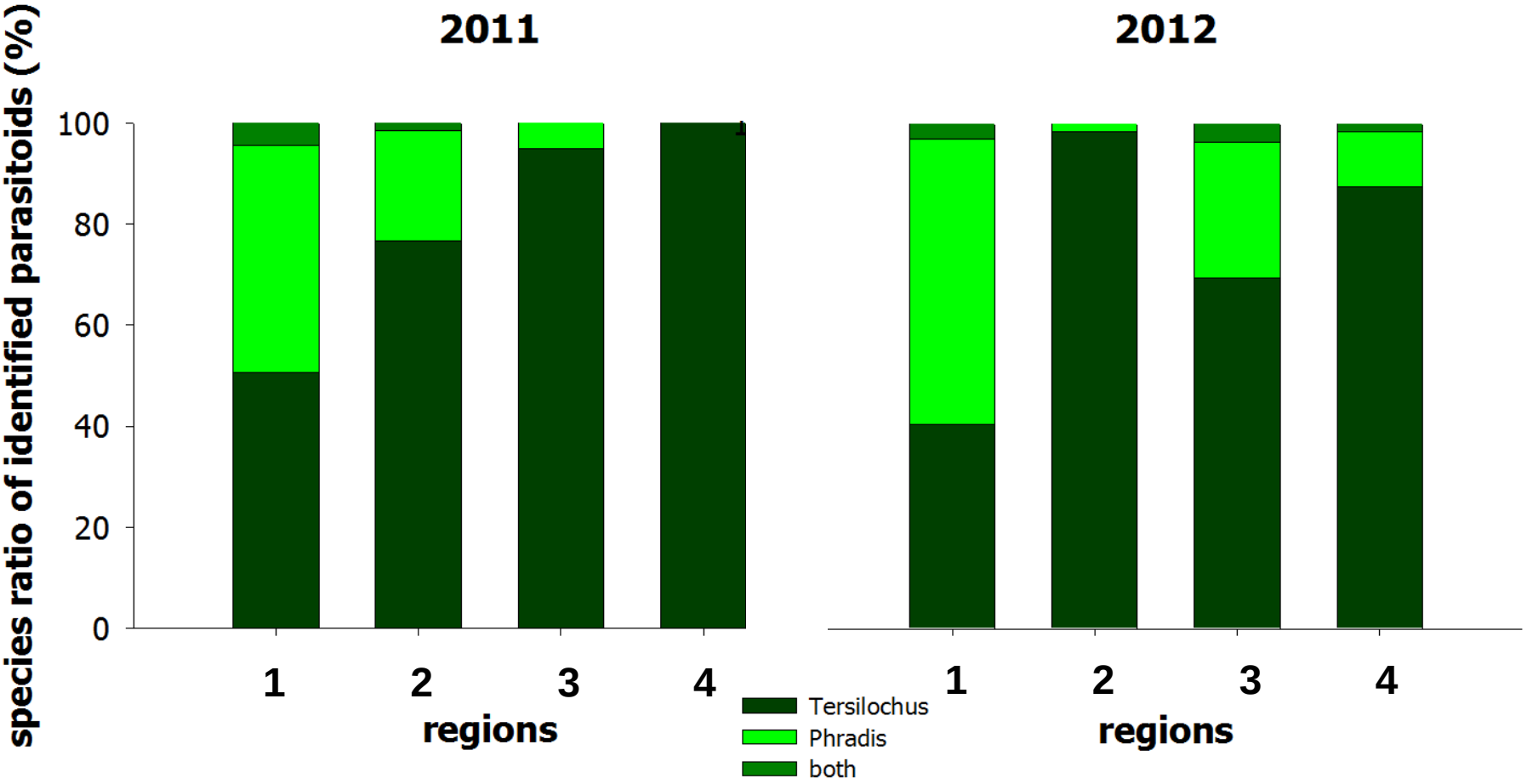
18 – 46% in DE and PL

26 – 80% in SE and the UK

(max. 97% in the UK)

