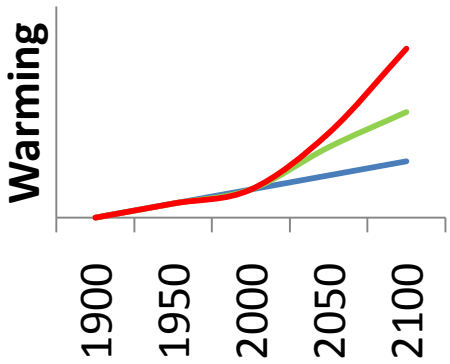
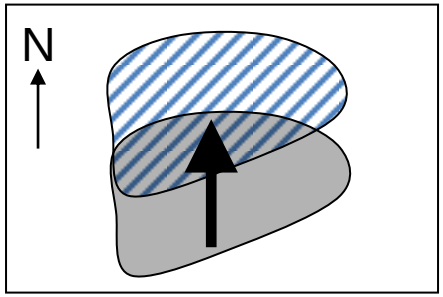
IUFRO WORLD CONGRESS SEOUL 2010
Session: Forest health in a changing environment

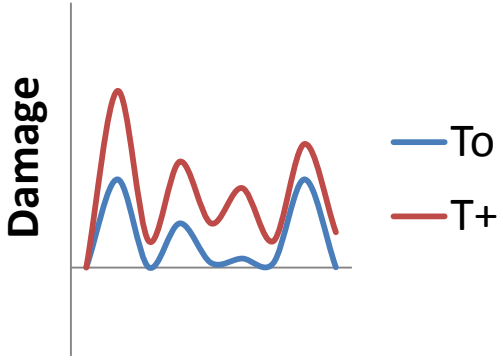
Responses of forest pests to climate change

Andrea Battisti (Padova University, Italy)
Maartje Klapwjik (SLU Uppsala, Sweden)
Stig Larsson (SLU Uppsala, Sweden)

How important is climate change for frequency and distribution of insect outbreaks?



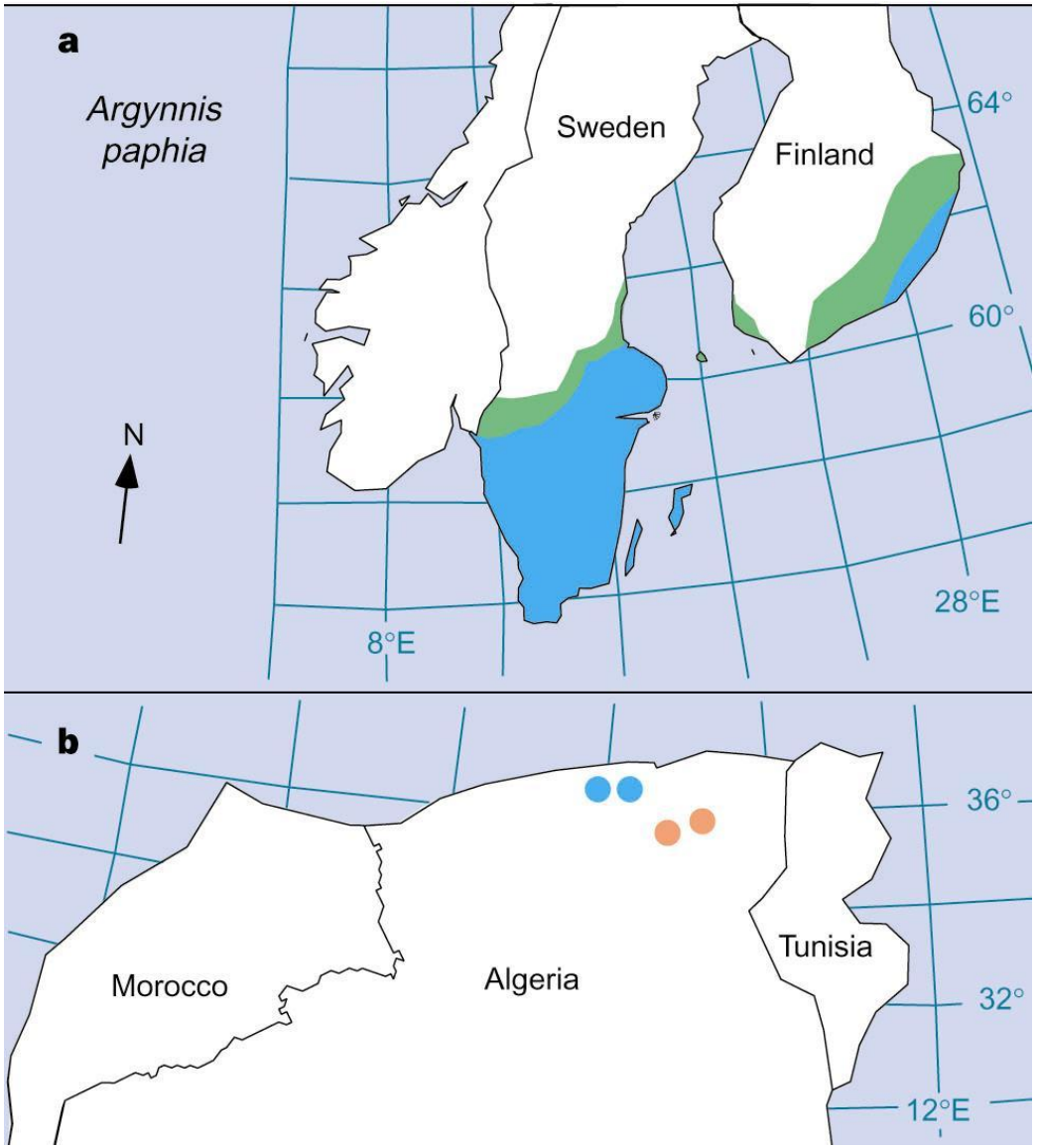




1999 **letters to nature**

Poleward shifts in geographical ranges of butterfly species associated with regional warming

Camille Parmesan*†, Nils Ryrholm‡, Constantí Stefanescu§, Jane K. Hill‖, Chris D. Thomas¶, Henri Descimon#, Brian Huntley‖, Lauri Kaila☆, Jaakko Kullberg☆, Toomas Tammaru**, W. John Tennent††, Jeremy A. Thomas‡‡ & Martin Warren§§



2000

ELSEVIER

The Science of the Total Environment 262 (2000) 263–286

the Science of the Total Environment
An International Journal for Scientific Research into the Environment and its Relationship with Man

