Climate change and bioinvasiveness of plant pathogens

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3 December 2008, Pests and Climate Change, Alterra, Wageningen

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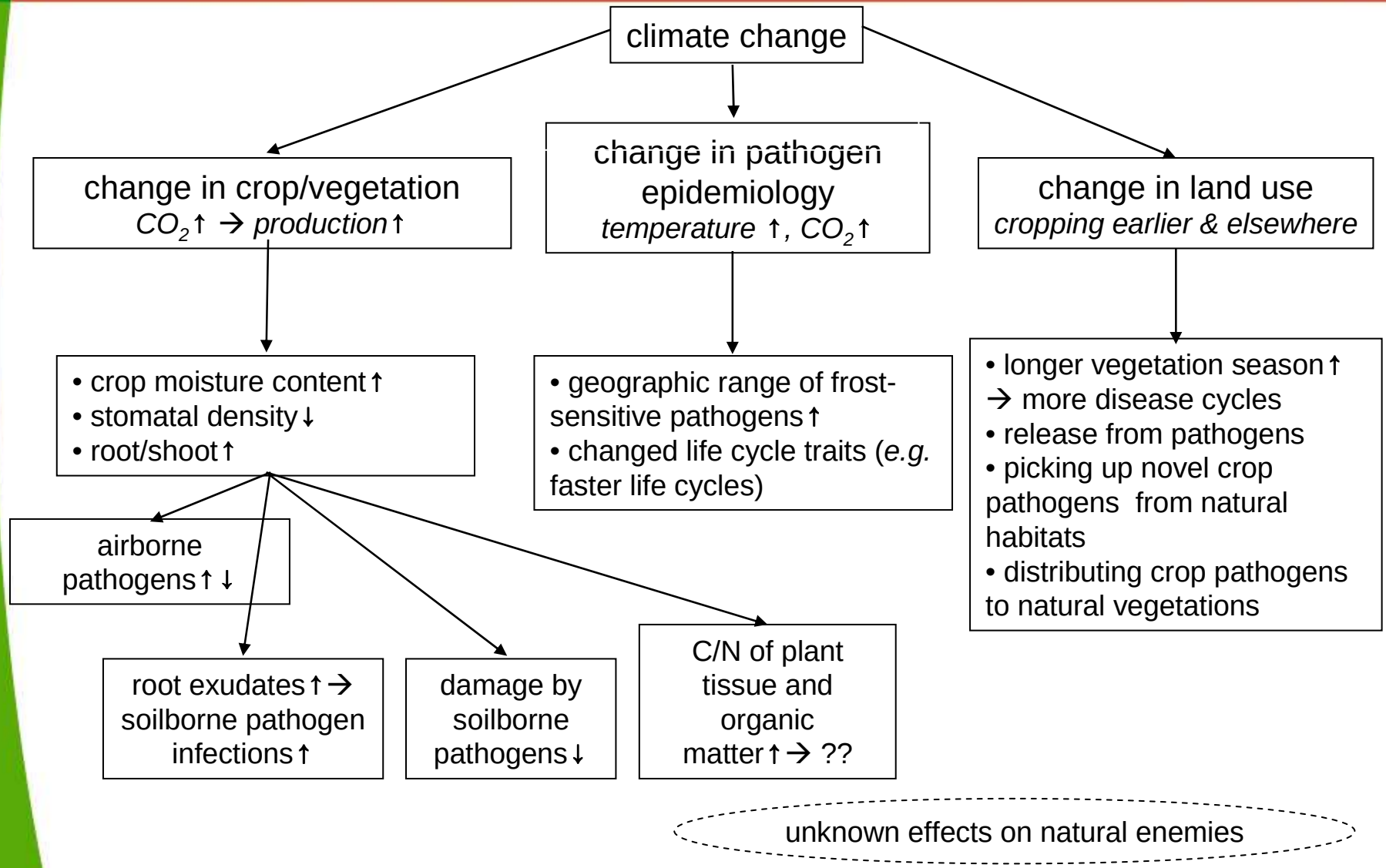
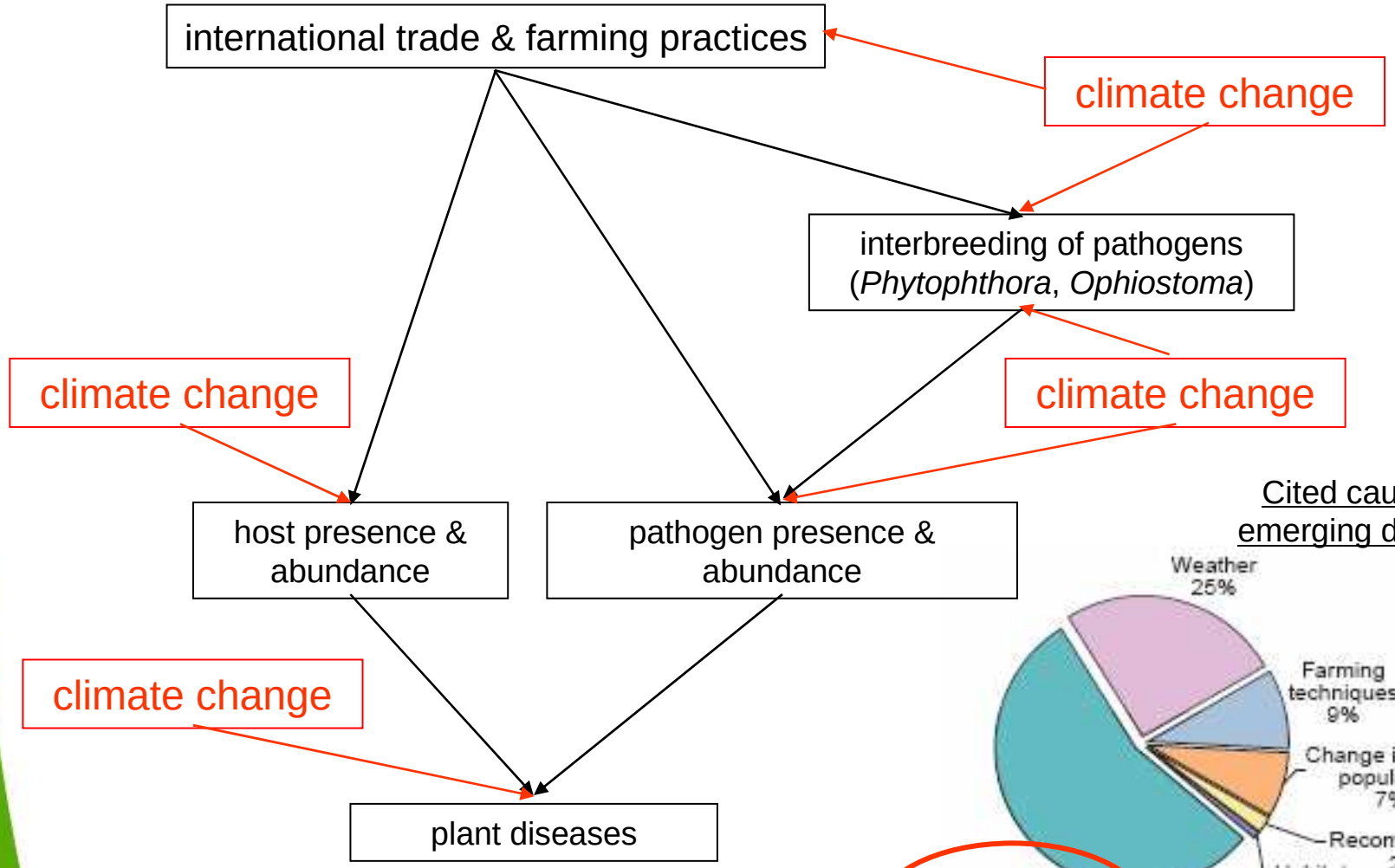
Some climate change scenarios



