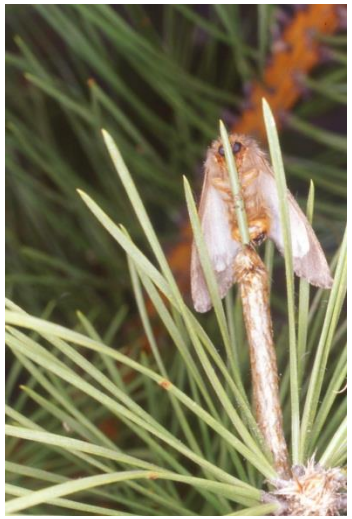
Course contents:	1. Insect abundance and distribution: species-area relationships. Diversity of forest insects in relation to tree species, feeding guilds, and to the history of forest stands. Invasive species in forestry: definitions, concepts, and applications. 2. Classification of the outbreaks and related examples. Population dynamics: demographic growth versus mortality. Population cycles in different types of forest ecosystems. 3. Ecological factors affecting the populations of forest insects. Effects of climate and temperature, including climate change. **Mechanisms of resistance developed by the host plants and adaptations of the insects (natural enemies)..** Role of competition and of natural enemies in population regulation. 4. Principles of integrated pest managements based on the knowledge of the insect ecology. Prevention, direct and indirect control, economic assessment of costs and benefits of IPM in forestry.

Host plant quality and tritrophic interactions

Speed of reproduction

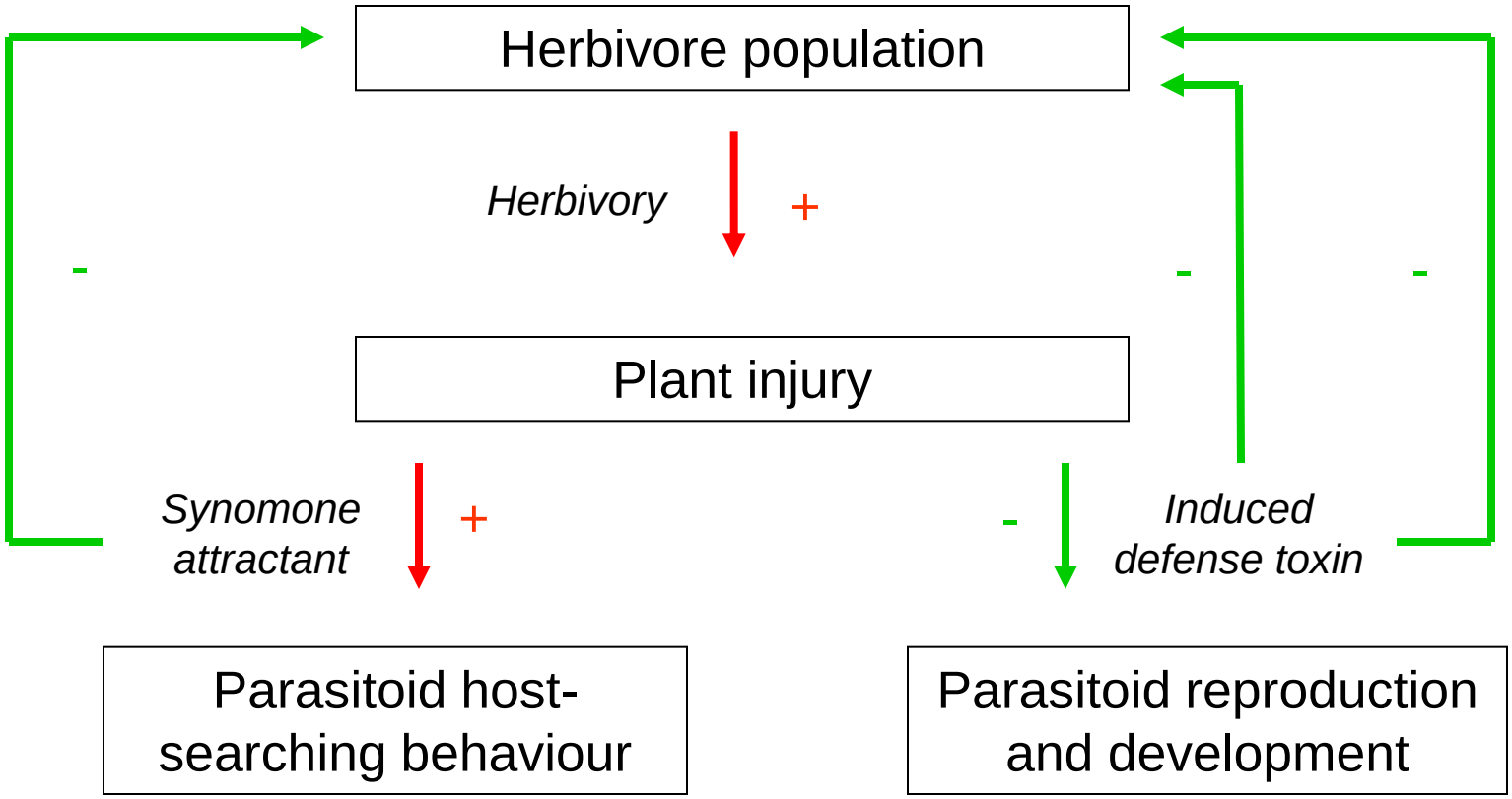
Coniferous tree: >>30 y



Herbivore: ~ 1 y

Parasitoid: <= 1 y

Havill & Raffa 2000 – Conceptual model of tritrophic interactions.