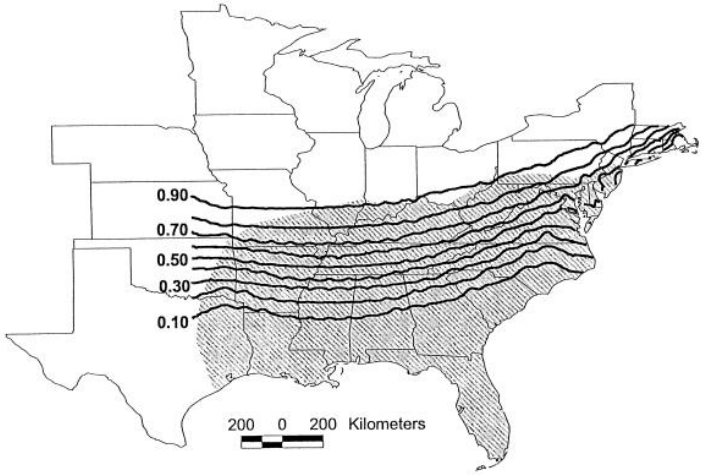
www.elsevier.com/locate/scitotenv

Assessing the consequences of global change for forest disturbance from herbivores and pathogens

Matthew P. Ayres*, María J. Lombardero

Department of Biological Sciences, Dartmouth College, Hanover, NH 03755-3576, USA

Southern pine beetle
Dendroctonus frontalis
Lower lethal temperature

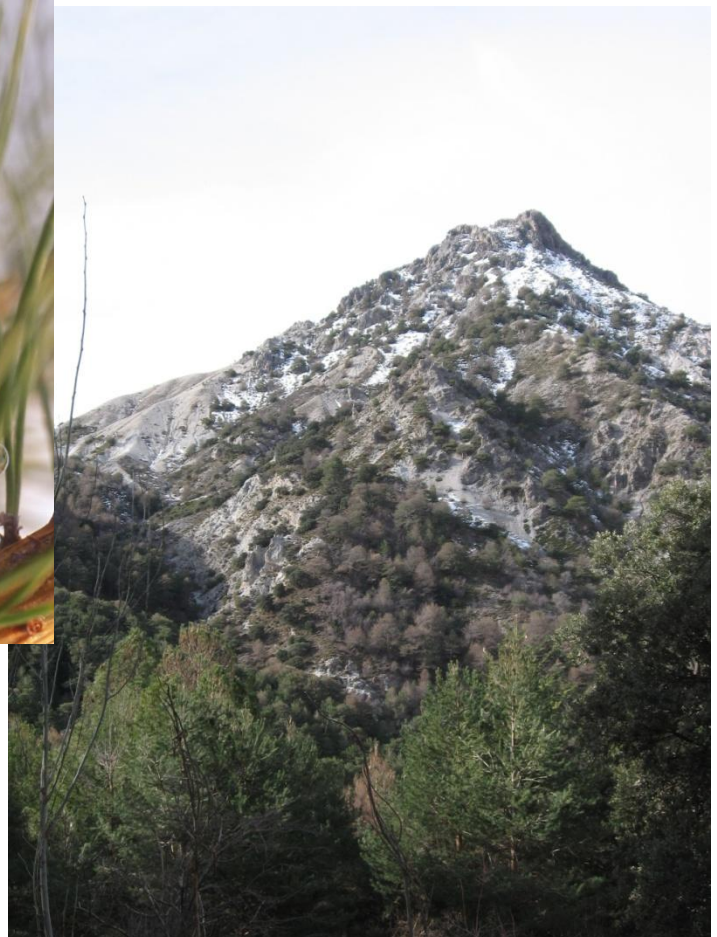


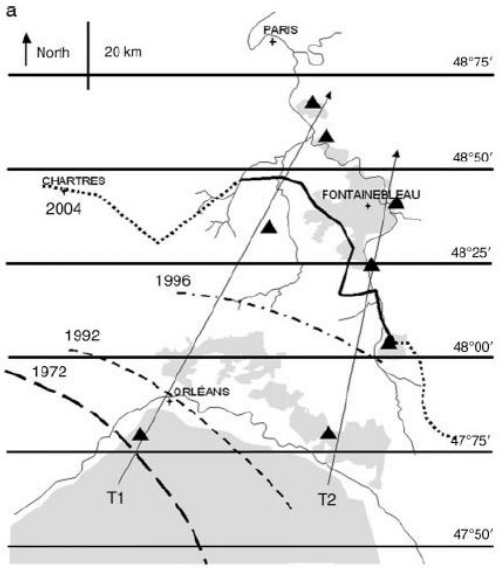
Ecological Applications, 15(6), 2005, pp. 2084–2096

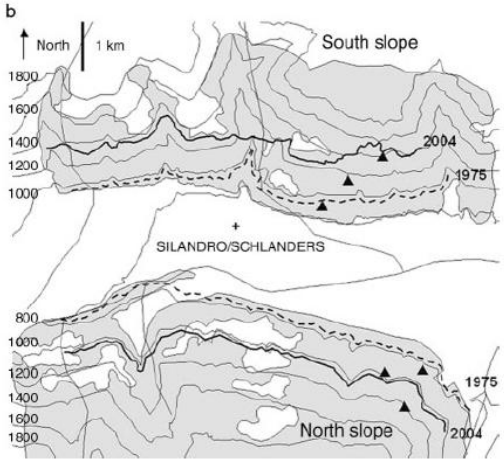
2005

EXPANSION OF GEOGRAPHIC RANGE IN THE PINE PROCESSIONARY MOTH CAUSED BY INCREASED WINTER TEMPERATURES

ANDREA BATTISTI,[1,6] MICHAEL STASTNY,[2] SIGRID NETHERER,[3] CHRISTELLE ROBINET,[4] AXEL SCHOPF,[3] ALAIN ROQUES,[4] AND STIG LARSSON[5]