Potential scenarios



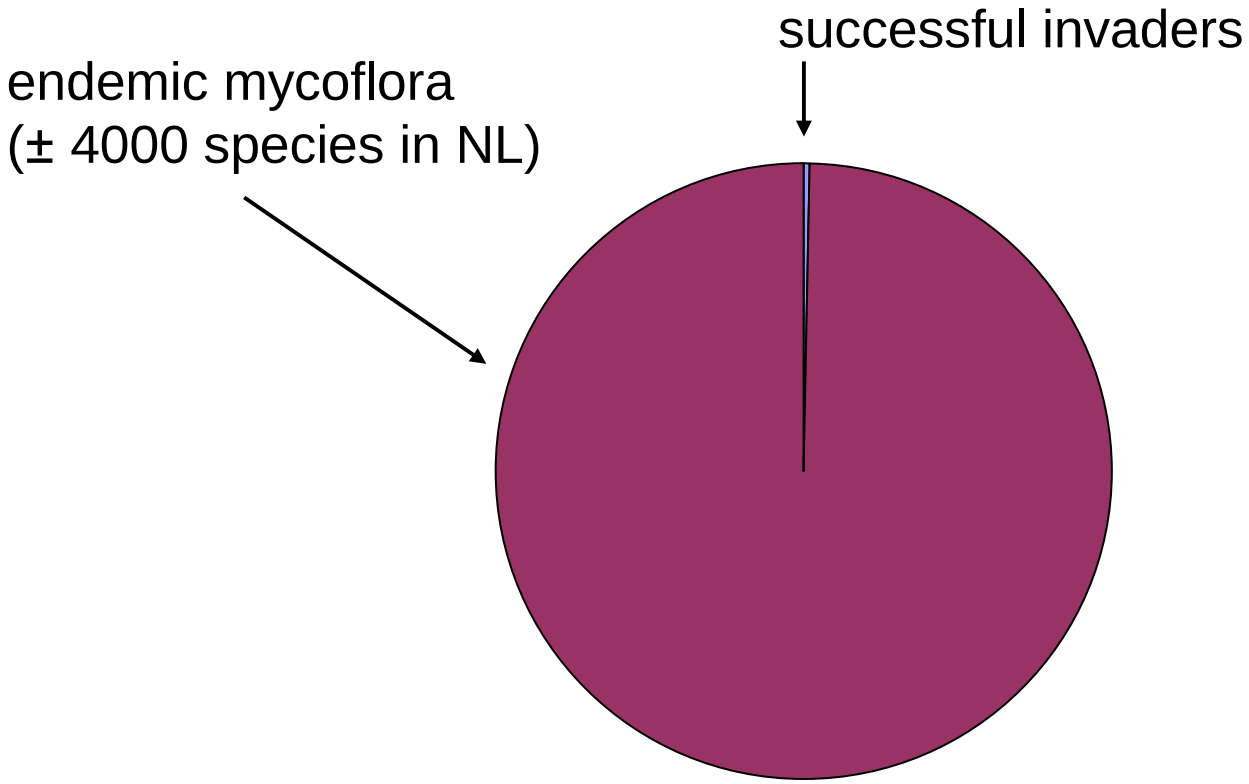
Cited causes of emerging diseases

Anderson et al., TEE 19: 535

Structure

- fungal invasions
  - successful
  - failed
- how climate can affect fungal invasions
- conclusions

Mushroom invasions are rare



Mushroom invasions on novel substrate: wood chips

wood chip colonizing macromycetes

- *Psilocybe aurantiaca* (1995 S-Africa)
- *Psilocybe cyanascens* (1994 America)
- *Psilocybe rugoso-annulata* (Europe)
- *Agrocybe rivulosa* (2001 new species, NL)

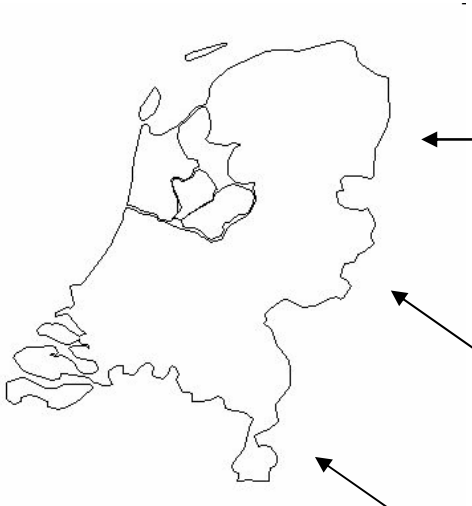
Stropharia aurantiaca

Psilocybe cyanascens

Stropharia rugoso-annulata

Agrocybe rivulosa

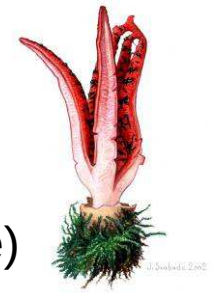
Mushroom invasions: saprotrophs



Pycnoporus cinnabarinus
(1967 c-Europe)

