

Control of codling mothm *Cydia pomonella*, with entomopathogenic nematodes

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Why nematodes ?

- Larvae of codling moths are natural hosts for nematodes
- Alternativ measures available only in summer
 - Granulosis viruses (Granuloseviren)
 - Parasitoids (*Trichogramma sp.*)
 - Pheromones (Mating disruption)
 - Chemical insecticides
- Nematodes may provide additional control against diapausing larvae in winter



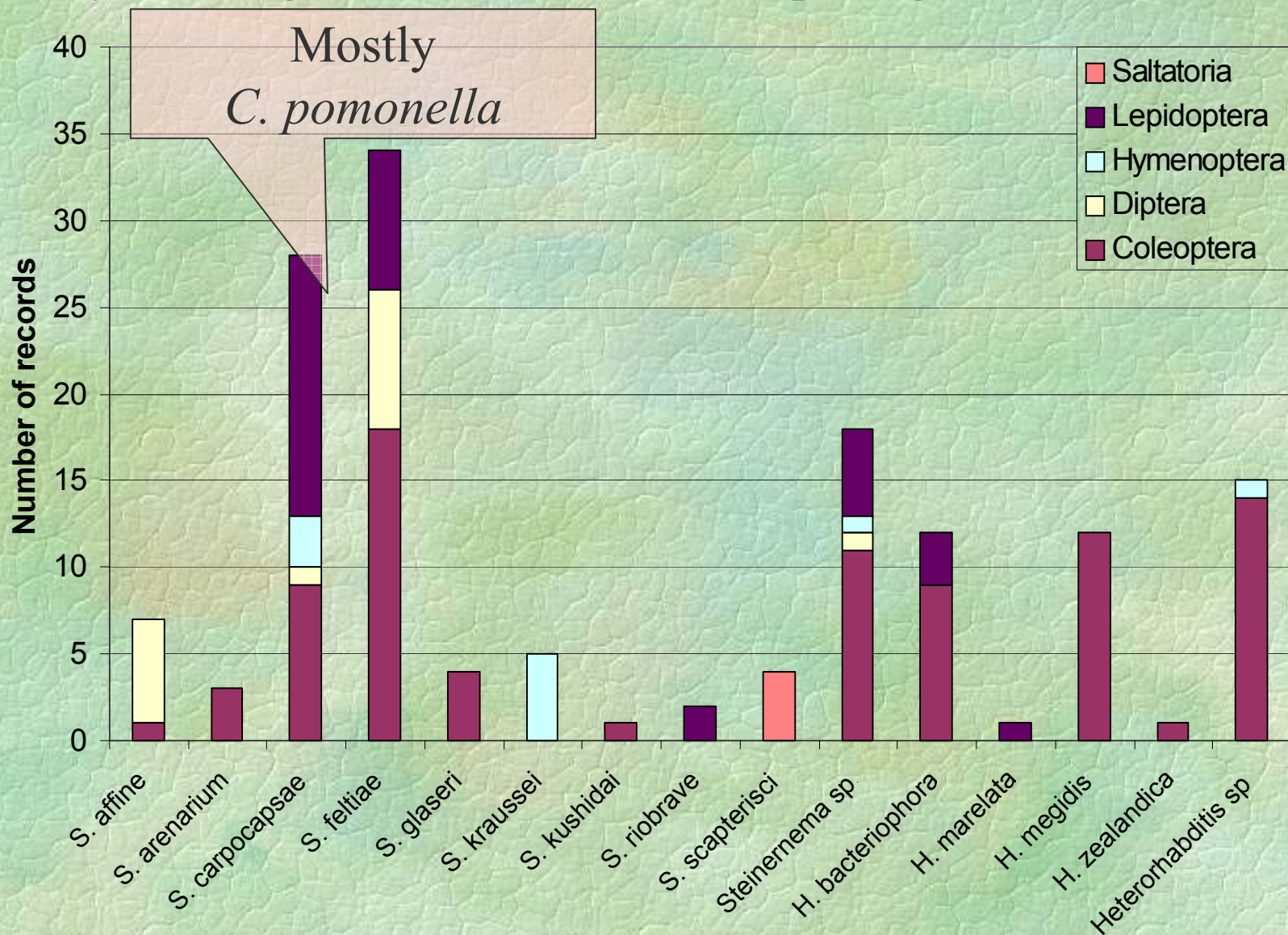
- Eggs are laid end of May
 - 80 eggs / female
- Hatching after 10 days. Short cruising and penetration into fruit
- After 4 weeks descent of larvae (mid July)
- Pupation and 2nd generation
- Descent of Mid September
 - Diapausing larvae in cocoon