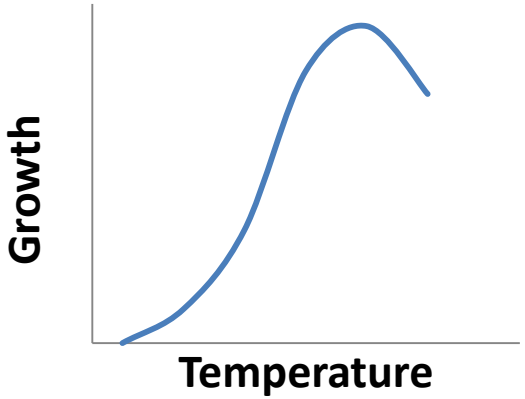






Direct and indirect responses

Direct responses of herbivores to temperature



Direct and indirect responses

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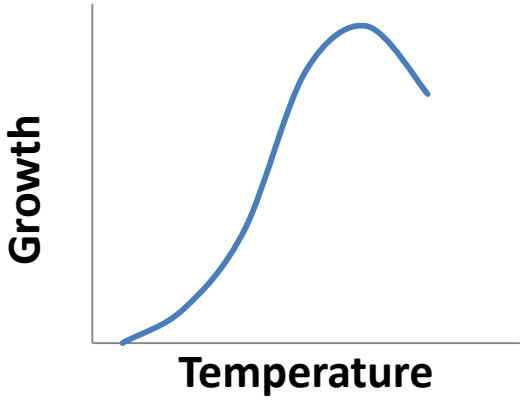
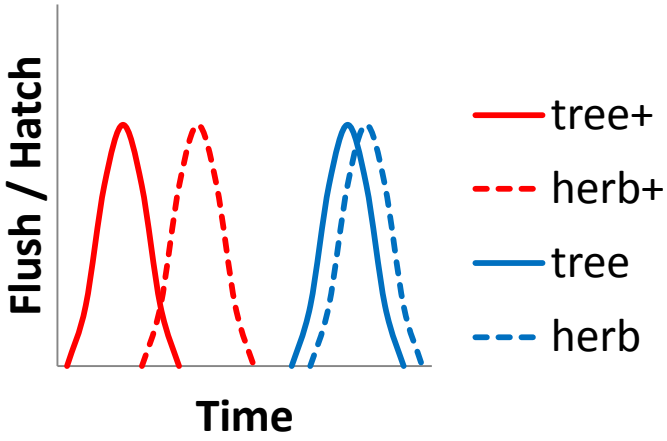
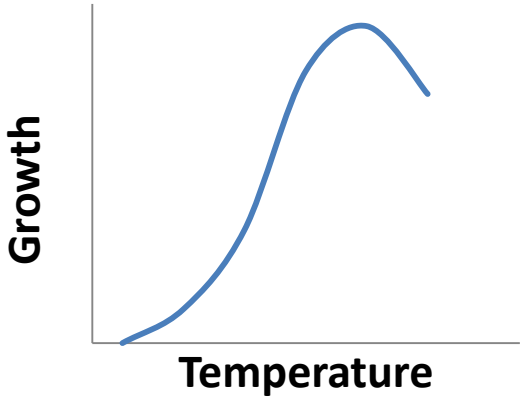


Indirect through host plant: how trees respond to cc and affect herbivores



Direct and indirect responses

Direct responses of herbivores to temperature



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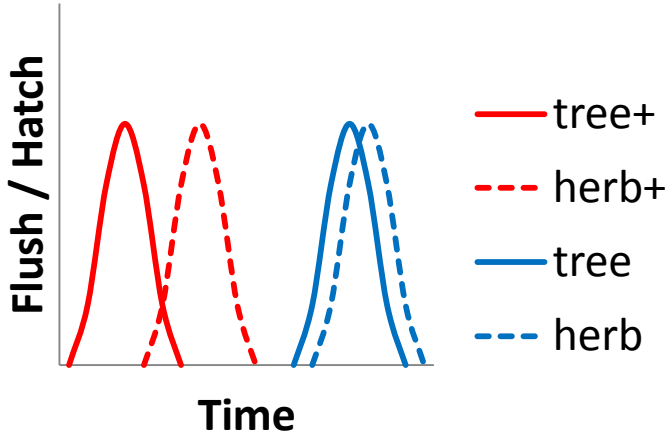
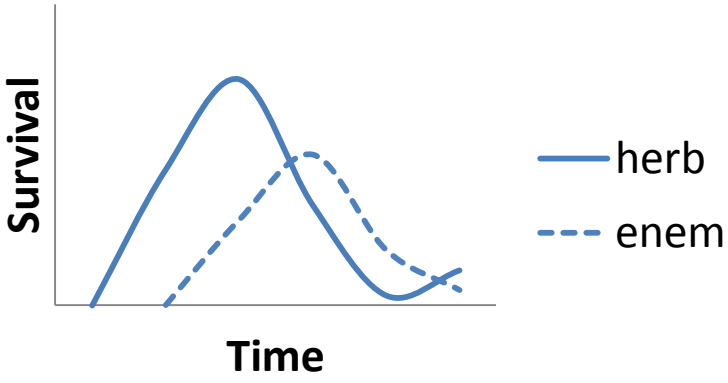
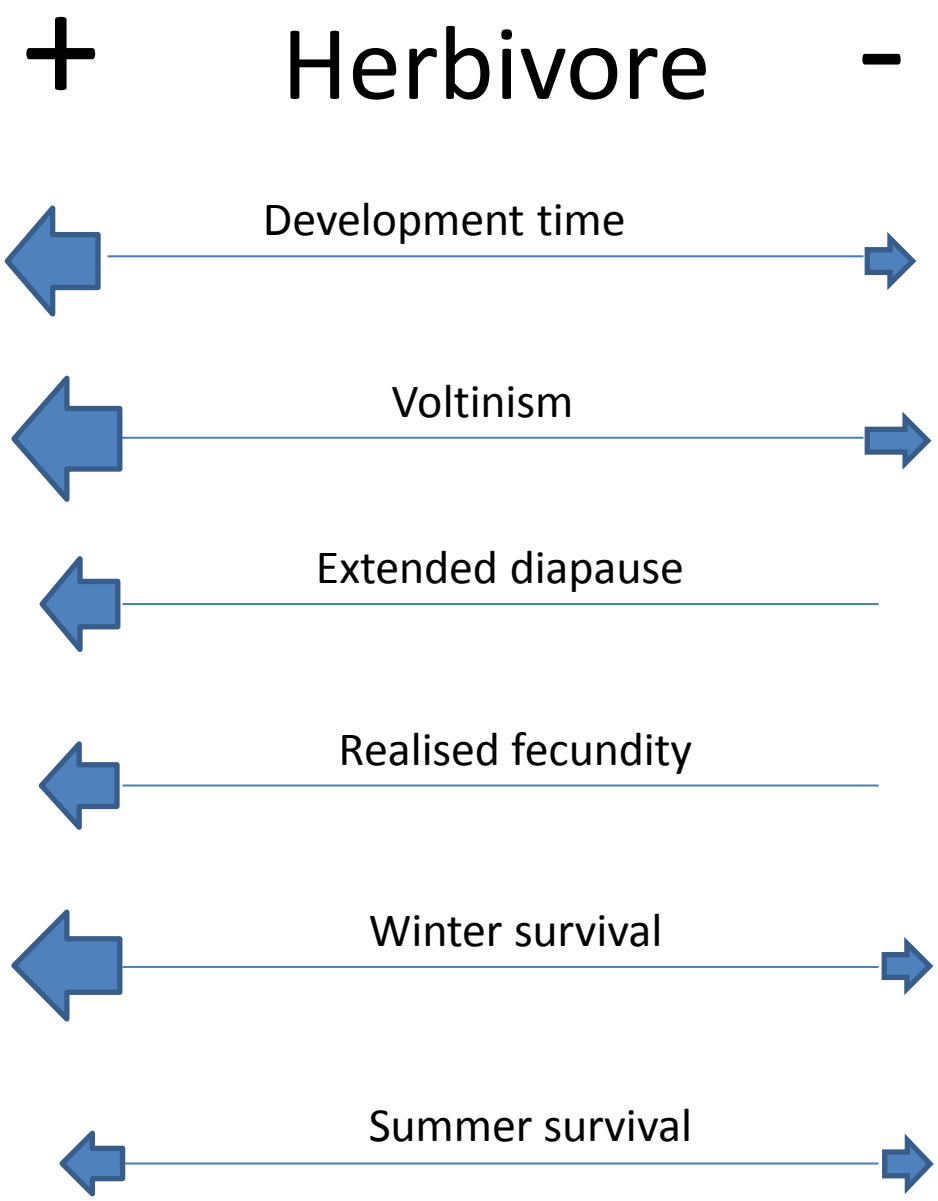


