Martin M. Gossner

Introduced tree species in central Europe – consequences for arthropod communities and species interactions

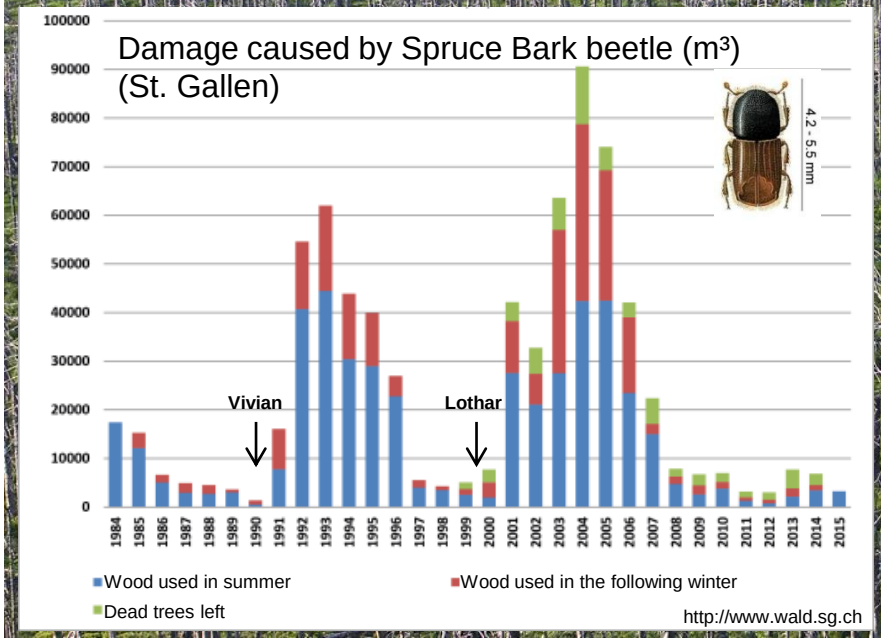
Forests in Europe

Prominent example of an anthropogenically changed ecosystem, affected by humans for >5000 years

Schelhaas et al. (2003): *Global Change Biology 9: 1620-1633*

Forests in Europe

Large scale losses (wind-throws, bark beetle attacks)

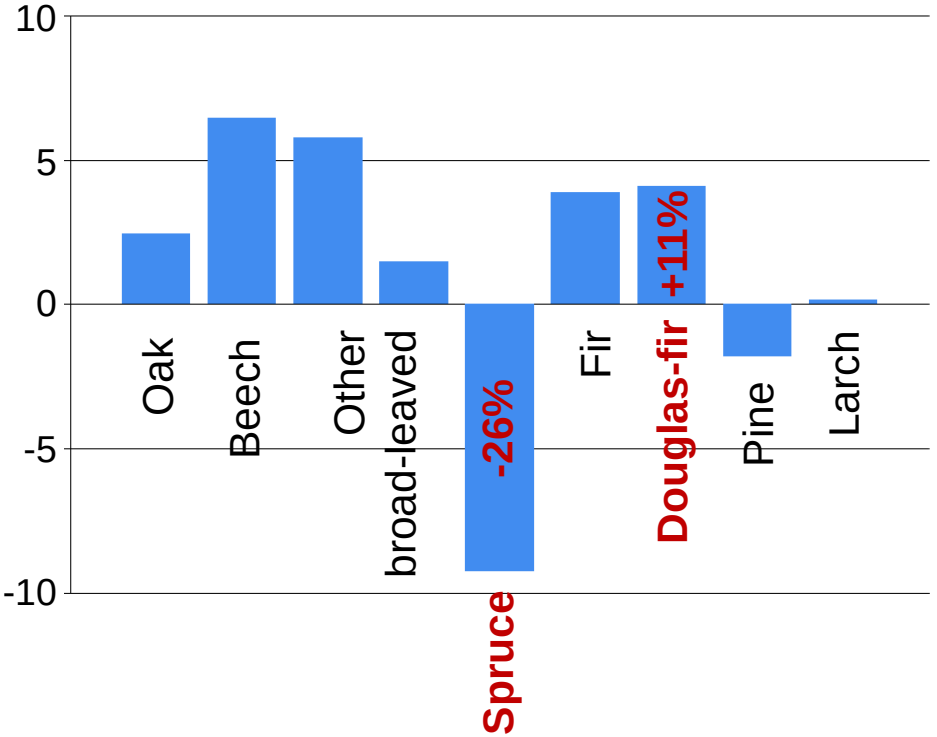


©Ingo Arndt

Forests in Europe

→ Searching for suitable alternative tree species (low risk, high yield) (Bolte et al. 2009)

Change in solid volume [m³/ha] (2002-2012)
BWI – Baden-Württemberg



Bolte et al. (2009): *Scandinavian Journal of Forest Research* 24: 473-482

Research question

What are the consequences for arthropod communities and species interactions?