Pupation in April/May

Cydia (Carpocapsa) pomonella

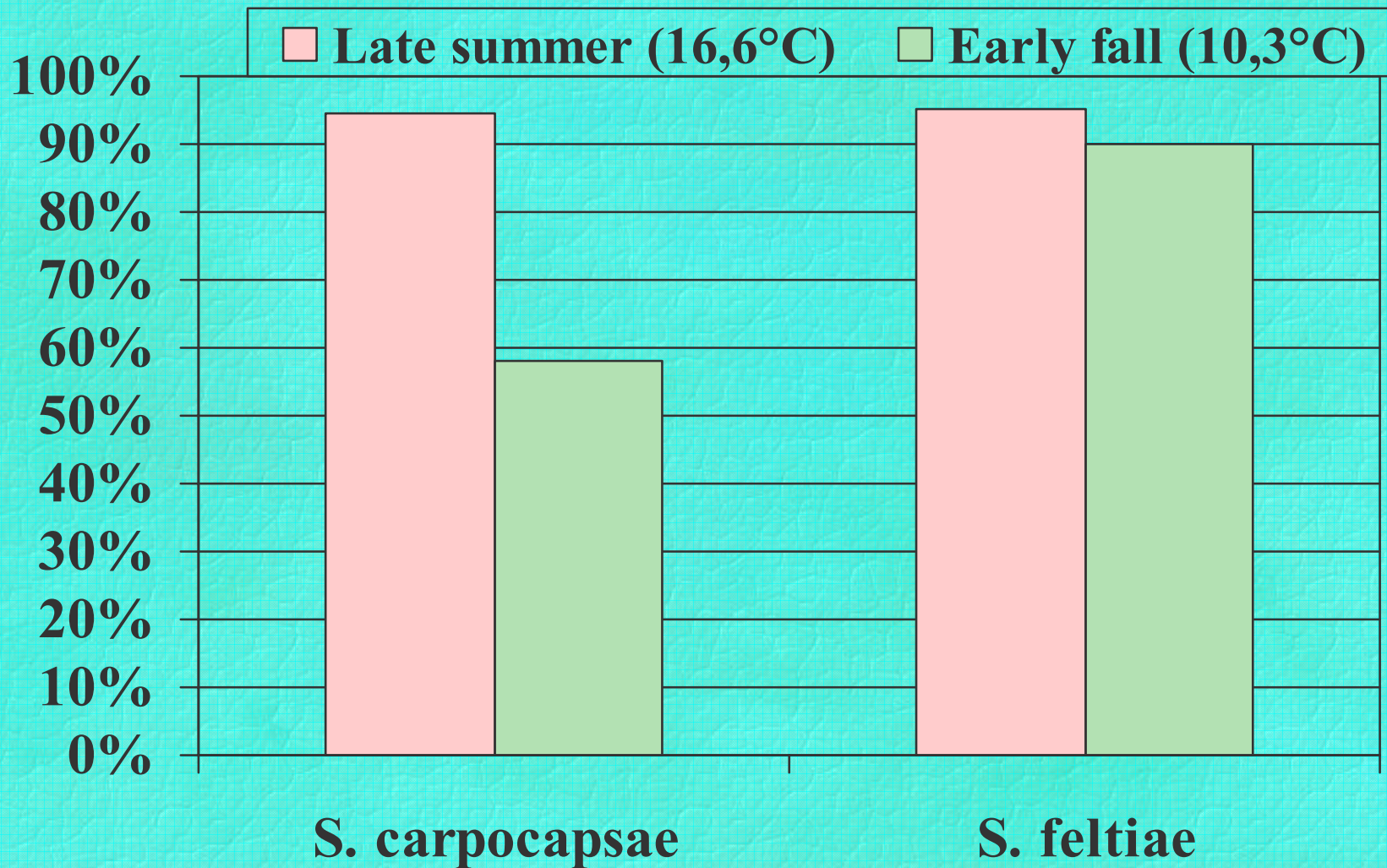
- Lepidoptera, Tortricidae
- Larvae often infected with *Steinernema carpocapsae*
 - USA, Mexiko
 - Polen, Tschechien, Italien, Bulgarien
- *Steinernema feltiae* also occurs as natural hosts