Indirect through natural enemies: how parasitoid, predators and pathogens respond to cc and affect herbivores



Direct effects of climate change on



Direct effects of climate change on

+ Herbivore -

Development time

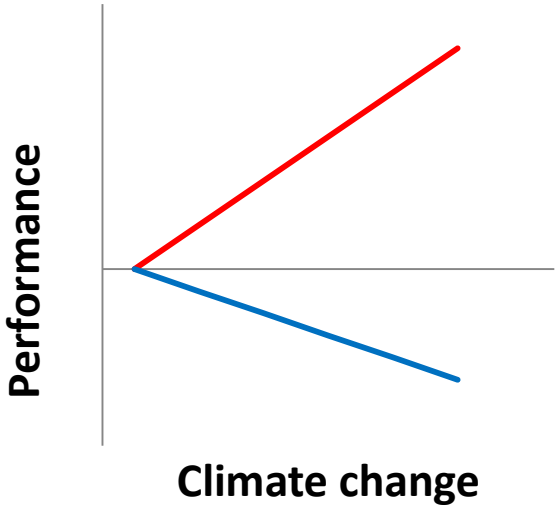
Voltinism

Extended diapause

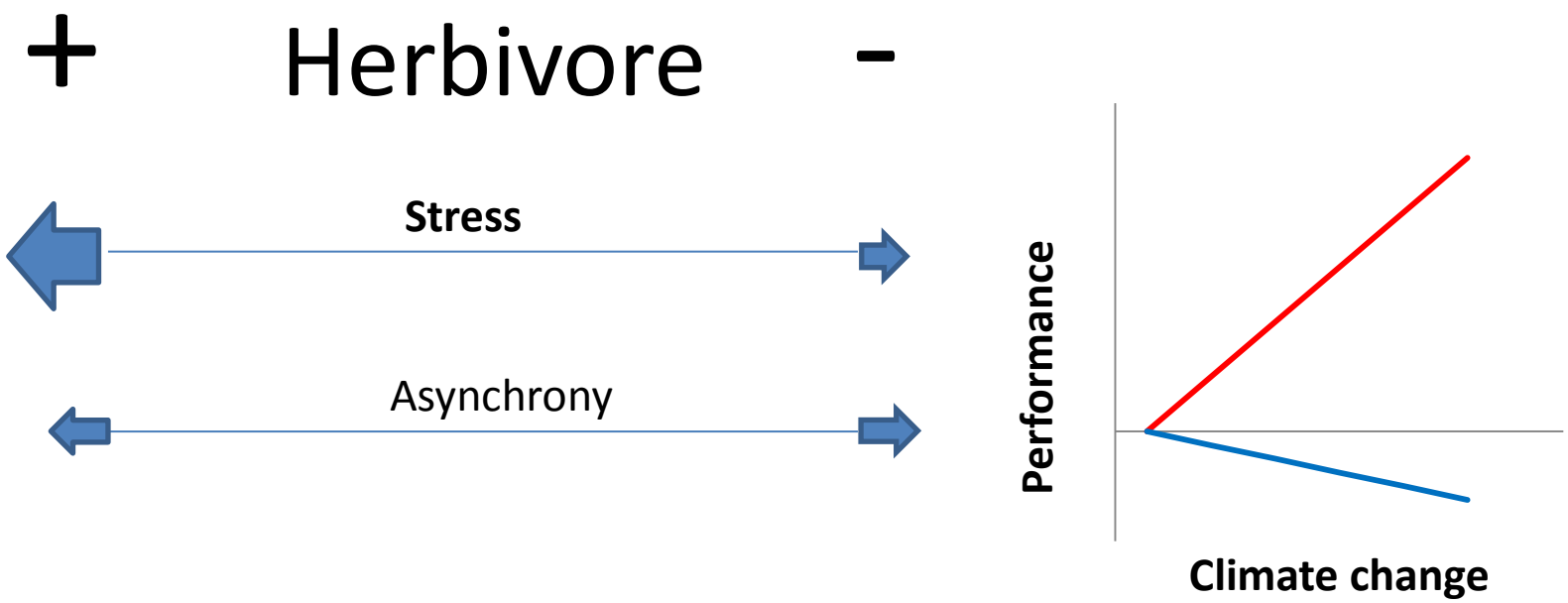
Realised fecundity

Winter survival

Summer survival

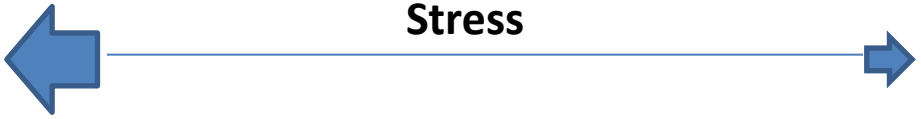


Indirect effects of climate change through host plant on

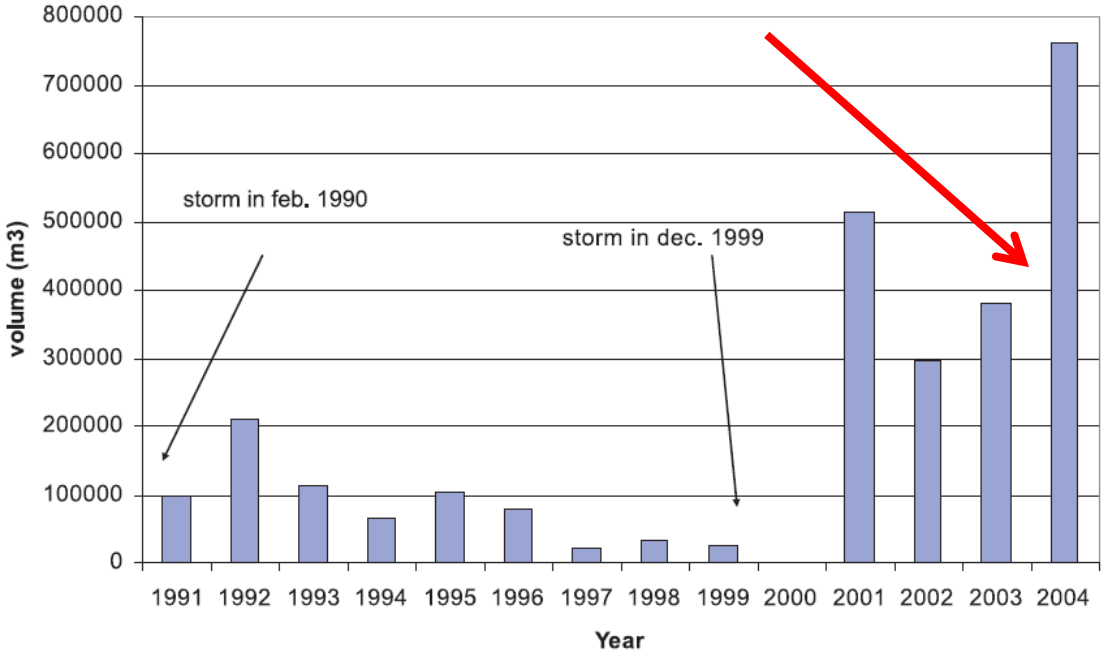


Indirect effects of climate change through host plant on

\+ Herbivore -