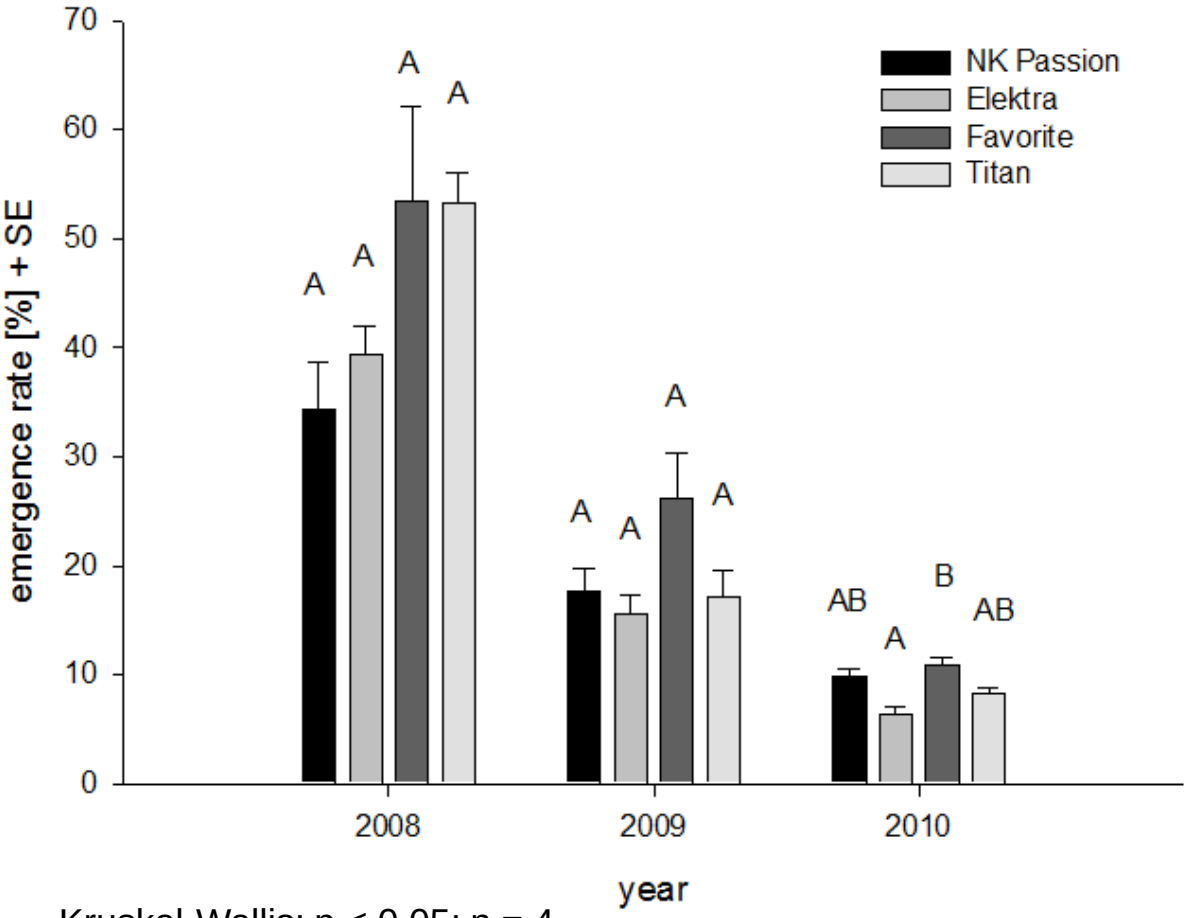
Data collected by Ulber/DE, Luik/EE, Klukowski/PL, Nilsson/SE, Williams/UK

Species composition of *T. heterocerus* and *Phradis* spp. in parasitized pollen beetle larvae collected from 4 regions in Northern Germany



Percent emergence* of new-generation pollen beetles

* Number of emerging beetles as percentage of dropping larvae



Kruskal-Wallis; $p < 0.05$; $n = 4$

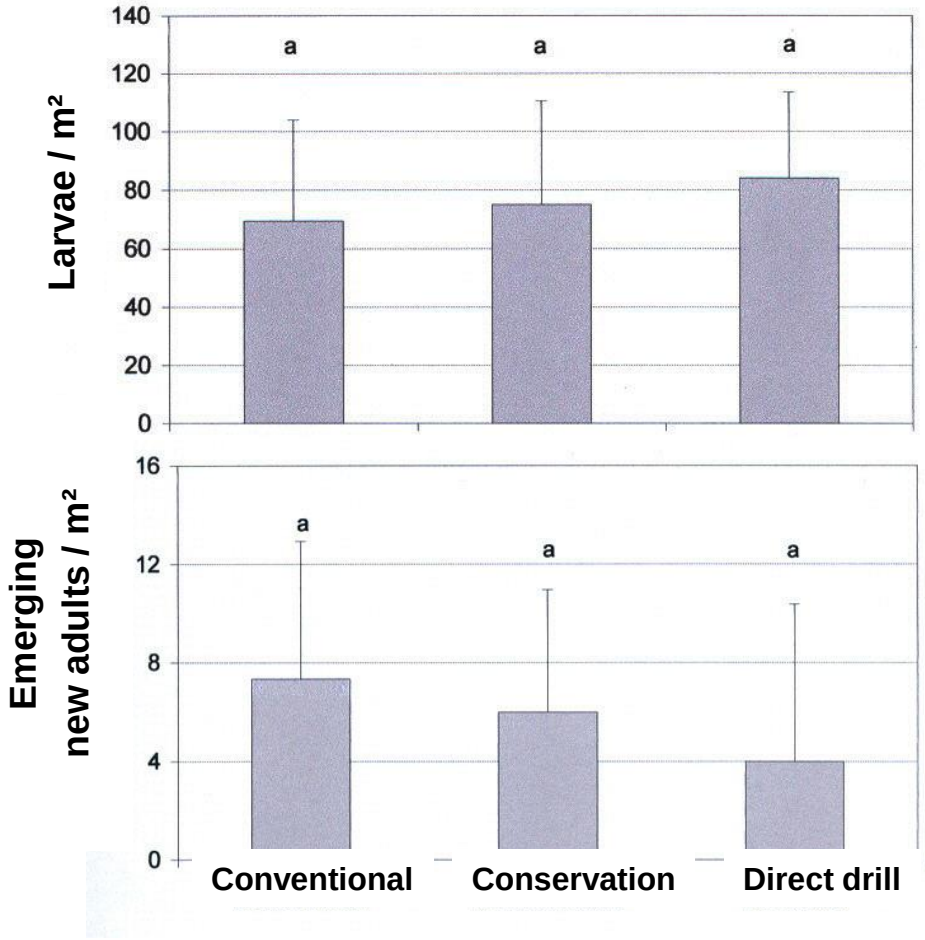
Level of larval parasitism:

2008: 39.1 – 42.3 %

2009: 42.2 – 46.3 %

2010: 70.8 – 77.3 %

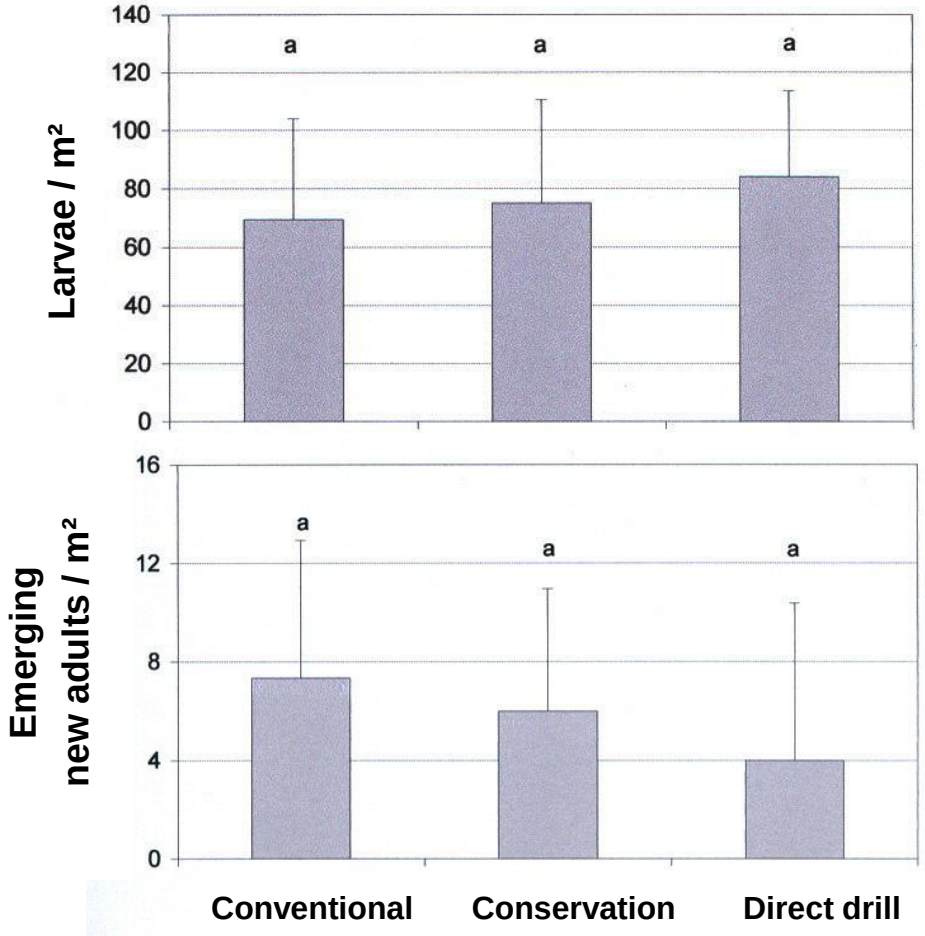
Effect of larval parasitization on the abundance of emerging new generation pollen beetles



Adult emergence rate:	**10.5 %**	**8.0 %**	**4.8 %**
(larval parasitism 68-83%)			

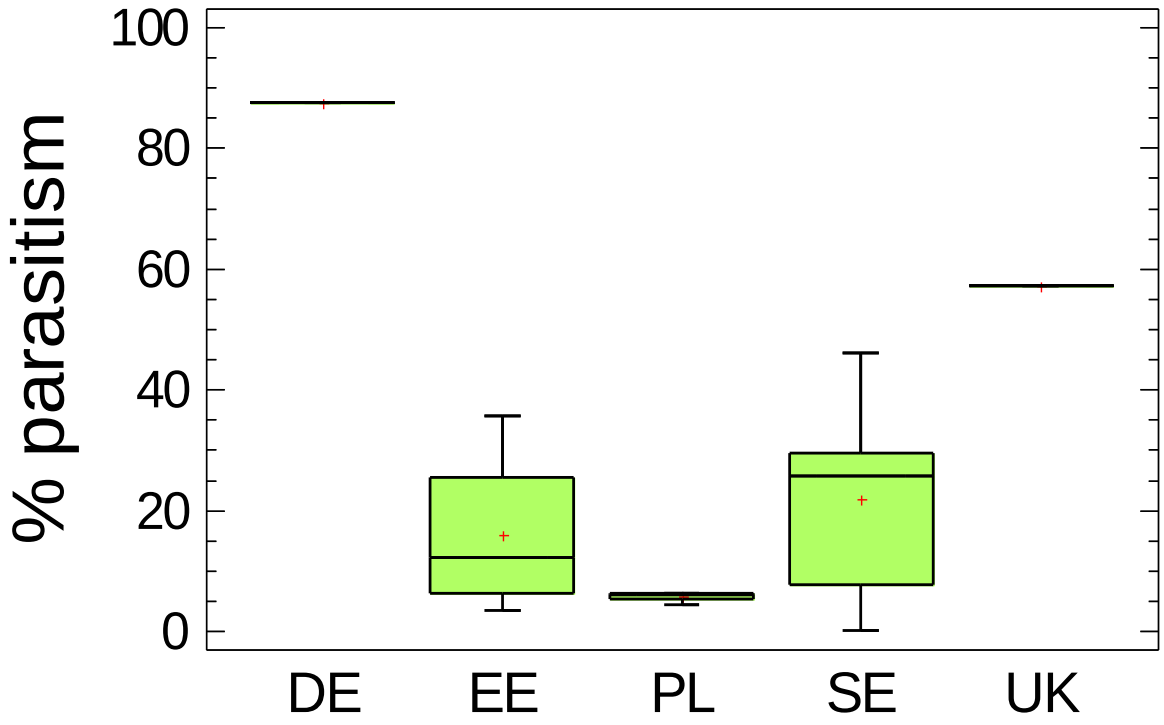
(Ulber & Schierbaum-Schickler, 2005)

Effect of larval parasitization on the abundance of emerging new generation pollen beetles



Adult emergence rate:	**10.5 %**	**8.0 %**	**4.8 %**
(larval parasitism 68-83%):			
Adult emergence rate calculated	***61.6 %***	***25.2 %***	***25.7 %***
- in absence of parasitism:			

Percentage larval parasitism of *C. obstrictus* in IPM OSR plots in EU countries (2003 – 2005)