Naturally occurring infections with entomopathogenic nematodes



First experiences from the USA

L. Lacey & T. Unruh (2005)



Conditions

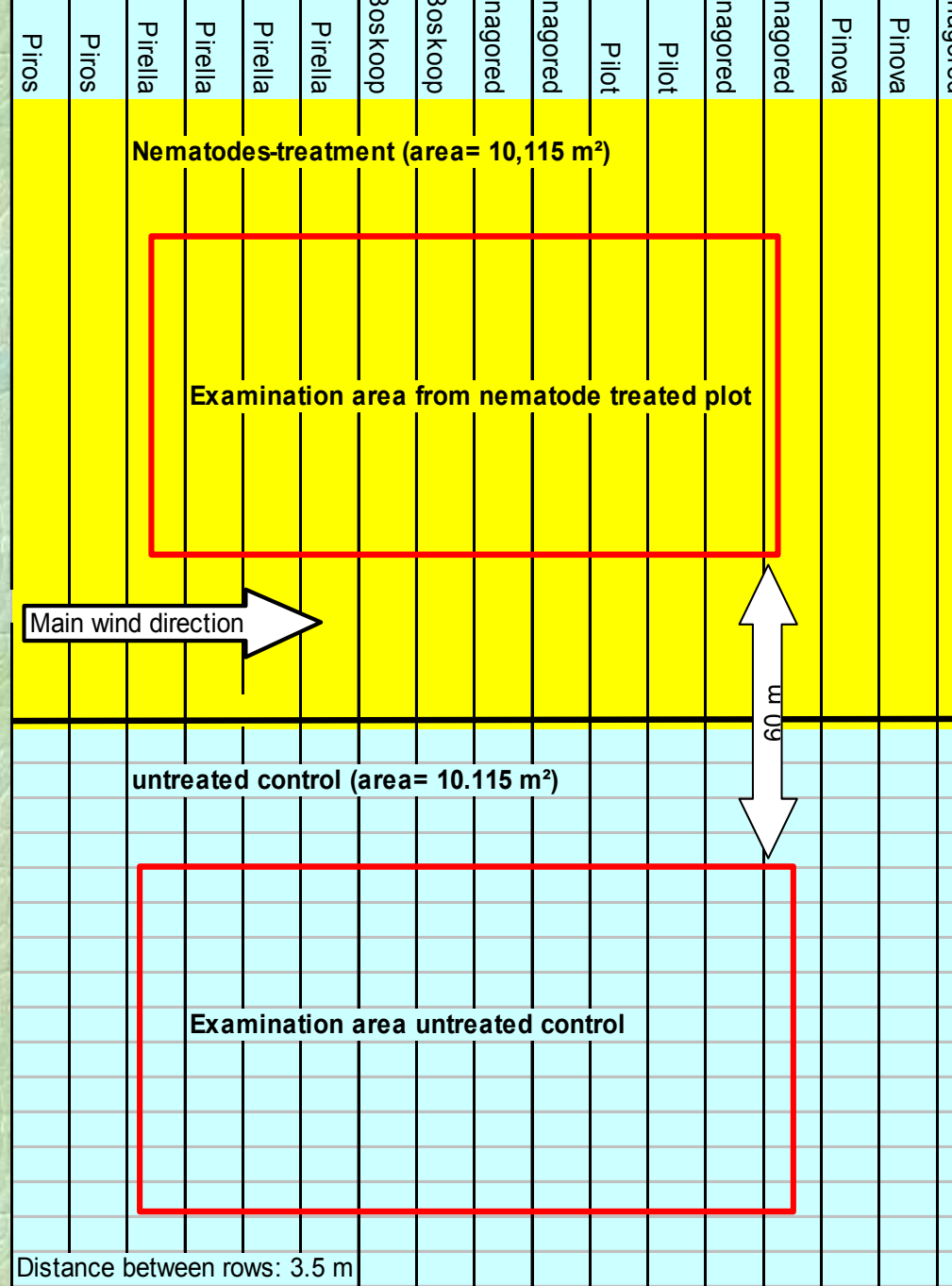
- Approx. 1 million nematodes per tree
- 2.5 billion nematodes per ha
- approx. 4000 l water per ha
- Backpack sprayer or airblast-sprayer
- Wetting agent and high relative humidity important
- Larvae on trunk and in the soil
- Examination by placing sentinel larvae and assessing infection 24 h after treatment