Summer 2003 and spruce bark beetle *Ips typographus* Rouault et al. (2006)



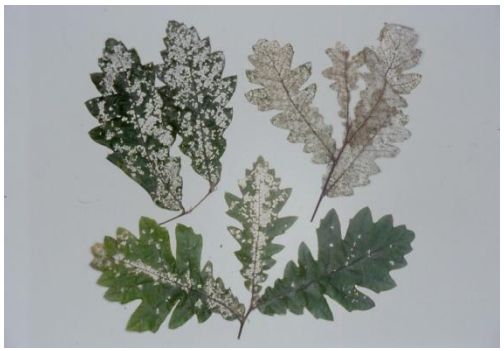
Indirect effects of climate change through host plant on

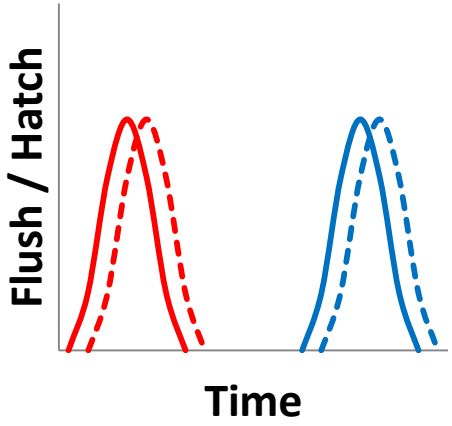
\+ Herbivore -

Host

Herbivore

Asynchrony





Egg overwinter on *Quercus*

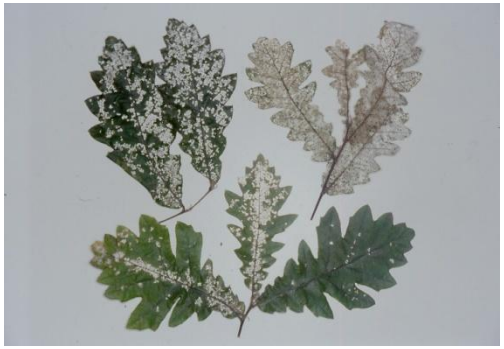
Indirect effects of climate change through host plant on

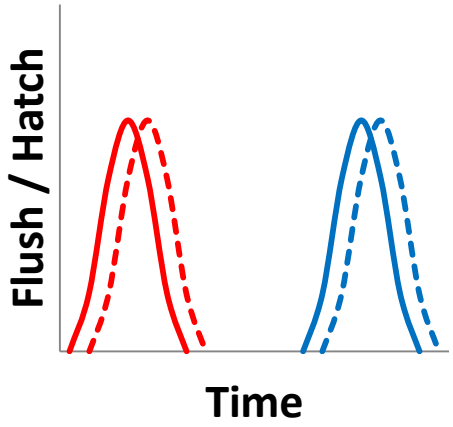
\+ Herbivore -

Host

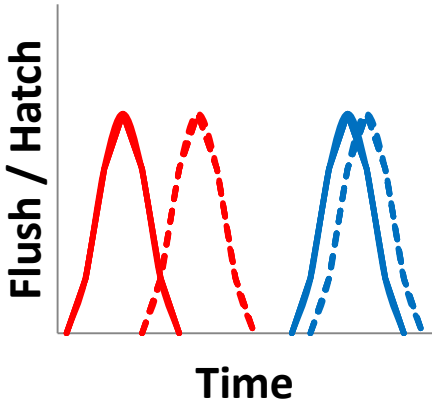
Herbivore

Asynchrony





Egg overwinter on *Quercus*



Pupa overwinter on *Quercus*

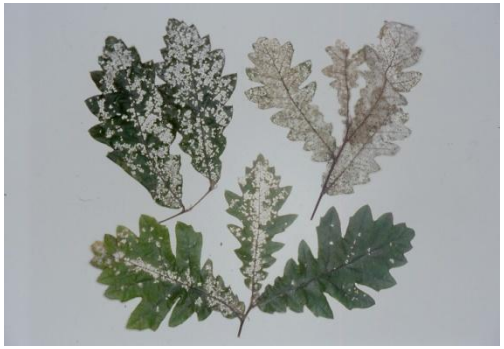
Indirect effects of climate change through host plant on