Levels of parasitism ranging between

4 – 6% in PL

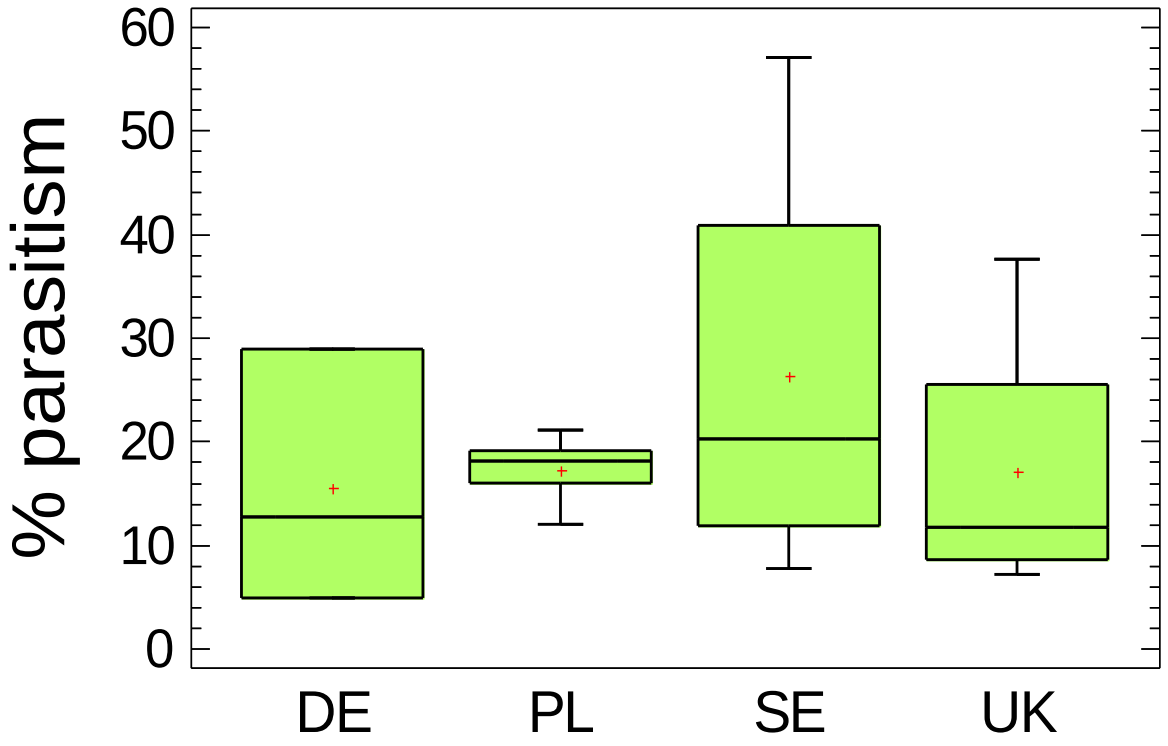
0 – 46% in EE and SE

57% in the UK (1 exp.)

87 % in DE (1 exp.)

Data collected by Ulber/DE, Luik/EE, Klukowski/PL, Nilsson/SE, Williams/UK

Percentage larval parasitism of *C. pallidactylus* in IPM OSR plots in EU countries (2003 – 2005)



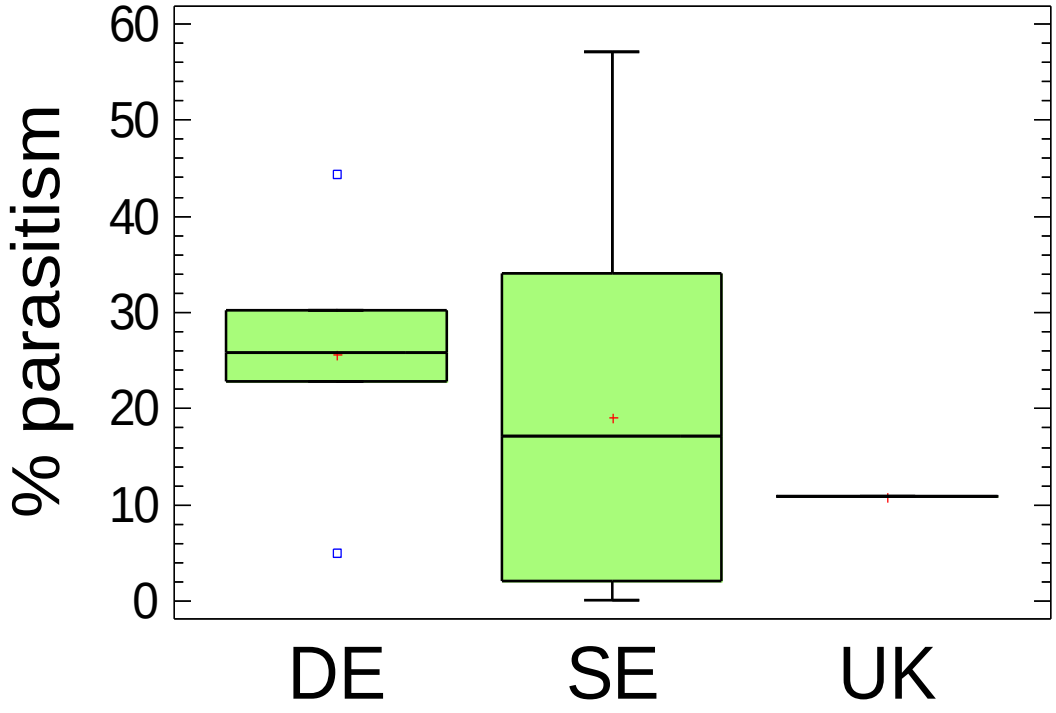
Levels of parasitism ranging between

5 – 37% in DE, PL, SE and in the UK

up to 57% in SE

Data collected by Ulber/DE, Klukowski/PL, Nilsson/SE, Williams/UK

Percentage larval parasitism of *P. chrysocephala* in IPM OSR plots in EU countries (2003 – 2005)