Trials in Germany

- Orchard in Werder (close to Berlin)
- 4000 l / ha
- 3.75 billion / ha (1.5 million / tree)
 - *Steinernema feltiae* (nemaplus)
- Application 21. October 2004
- No sentinel larvae
- Instead, examination of fruit symptoms next summer (12. July 2005)

The trial plot:

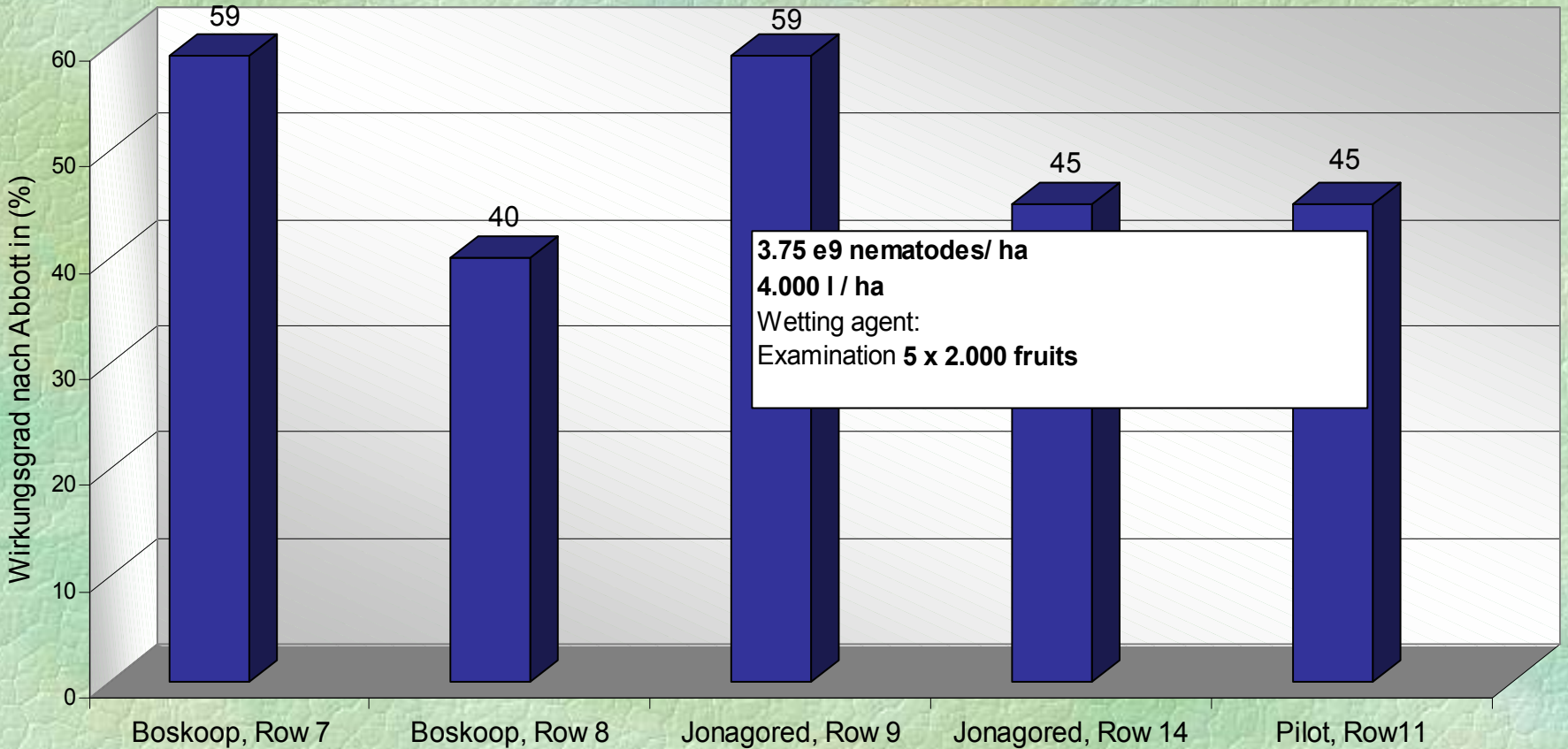
- sufficient size
- main wind direction







Treatment: 21.10.2004, Examination: 12.07.2005



Conclusions

- First trial with assessment of fruit damage instead of sentinel larvae
- adverse conditions :
 - Trees still covered with leaves
 - Frost before and few days after treatment
- nematode dosage still high (3.75 billion/ha)
 - economically difficult
 - trials in 2005 with 1.5 und 2 billion/ha (results in July 2006)
- combination with other biological measures
 - Additional option for Integrated Control and Resistance Management

field trials of the insect-specific nematodes, *Steinernema carpocapsae* and *S. feltiae* were conducted in apple and pear orchards under a variety of conditions to determine the effects of nematode species and seasonal temperature, formulation, post-application irrigation and method of application on efficacy. Applications of one million infective juveniles (IJs) of *S. carpocapsae* or *S. feltiae* per apple tree with a backpack sprayer plus wetting agent and supplemental wetting in late summer and early fall with mean temperatures of 16.6°C and 10.3°C during the initial 24 h following treatment resulted in larval mortalities caused by *S. carpocapsae* of 94.4 and 58.2, respectively and 95.1% and 90.1%, respectively, due to *S. feltiae*. Similar tests with *S. feltiae* in the same location in mid-October (mean temp. 7.3°C) using cocooned sentinel larvae in logs and cardboard strips were conducted with and without: post-application wetting, wetting agent and a humectant. The highest mortality (80%) was observed in cardboard substrates receiving post-application wetting, and either wetting agent or humectant. Apple trees that were treated in late summer (mean temp. 20.1°C) with two million IJs of *S. feltiae* per tree using an