Plicaturopsis crispa
(1989 SE-Europe)

Clathrus archeri
(1973 Australia → S-Europe → c-Europe)



Mushroom invasions: ectomycorrhizae

- many introductions specifically associated with imported tree species, e.g. pine and spruce with *Lactarius hepaticus* and *Chroogomphus rutilus*

- a few S-European species are now perhaps invading, e.g. *Amanita ceciliae*

Lactarius hepaticus

Chroogomphus rutilus

Amanita ceciliae

Blgg

Plant pathogen invasions

- *Cercospora beticola* (±1980 s-Europe), sugar beet
- *Fomes fomentarius* (±1980, c-Europe)
due to forest management change?
- *Rhizoctonia solani*, sugar beet (±1995)
- *Phytophthora infestans* (1840 & 1980)
- *Phytophthora cambivora* x *?fragariae*
collar root disease of Alnus spp. (1993)
- *Ophiostoma ulmi* (1910-30), *O. novo-ulmi* (1940-70),
O. ulmi x *novo-ulmi* (now) (Dutch elm disease)
- *Phytophthora ramorum*
'sudden oak death'(±2000 Europe)
- *Phytophthora kernovii*
oak decline (2004 UK)
- *?Pseudomonas syringae*
chestnut die-back (2002 NL)

Plant invasions in relation to pathogens

Plant/parasite relationship:

host	specific soilborne pathogens
endemic	common
exotic	rare

Prunus serotina

Van der Putten, Engelkes, NIOO

Pathogen release after moving the crop

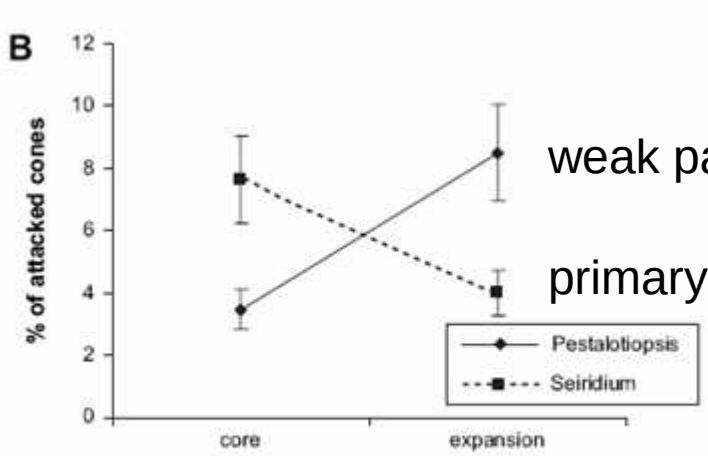


Fig. 3 – Percentage of cones attacked by insects (A) and fungi (B) in core and expansion areas of cypress in Trentino. Vertical bars indicate SE.