Levels of parasitism ranging between

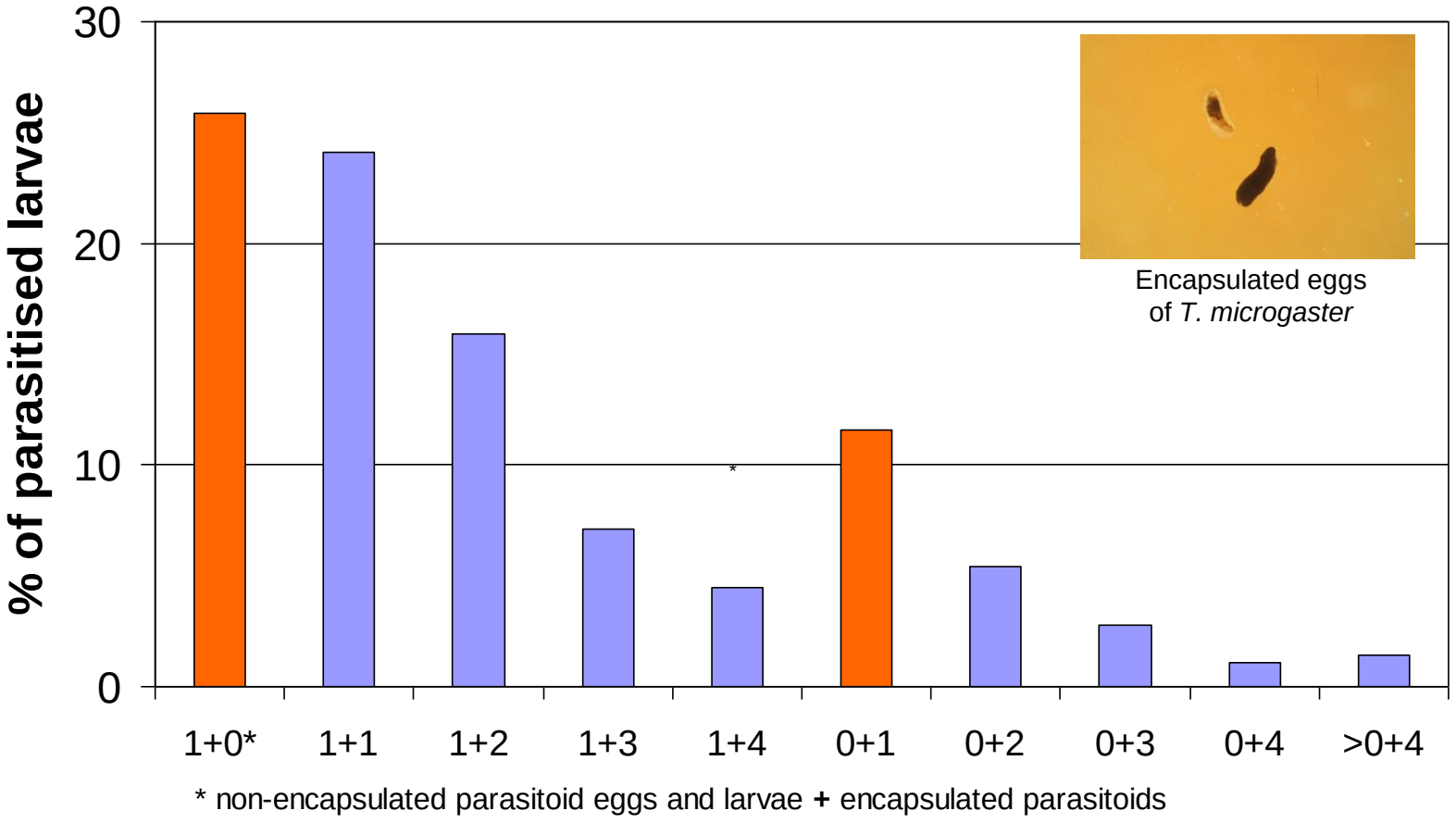
0 – 57 % in DE and SE

11 % in the UK (in 1 exp.)