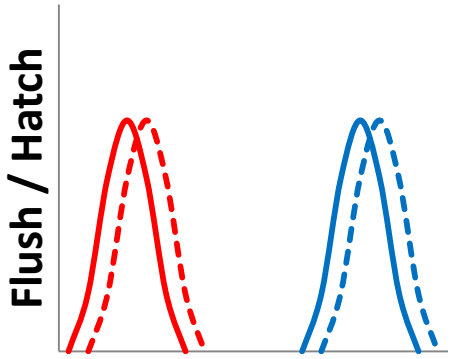
\+ Herbivore -

Host

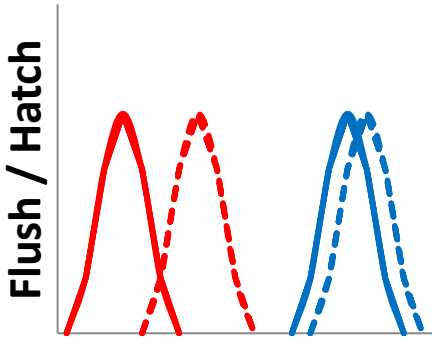
Herbivore

Asynchrony

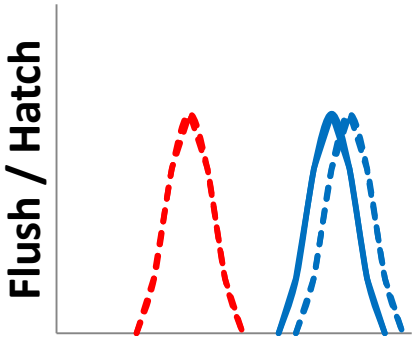




Egg overwinter on *Quercus*



Pupa overwinter on *Quercus*



Eggs overwinter on *Fagus*

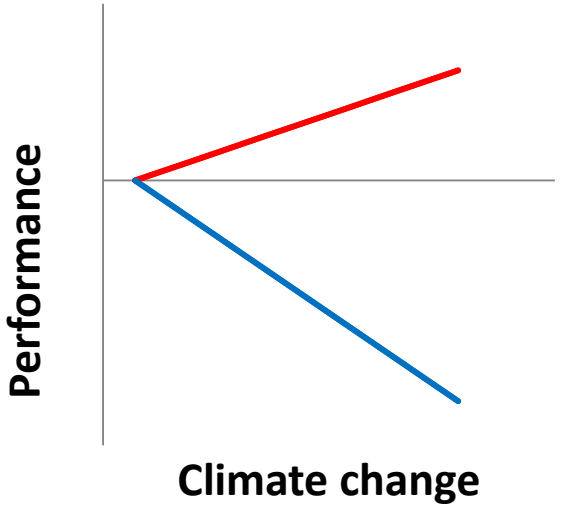
Indirect effects of climate change through natural enemies on

\+ Herbivore -

Arthropod fitness and behaviour

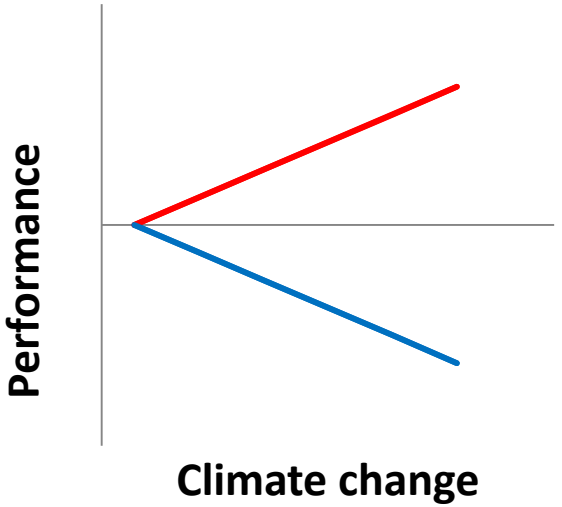
Voltinism

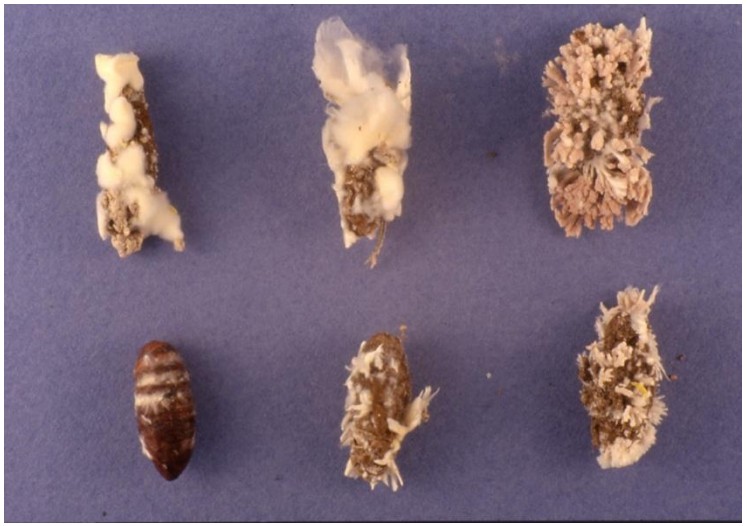
Intra-guild killing rate



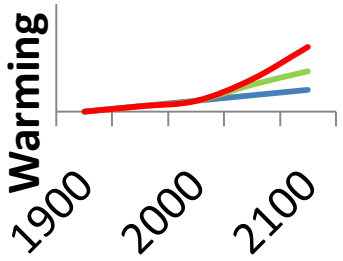
Indirect effects of climate change through natural enemies on