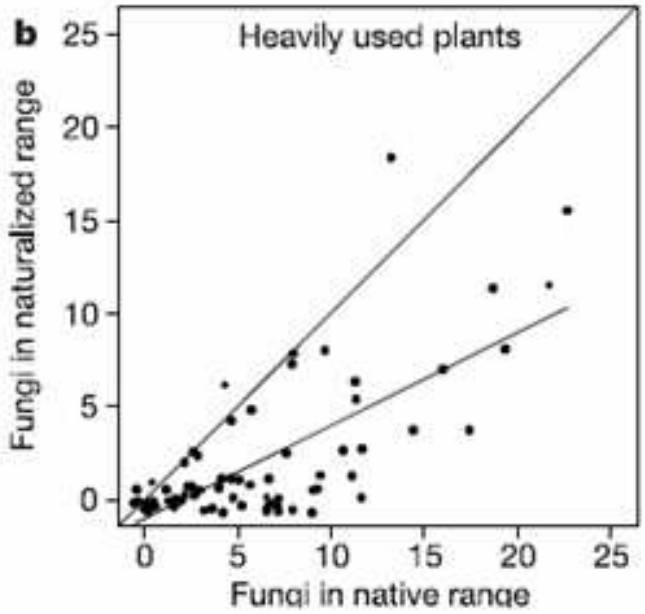
weak pathogen

primary pathogen

Plants moved to novel areas tend to be temporary released from their pathogens

Zocca et al., Acta Oecol. 33:307

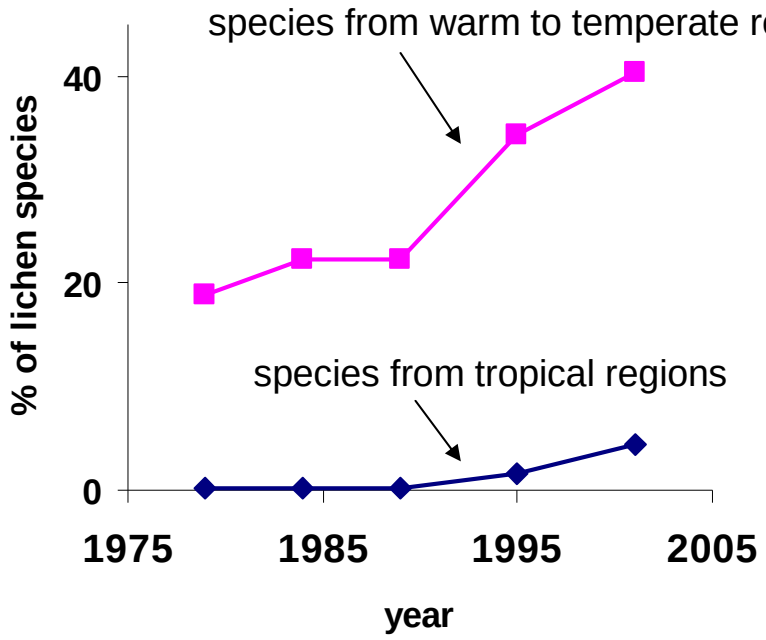
Pathogen release after moving the crop



So, dispersal of pathogens is relatively slow!

Mitchell & Power, Nature 431: 625

Lichens show climate-driven invasions



Parmotrema pseudoreticulatum

van Herk et al., Lichenologist 34: 141

Failures of fungal invasion

Failures of invasion

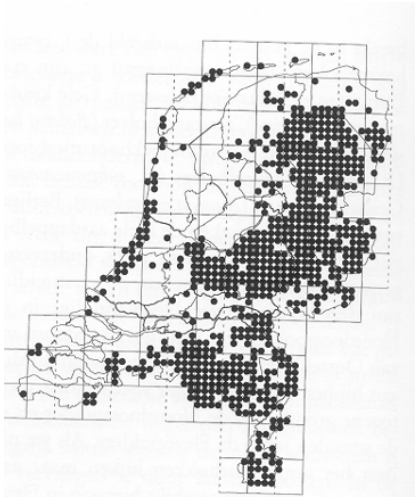
All ectomycorrhizal fungi:

- in nature very common
- inoculations leading to predictable mushroom production have <u>always</u> failed

Cantharellus cibarius

The Flevopolders, a special case

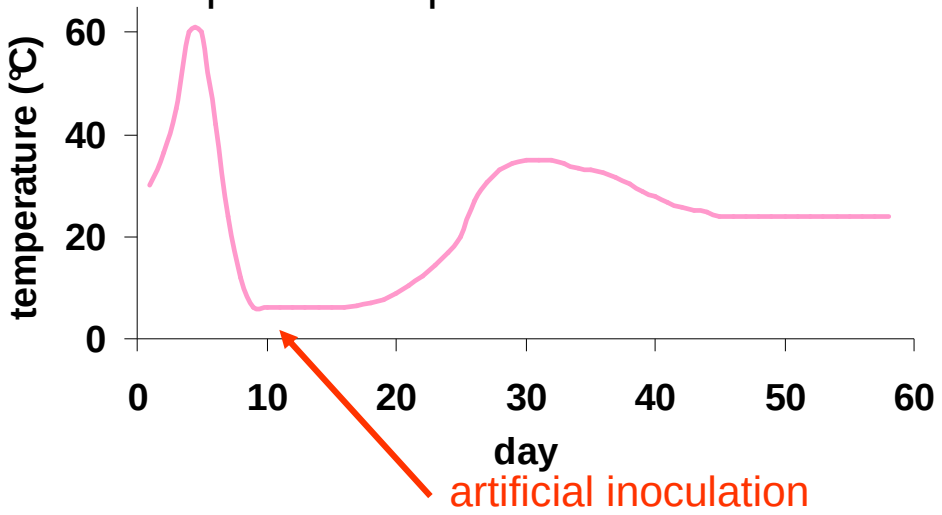
- reclaimed from the sea 1942-1968
- quite different mycoflora
- ±30 species much less common than elsewhere
  - saprotrophs because of lack of old wood
  - ectomycorrhizal fungi