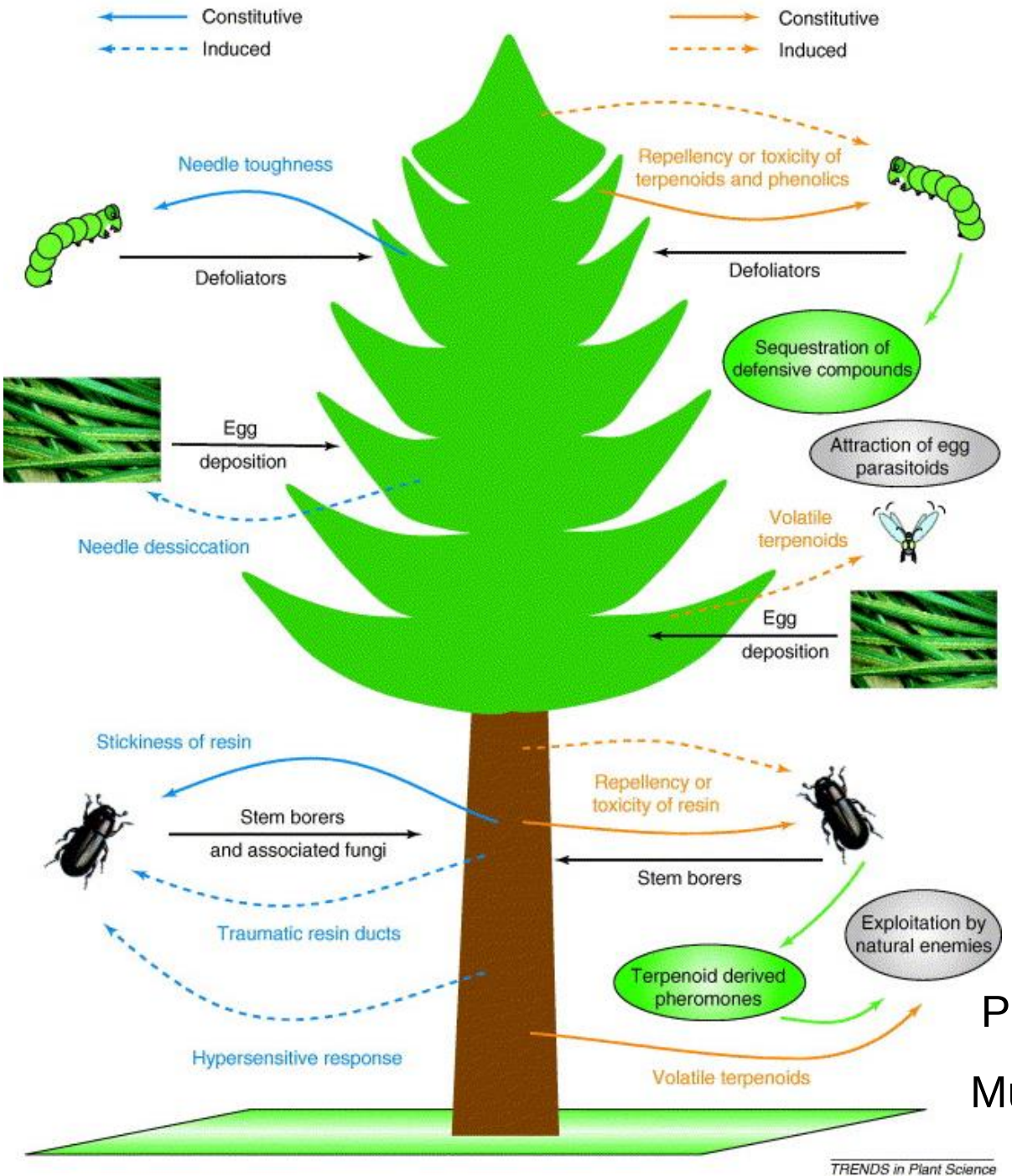
2 + followed by 1 - → negative feedback

1 - → negative feedback
2 - → positive feedback

Constitutive physical-chemical defenses:

tissue toughness

constitutive terpenoids



Induced chemical defenses:

induced terpenoids

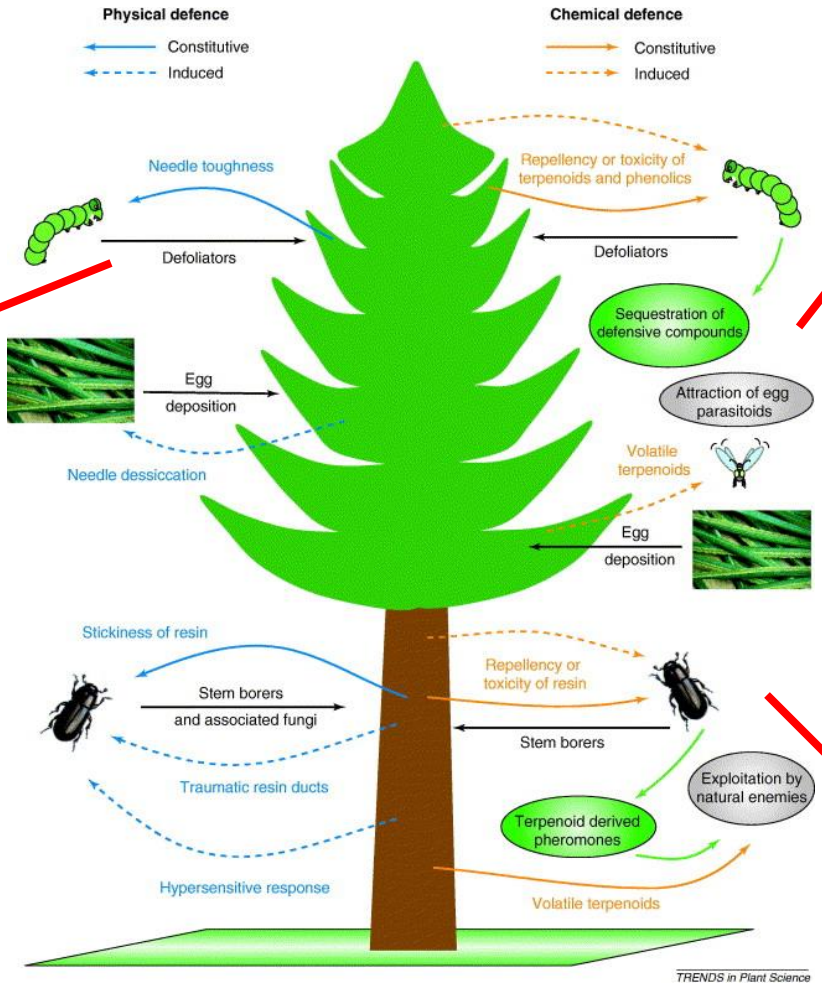
Pine defenses

Mumm & Hilker 2006

THREE SYSTEMS

1. Diprionid sawfly and egg parasitoids

   Hilker and coll.



2. Bark beetle and larval parasitoids

   Pettersson and coll.