Data collected by Ulber/DE, Nilsson/SE, Williams/UK

Superparasitism of *P. chrysocephala* by *T. microgaster*

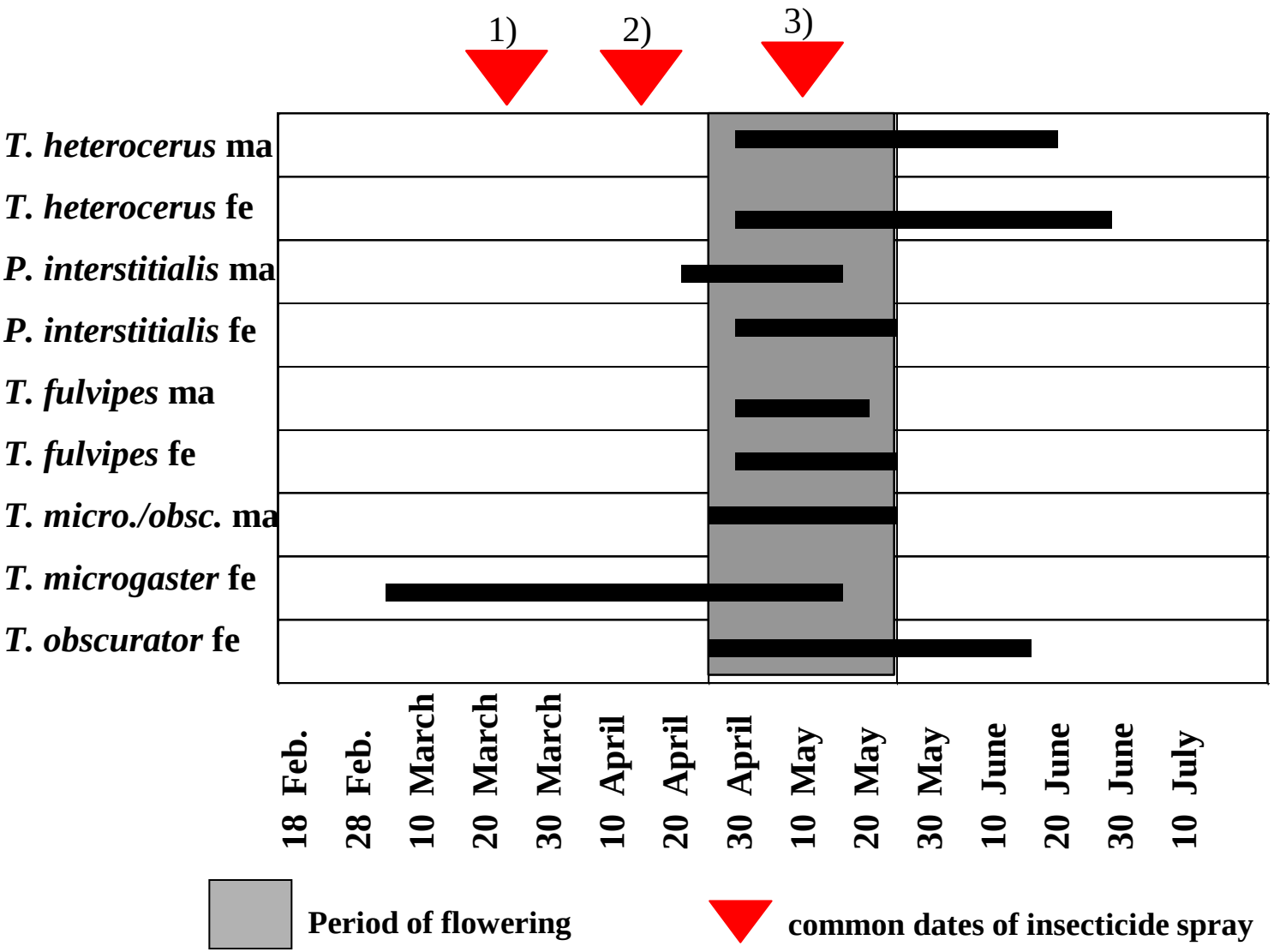
Total number of host larvae = 352 (Goettingen, 15 April 2002)



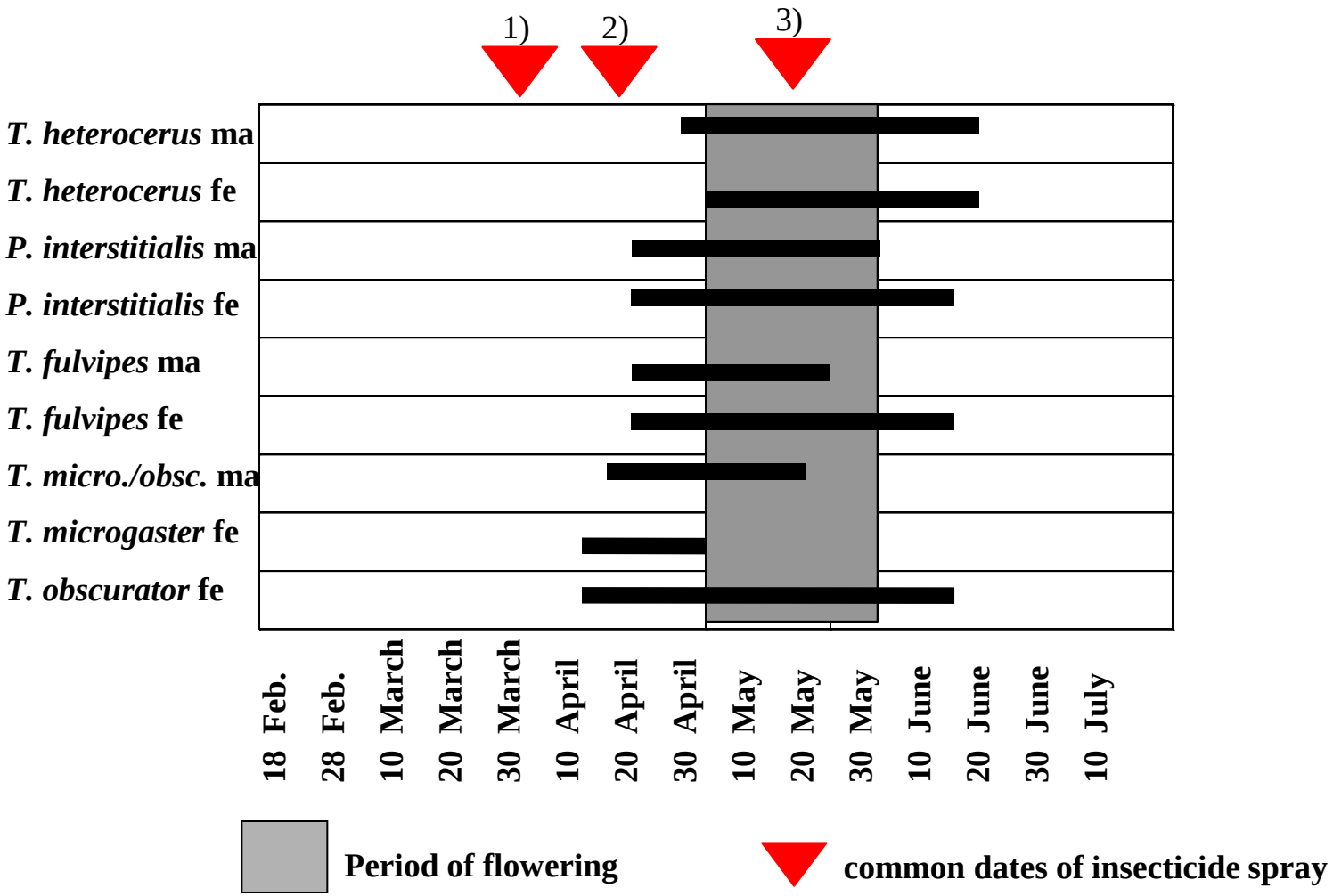
4. Some factors affecting parasitoid efficacy