\+ Herbivore -





Summary of the action of climate change on trophic levels



CC

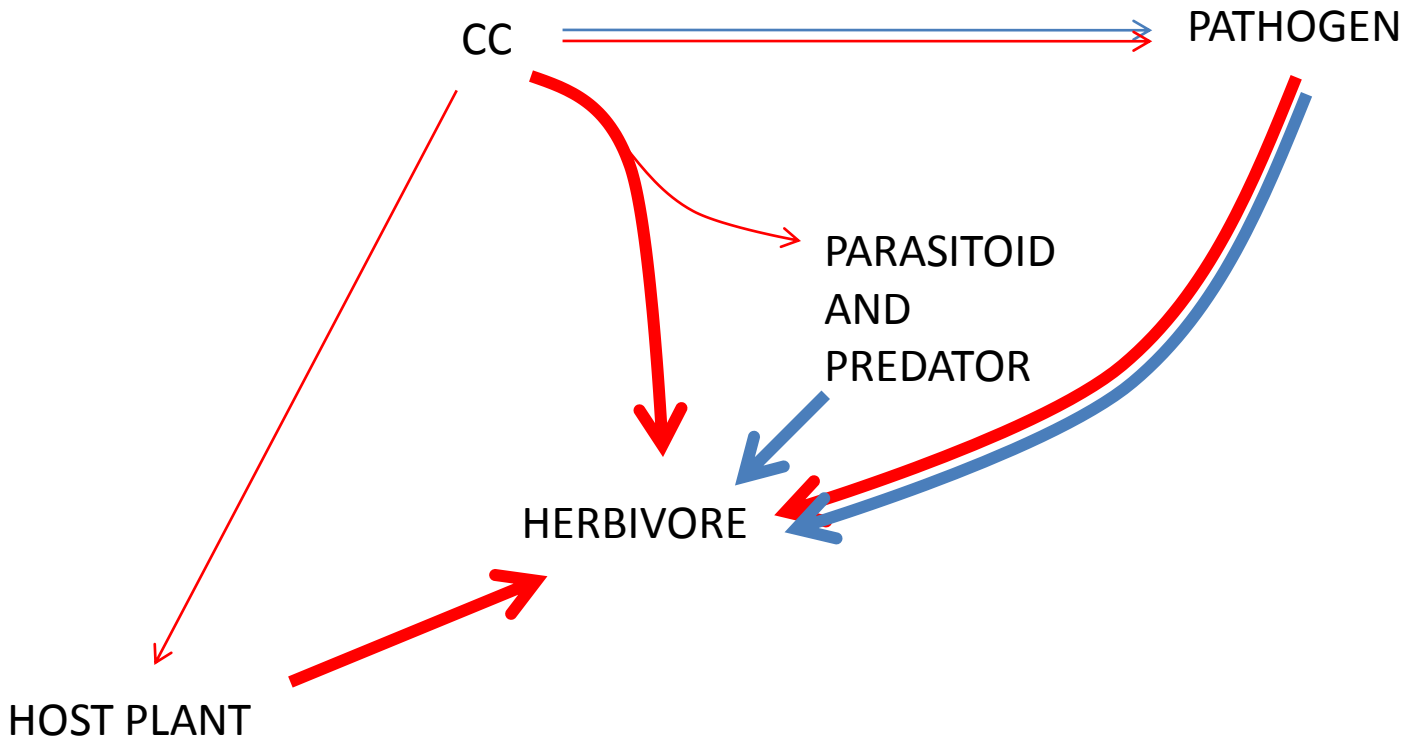
PATHOGEN

PARASITOID
AND
PREDATOR

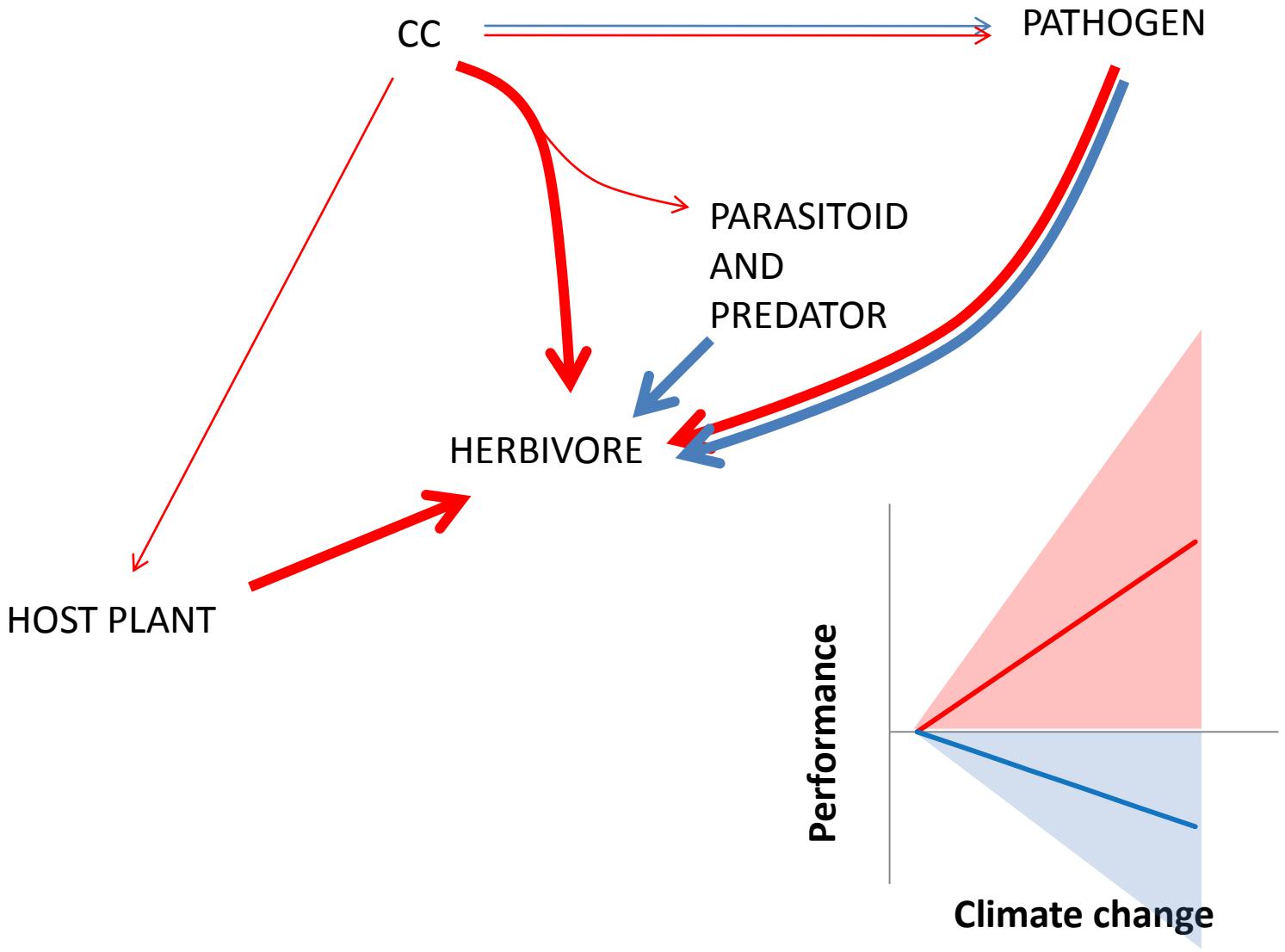
HERBIVORE

HOST
PLANT

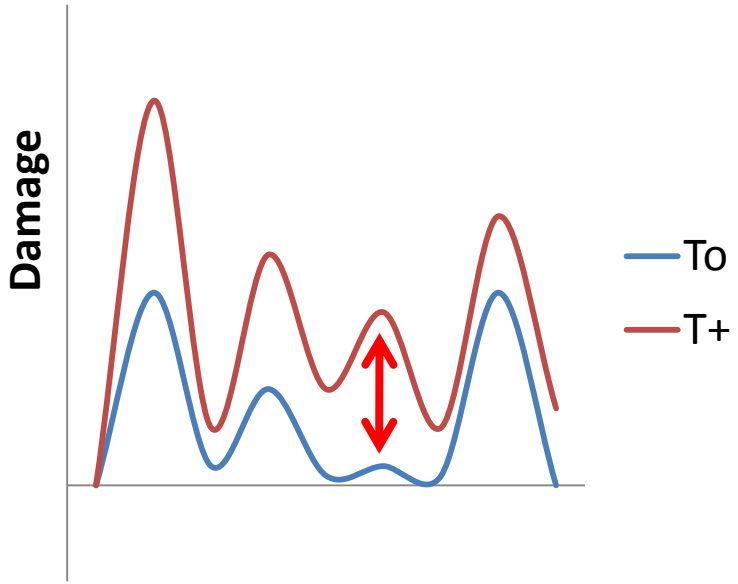
Direct and **indirect** effects of cc on herbivore performance



Direct and **indirect** effects of cc on herbivore performance



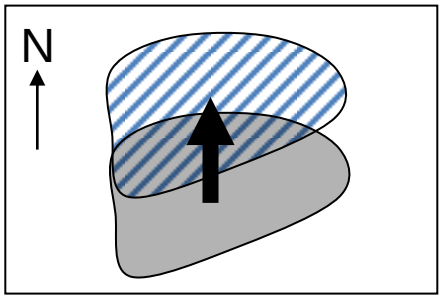
Will climate change affect the probability of **escape** from control?