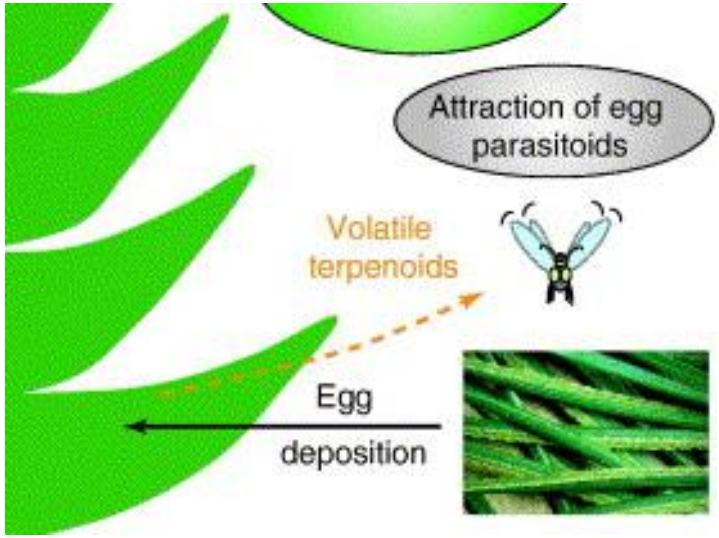
3. Pine processionary moth and egg parasitoids

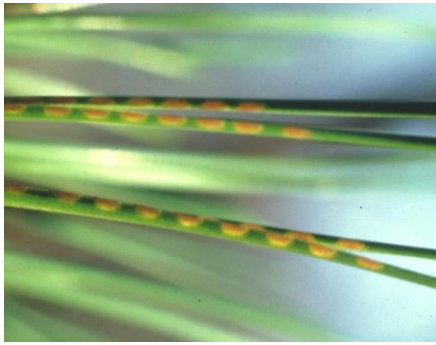
   Battisti and coll.

1. *Diprion pini*, *Neodiprion sertifer* and *Pinus sylvestris*, defoliating sawflies

Chrysonotomyia ruforum, egg parasitoid

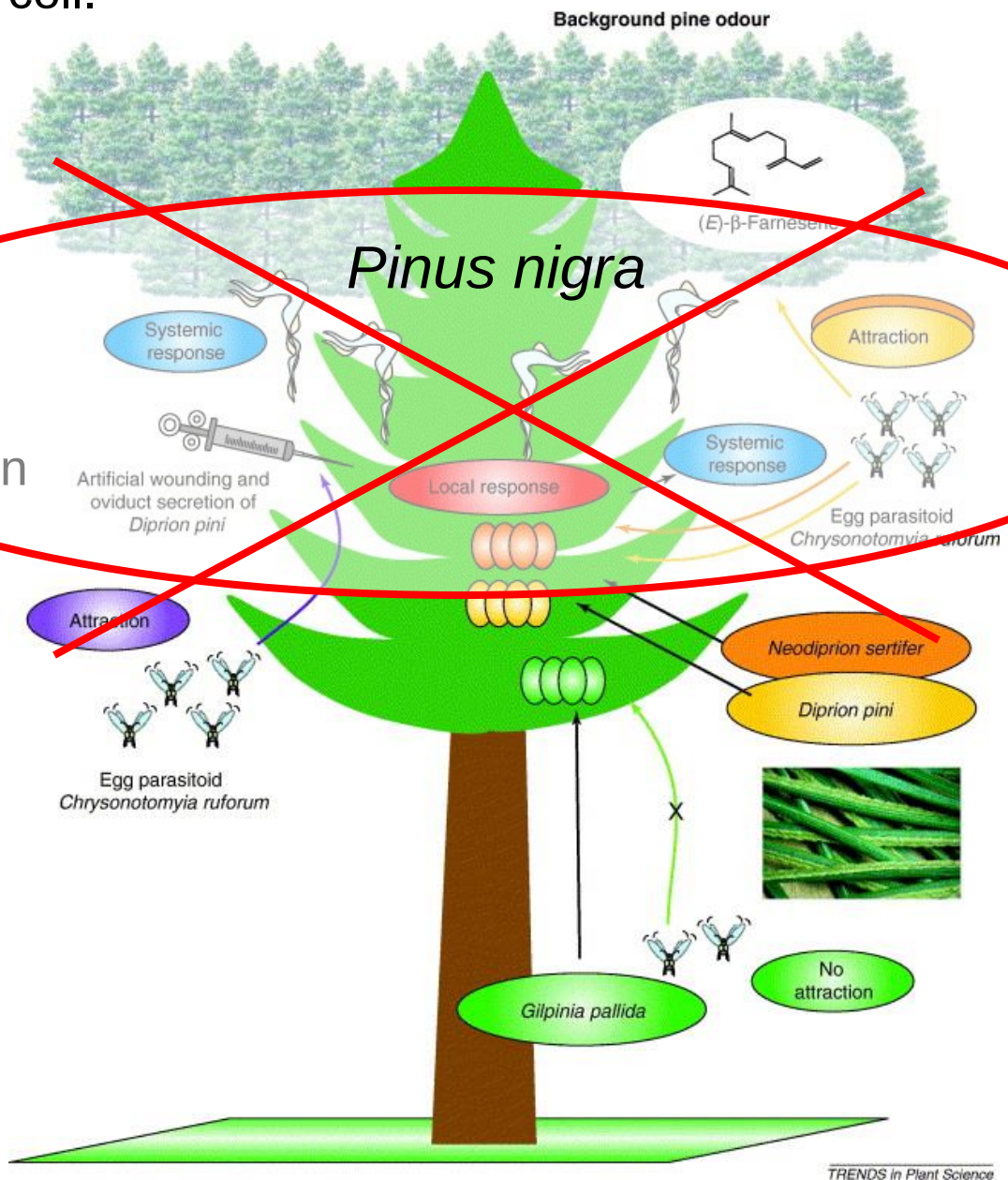
Hilker and coll.





1. *Diprion pini*, *Neodiprion sertifer* and *Pinus sylvestris*

Hilker and coll.