Xerocomus badius

Attempt to infest compost with biocontrol agents largely failed

- experimental factors:
  - compost type / age / infestation place
  - 7 control species
  - done at WU and INRA using different composts and procedures
- result: complete failure

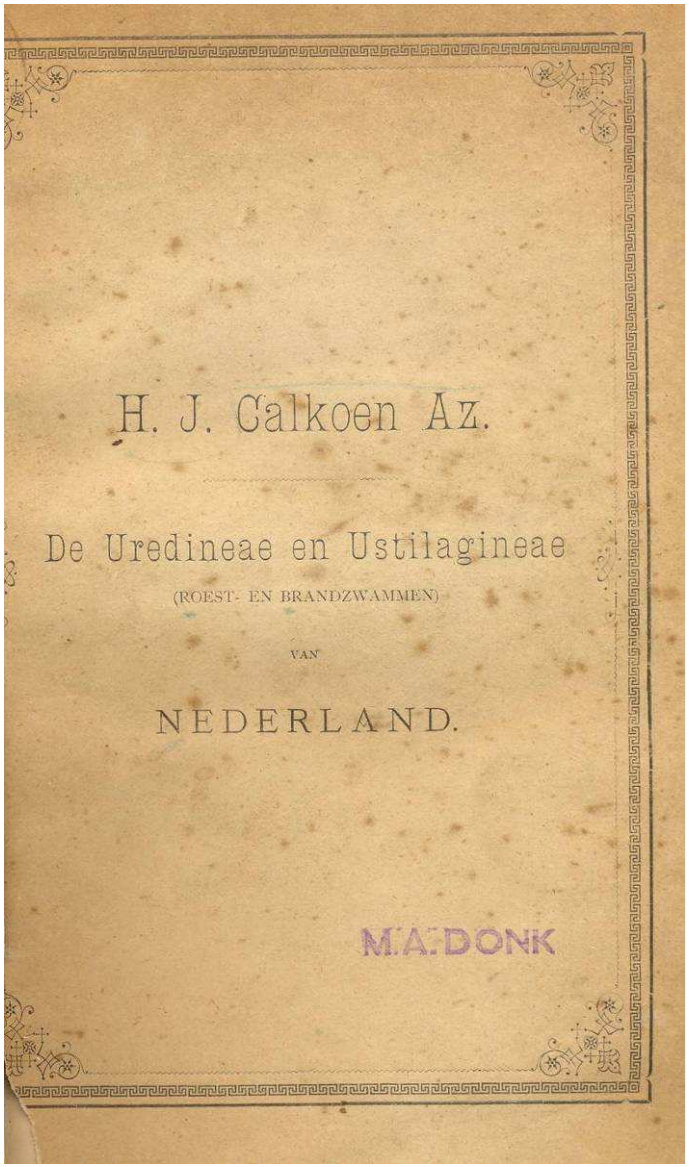


Why failure?

- slow rate of dispersal
- high competition
- in the field: low availability of substrate

Rusts in the Netherlands

Puccinia punctiformis



Rust invasions into Europe

- Since ±1840 only 19 rust species have entered Europe that could occur in NL; 13 of them do occur in NL
- examples:
  - *Puccinia malvacearum* (1869 Chile)
  - *Gymnosporangium sabinae* (pear rust, <1729?, ?)
  - *Puccinia horiana* (chrysanthemum rust, 1964 Japan)

Puccinia malvacearum

Gymnosporangium sabinae

Puccinia horiana

Role of cultivated plants in rust distribution in NL

rusts of plants that occur in the Netherlands:

	in NL	not in NL
exclusively on wild plants	125	128
(in part) on cultivated plants	28	51

why haven't they invaded NL??