- **Spatio-temporal synchronisation between insect pests and their parasitoids (e.g. Ferguson et al., 2003, 2004; Johnen et al., 2010)**
- **Plant species and plant phenology (e.g. Veromann et al. 2006; Kaasik et al., 2014)**
- **Crop management:**
  - **Insecticide application (e.g. Ulber et al., 2010; Jansen & San Martin y Gomez, 2014)**
  - **Post-harvest soil tillage (e.g. Nitzsche 1998; Nilsson, 2010)**
  - **Plant density / Plant architecture (e.g. Ulber et al., 2010)**
  - **Field margins / banker plants (e.g. Barari et al., 2004)**
- **Landscape effects (e.g. Thies & Tscharntke, 2010; Zaller et al., 2009; Rusch et al., 2010; 2011)**

Activity period of tersilochine parasitoids on crops of oilseed rape in relation to insecticide treatment (1997)



Activity period of tersilochine parasitoids on crops of oilseed rape in relation to insecticide treatment (1996)



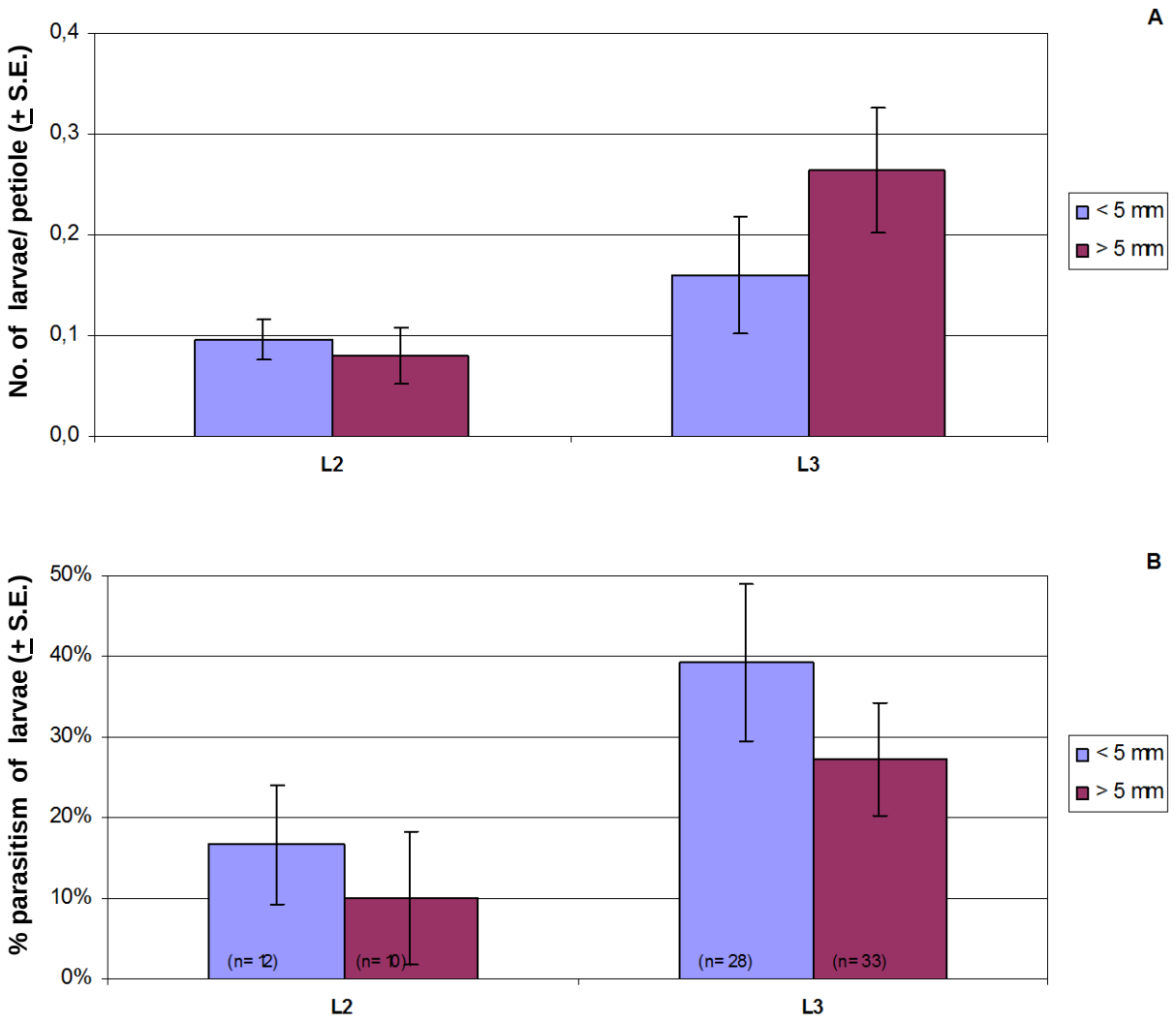
Post-harvest tillage effects on adult parasitoids emerging from soil in spring (Ind./m²)