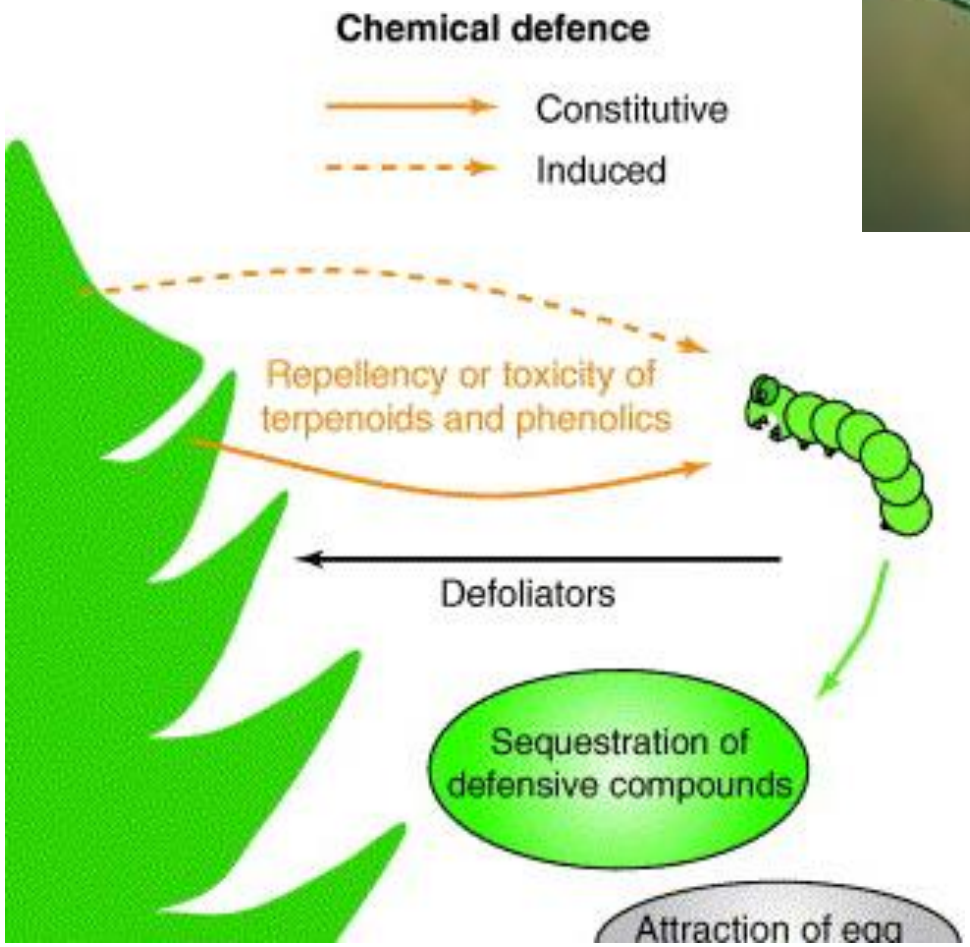
Wounding + oviduct secretion produces the same results

Oviposition induces the local and systemic release of farnesene

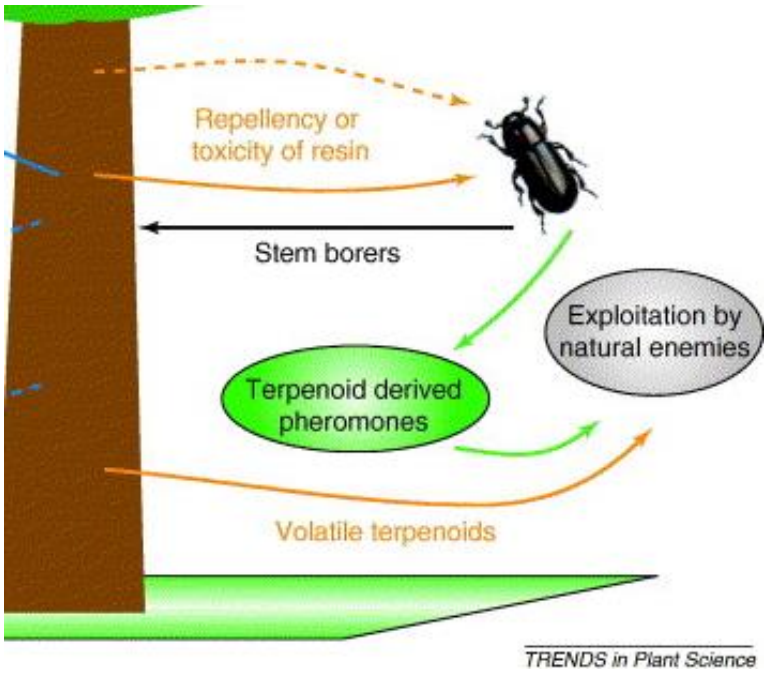
+ background odour

= attraction of egg parasitoid

Mumm & Hilker 2006


Chemical defence
Constitutive
Induced
Repellency or toxicity of terpenoids and phenolics
Defoliators
Sequestration of defensive compounds
Attraction of egg

2. Bark beetles and associated organisms – tree-killing agents



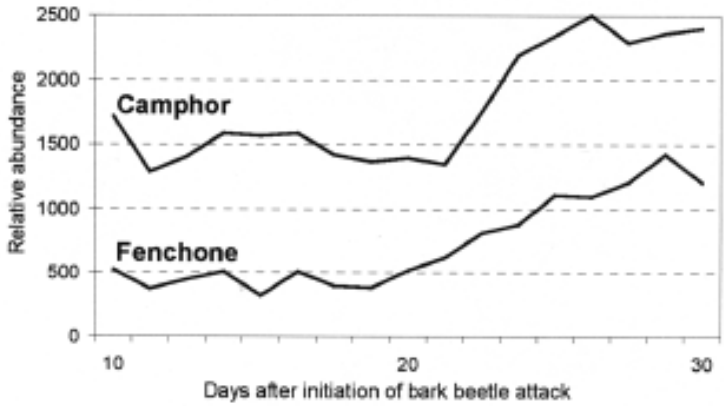
2. Bark beetles - colonization

Aggregation pheromone + background

2. Bark beetle breeding: *Ips typographus, Coeloides bostrichorum, Picea abies*

Pettersson and coll.