airblast sprayer or with a hand-held lance applicator plus supplemental wetting resulted in 83 and 92% mortality in sentinel CM larvae, respectively. CM mortality under two types of irrigation, conventional over head bringlers and micro-sprinklers, in a older commercial pear orchard that was treated with one billion IJs/acre of *S. carpocapsae* using an airblast sprayer resulted in nearly 100 % mortality in sentinel larvae.

Codling moth, *Cydia pomonella*, is a worldwide pest of apple and pear. Traditional control methods have been based predominantly on broad spectrum insecticides. Concerns over the safety, environmental impact, and sustainability of synthetic pesticides have stimulated development and use of softer control methods within the integrated pest management (IPM) strategy. Natural enemies (entomopathogens, predators and parasitoids) and their use as biological control agents play key roles in IPM. In this review we summarize the literature on biological control of codling moth and discuss its integration with other control options in orchard IPM. A variety of entomopathogens have been reported from codling moth, but only the codling moth granulovirus (CpGV) and entomopathogenic nematodes (EPNs) have been developed as microbial control agents. CpGV is highly virulent and selective for neonate codling moth larvae, but may require frequent reapplication due to solar inactivation, especially when population densities are high. The EPNs *Steinernema feltiae* and *S. carpocapsae* have good potential for control of overwintering cocooned larvae when temperatures are above 10 and 15°C, respectively and adequate moisture is maintained in the orchard for several hours after EPN application. Parasitism by *Mastrus ridibundus* (Ichneumonidae) in some Washington State orchards can exceed 40% in the year following releases which can further supplement parasitism by *Ascogaster quadridentata* (Braconidae) that sporadically approaches 25%. Together these parasitoids and many predators could provide significant biological control of codling moth when broad spectrum pesticides are minimized.