	Conventional tillage	Conservation tillage	Direct drilling
GÖ-Reinshof 1996			
P. interstitialis	**2 c**	**7 b**	**14 a**
T. heterocerus	**1 c**	**7 b**	**11 a**
GÖ-Weende 1997			
P. interstitialis	**38 c**	**88 b**	**113 a**
T. heterocerus	**17 c**	**49 b**	**55 b**

(Nitzsche, 1998)

- **Non-inversion tillage applied following harvest of oilseed rape increases the survival of parasitoids, thus contributing to IPM**

Mean number of *P. chrysocephala* larvae (A) and larval parasitism (B) in petioles of small (<5mm) and large (>5mm) diameter. May 2003



Potential of parasitoids for biocontrol of oilseed rape pests in Europe

Percent parasitism of pests in STN/ICM experiments

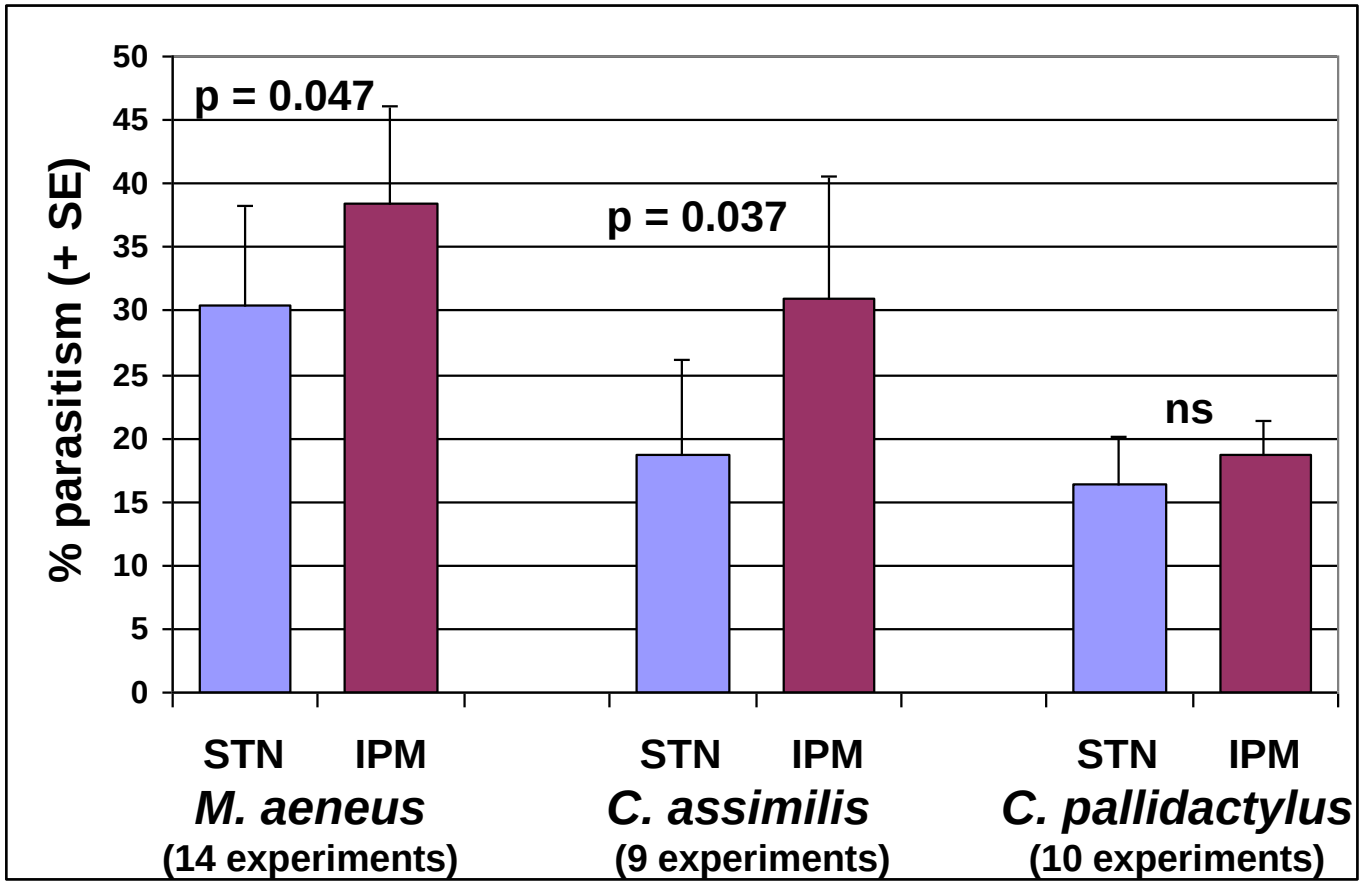
Collaborative field experiments on a farm-scale to compare two OSR crop management systems:

- Standard European OSR cropping system (STN)
- Integrated Pest Management system (IPM)

- in Germany (DE), Estonia (EE), Poland (PL), Sweden (SE), and (UK)
- in 2002/03, 2003/04, 2004/05

Mean percent larval parasitism of OSR pests in conventional STN and IPM plots

MASTER IPM Strategies experiments in EE, DE, PL, SE, UK
2003 - 2005



Data collected by Ulber/DE, Luik/EE, Klukowski/PL, Nilsson/SE, Williams/UK

Conclusions

- Twelve key parasitoids are sufficiently widespread and abundant across Europe to be of potential economic importance for biocontrol of pests. They occure in almost all EU countries where their host species are present
- Percentage parasitism of pest larvae varies between EU countries and years; levels frequently exceed 30%, indicating their impact on populations of new-generation adults
- Mean parasitism of *M. aeneus* and *C. assimilis* was increased by an Integrated Pest Management system, compared to a Standard Management system
- Strategies for conservation and enhancement of parasitoid efficacy need to be improved in further studies

…thank you for attention!