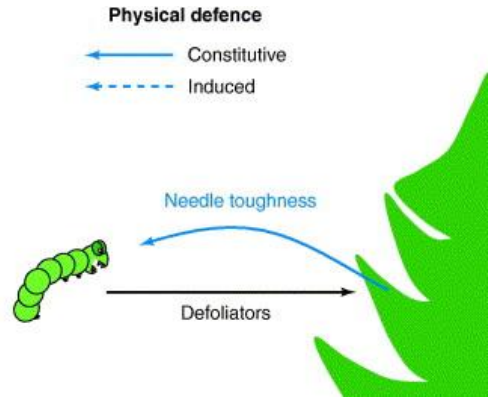
oxygenated monoterpenes + background → Synthetic baits



Petterson & Boland 2003

3. Pine processionary moth *Thaumetopoea pityocampa*, defoliating moth, Battisti and coll.

1568



Egg parasitoids

Ooencyrtus pityocampae
generalist

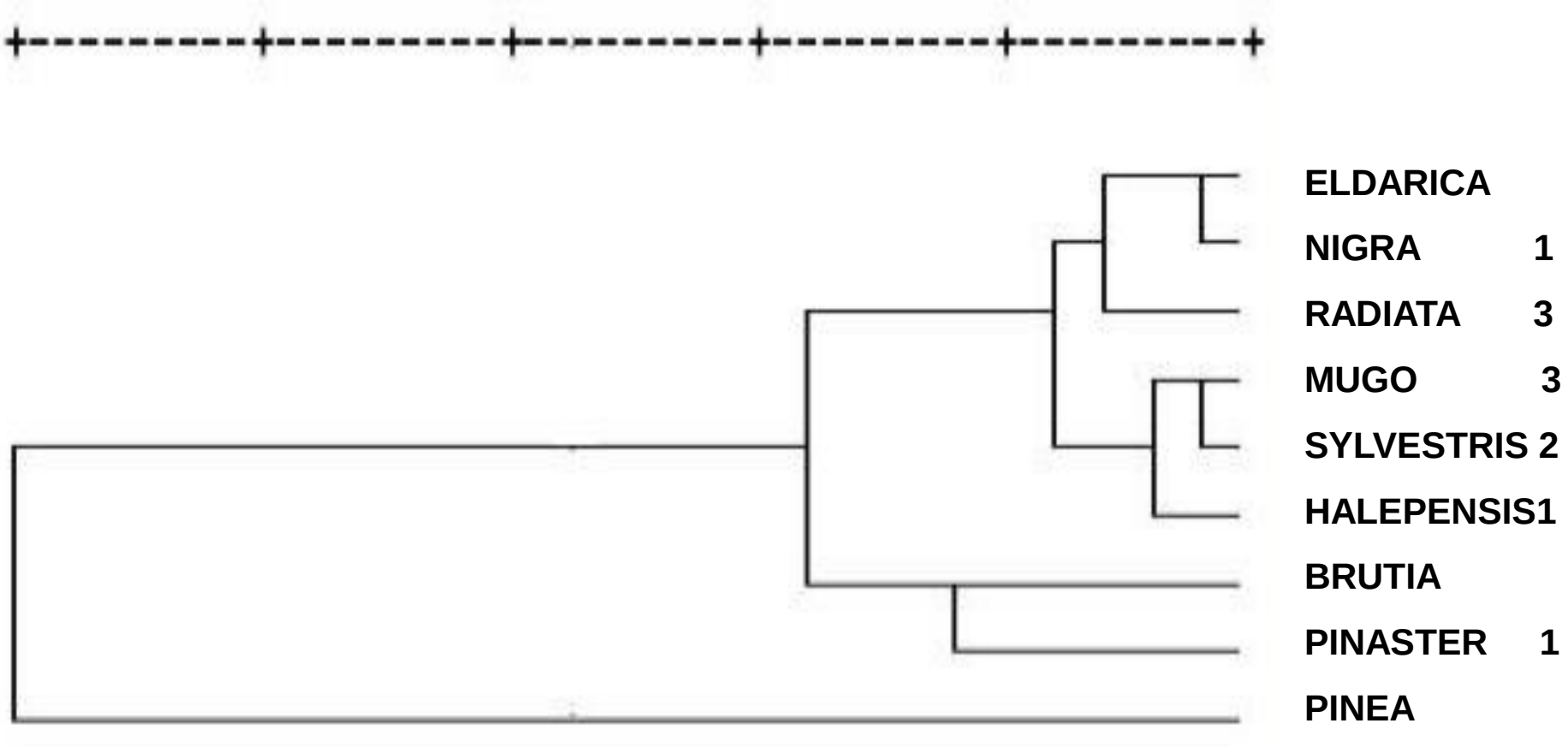
Egg batch laid on
pine needles

Baryscapus servadeii
specialist

Egg parasitism differed among Pinus hosts in the field

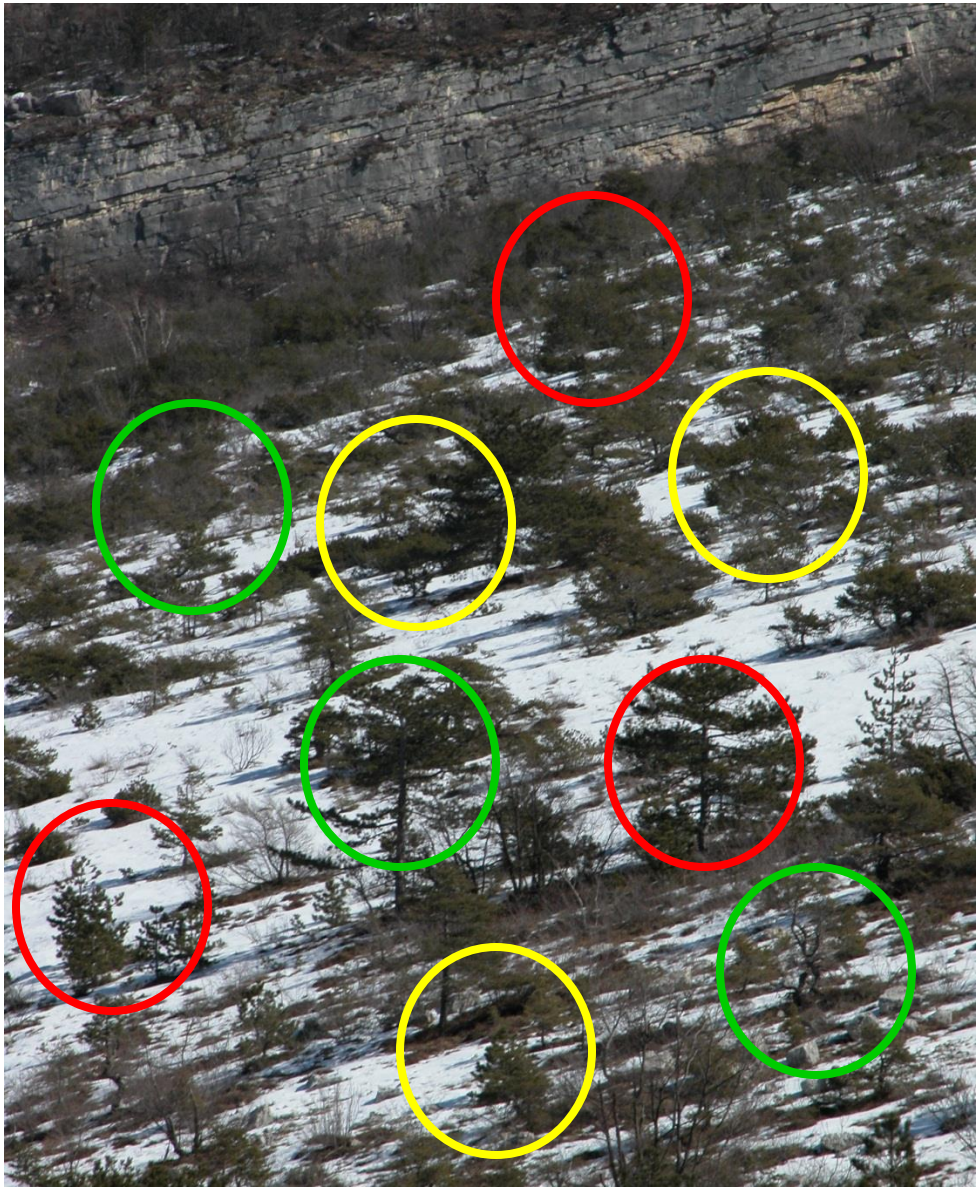