Pucciniastrum goodyerae

Puccinia adoxae

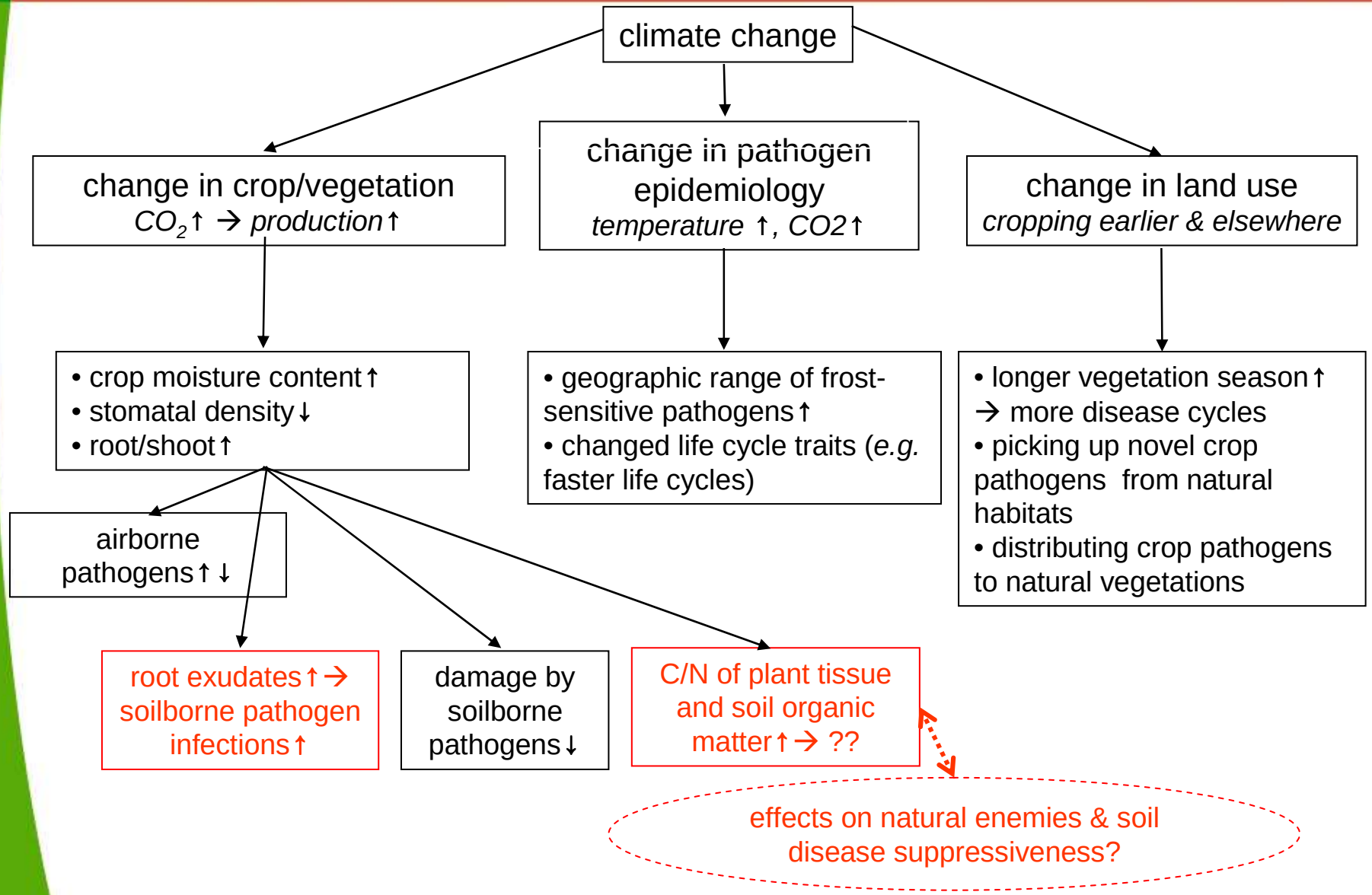
Summary

- fungal invasions are rare
- fungal invasions are competition-sensitive and substrate-driven:

sterile substrate, e.g. sterilized soil
lichen substrate
novel types of substrate
(aboveground) plant tissue
novel polder soils
belowground plant tissue
soil

but what if substrates structurally change due to climate change?

Focussing on substrate quality



Conclusions

Key-issues in climate change related bioinvasion of plant pathogens:

- changed presence of hosts & pathogens
- changed C/N-ratios of plant tissue and organic matter
- climate preference (frost sensitivity etc.)

What to do?

- precise prediction is impossible
- monitor what is going on
  - pathogen & disease presence
  - substrate change (organic matter quality) & subsequent biological change of soil quality

Blgg

Thank you for your attention!