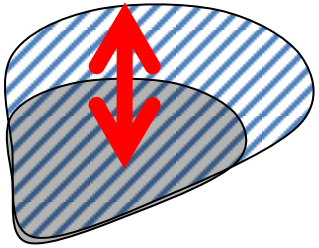
Examples:
tent caterpillars
spruce webspinning sawflies
green spruce aphid
European pine sawfly

Hypothesized mechanisms:
reduced mortality by enemies
increased host susceptibility
release from winter mortality
reduced mortality by enemies

Climate change and range expansion

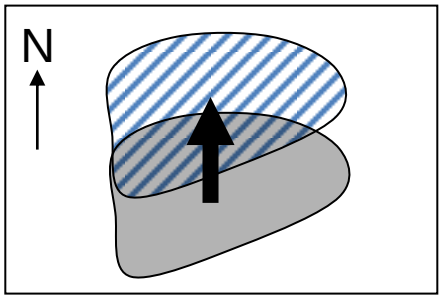


Winter moth
Operophtera brumata



Contiguous expansion / retraction according to winter egg survival

Climate change and range expansion



Winter moth
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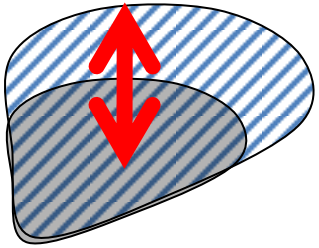
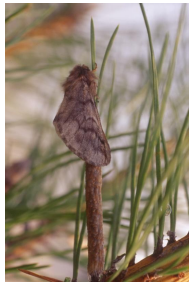
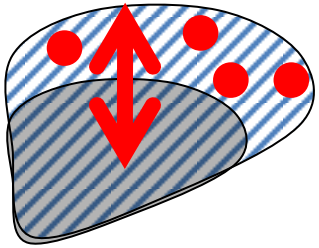


Contiguous expansion / retraction according to winter egg survival

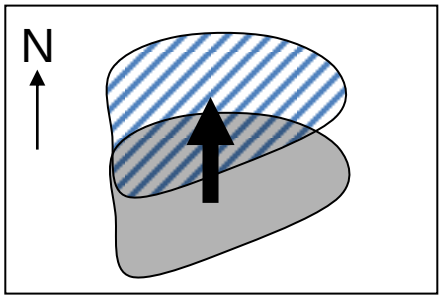
Pine processionary moth
Thaumetopoea pityocampa



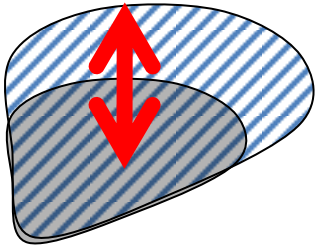


Contiguous expansion / retraction according to winter larval performance, with long-time colonisers

Climate change and range expansion



Winter moth
Operophtera brumata



Contiguous expansion / retraction according to winter egg survival

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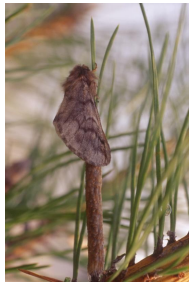
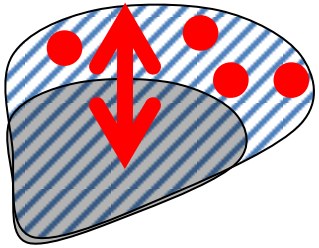
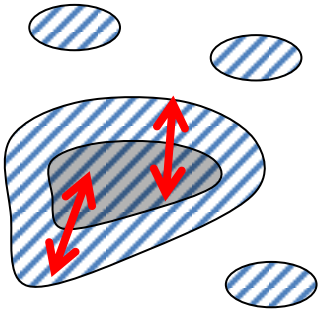




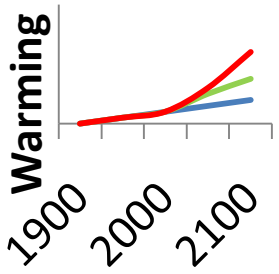
Contiguous expansion / retraction according to winter larval performance, with long-time colonisers

Mountain pine beetle
Dendroctonus ponderosae

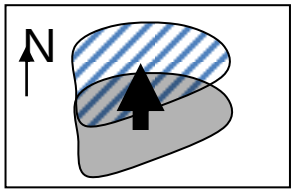


Distant dispersal + contiguous expansion / contraction

Range expansion and outbreak release



CC + range expansion

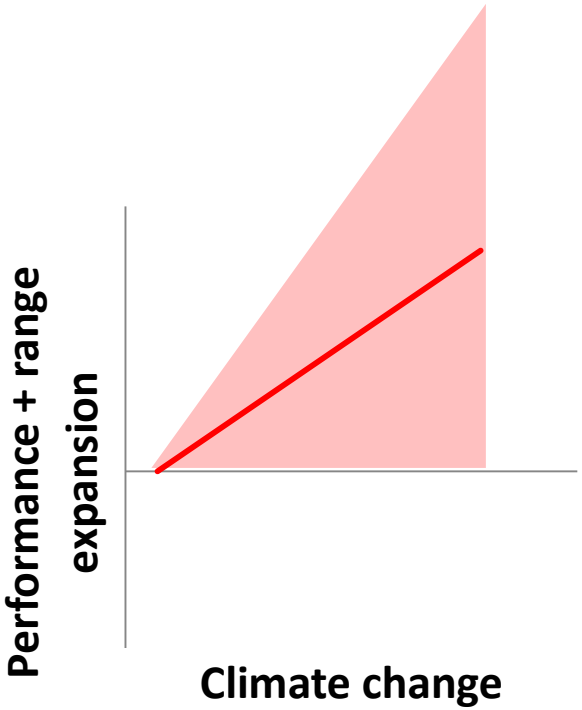


PATHOGEN

PARASITOID AND PREDATOR

HERBIVORE

HOST PLANT possibly new



Work in progress, contributions welcome!

Acknowledgements:
EU FP 7 ‘BACCARA’
Biodiversity and Climate Change: A Risk Analysis