1. P nigra > sylvestris > mugo (novel), Benigni & Battisti 1999
2. P pinaster > radiata (novel), Tiberi 1984
3. P halepensis > radiata > canariensis, Ben Jamaa 1992

Is there any pattern in host terpenoids (tot. 42) that may explain the differences?



Birgersson & Schlyter, unpubl.

What happens when ‘standard’ egg batches are exposed to parasitoids in the field under controlled condition of tree size and density?

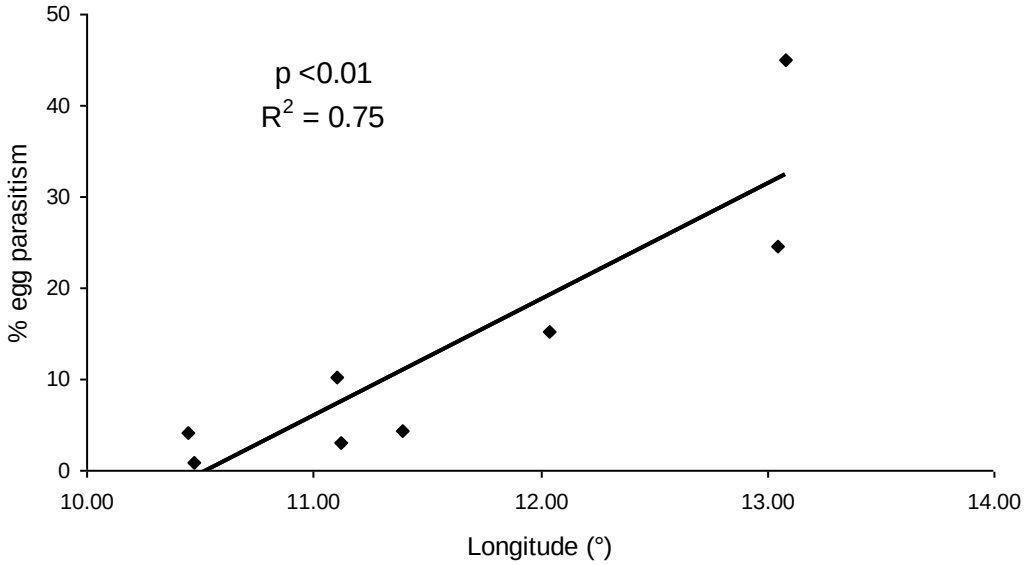


3 sites, 2-3 host-plant species, 2 years:

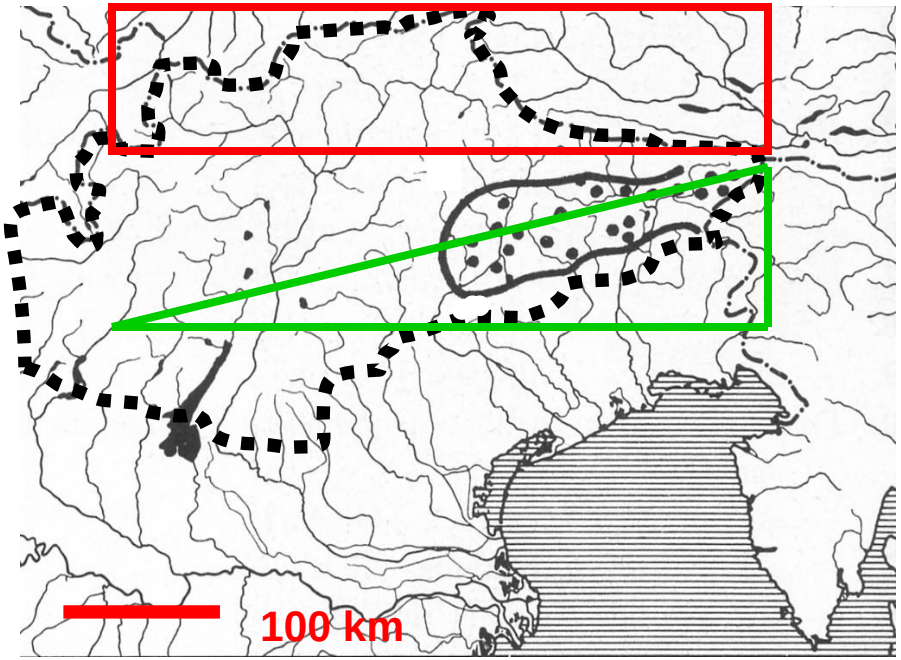
no significant differences

Searching for other patterns explaining variable parasitoid's performance

Egg parasitism varies with longitude



Host plants range and abundance

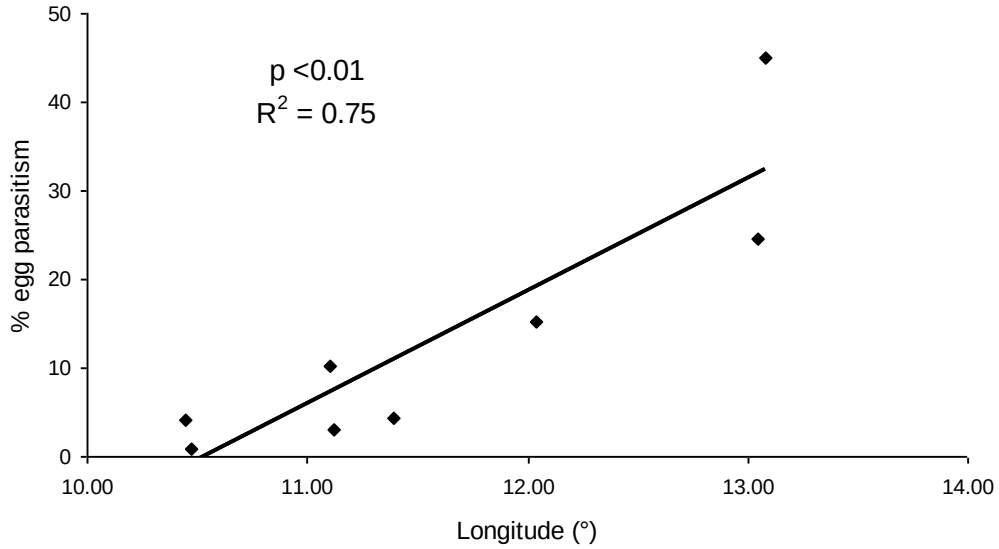


P sylvestris secondary host

P nigra primary host

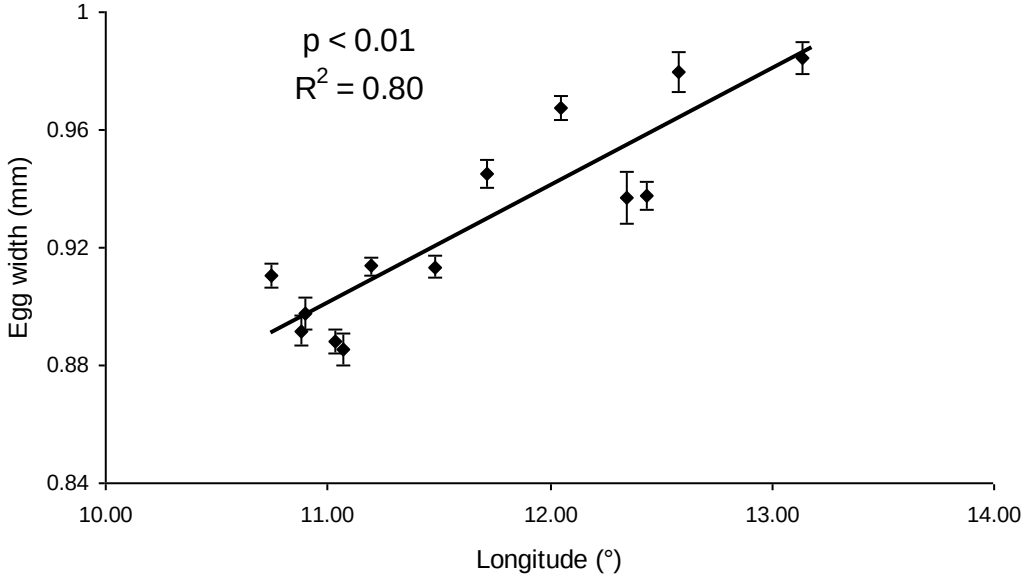
From a closer look at the eggs used for egg parasitism, it came up that also egg size varies with longitude across the same range

Egg parasitism



Egg size

(and L1)



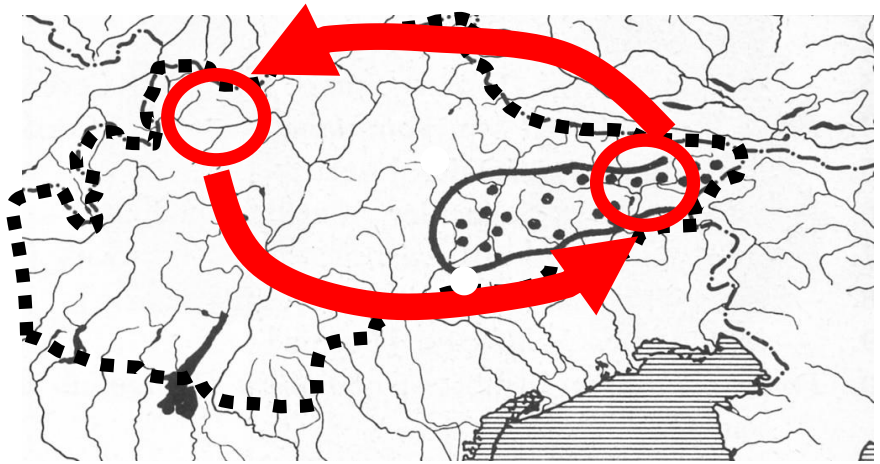
Adaptive value of egg and L1size?

A reciprocal transfer experiment was set up on the primary host to test the significance of egg and larval size for moth's survival

Venosta:

small eggs

soft leaves

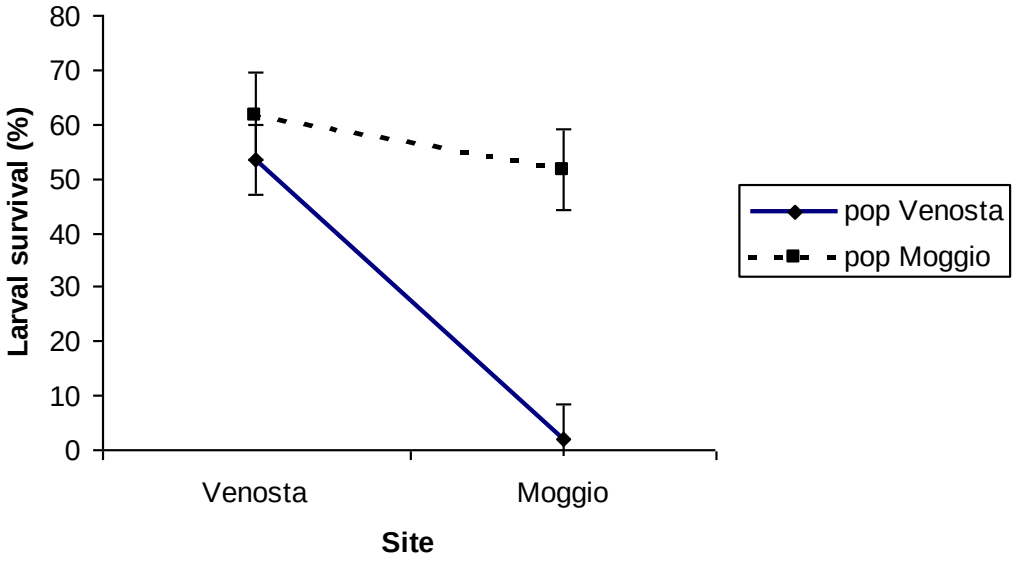


Moggio:

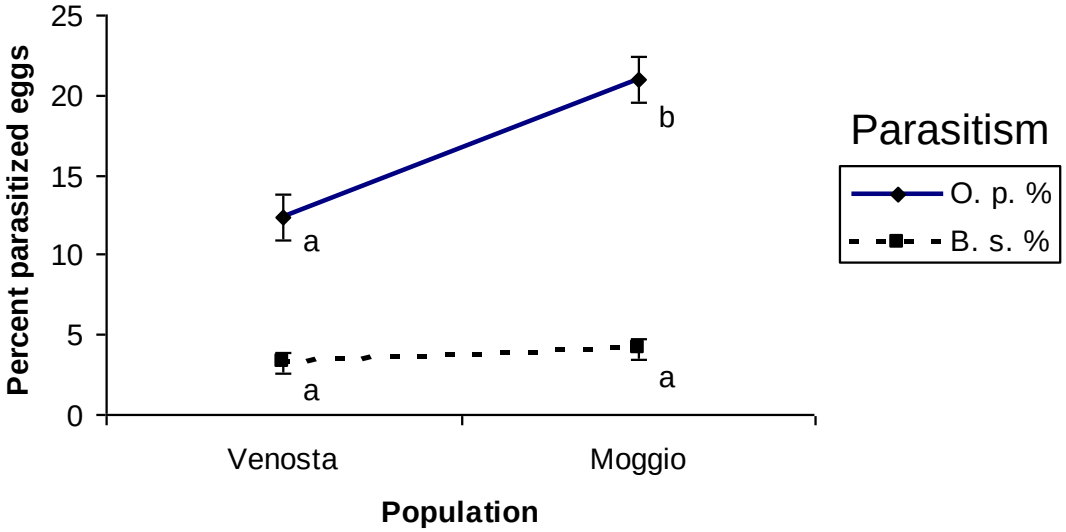
large eggs

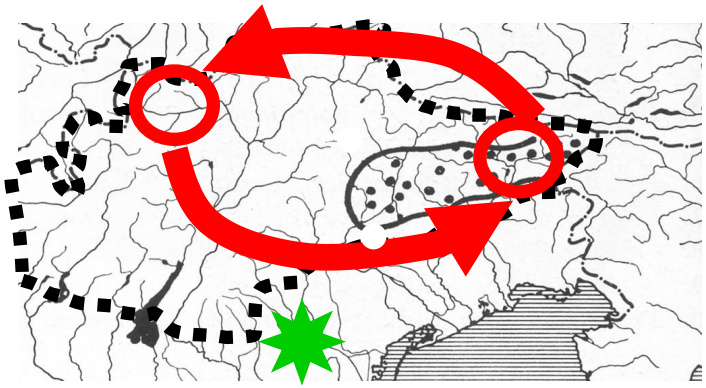
tough leaves

Leaf toughness mediates for egg/larval size



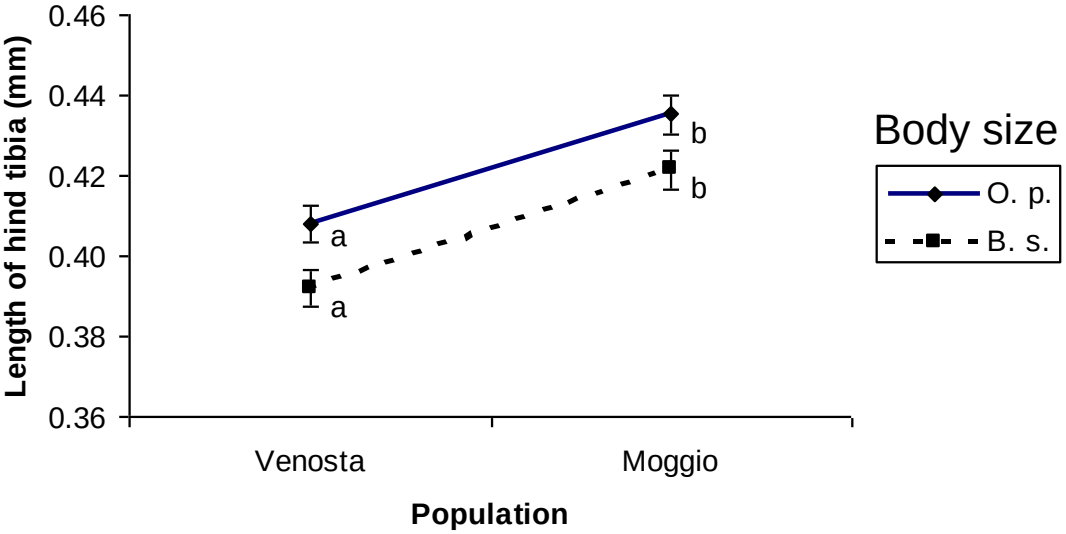
A common-garden experiment was set up to test for benefits of parasitoids in exploiting large eggs





small + large eggs

small eggs large eggs



Parasitism is higher only for the generalist.

Performance for both.

Summary: local adaptation has costs imposed by host plants and natural enemies. Zovi et al. 2008.