Discussion still emotional rather than evidence-based

→Need for evidence-based evaluation

Research question

Effects of introduced tree species may arise from:

(1) non-native insect species introduced together with or following the introduction of the tree species

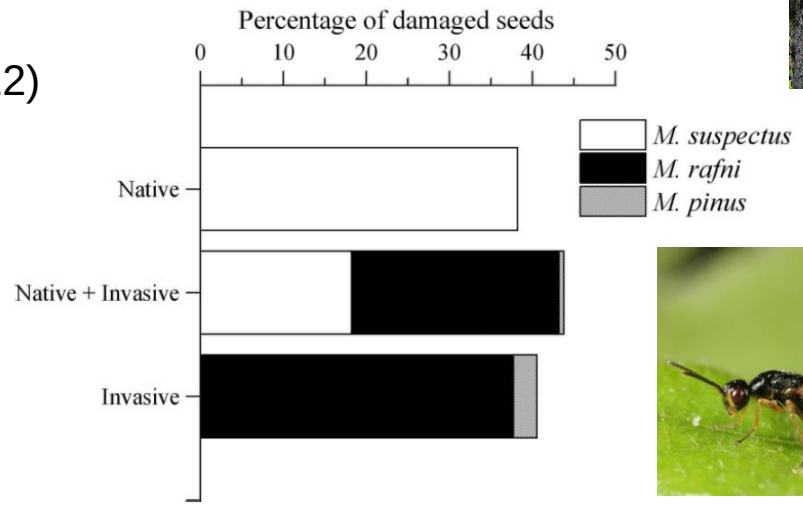
(2) missing adaptations of native insects to the introduced tree species

(3) tree structural differences to native tree species

(4) alterations of the abiotic environment of forests

Effects of non-native insect species

- reduce plant fitness of host in the new range
  (e.g. *Dasineura gleditchiae* on *Gleditsia triacanthos,* EPPO 2008)
  → higher when released from top-down control
- switch over to new host plant
  → cause damage
  (e.g. *Dreyfusia nordmannianae* on *Abies alba)*
  → displace native insects
  (e.g. cone wasps on *Abies alba,*
  Auger-Rozenberg & Roques 2012)

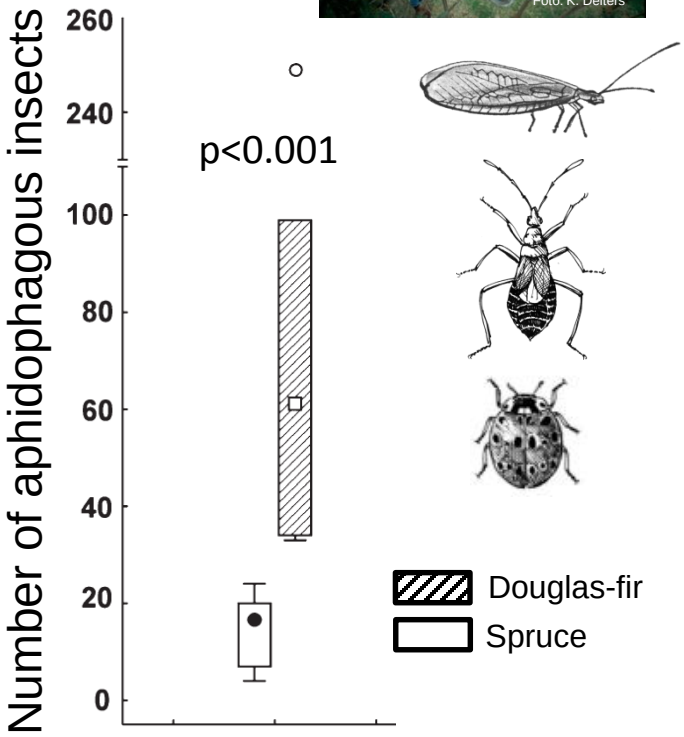


Auger-Rozenberg & Roques (2012): *Integrative Zoology* 7: 228-246

Effects of non-native insect species

- affect higher trophic level
  e.g. suitable food resource for native insects

Gilletteella spp. on Douglas fir



Gossner et al. (2005)

alternative host → increases the population density →may reduce the risk of herbivore outbreaks on indigenous tree species

Gossner et al. (2005): J*ournal of Applied Entomology* 129: 81-88

Effects of non-native insect species

Conclusion

- negative as well as positive effects on native plant- and animal communities
- specific direction and trajectories of effects highly depend on

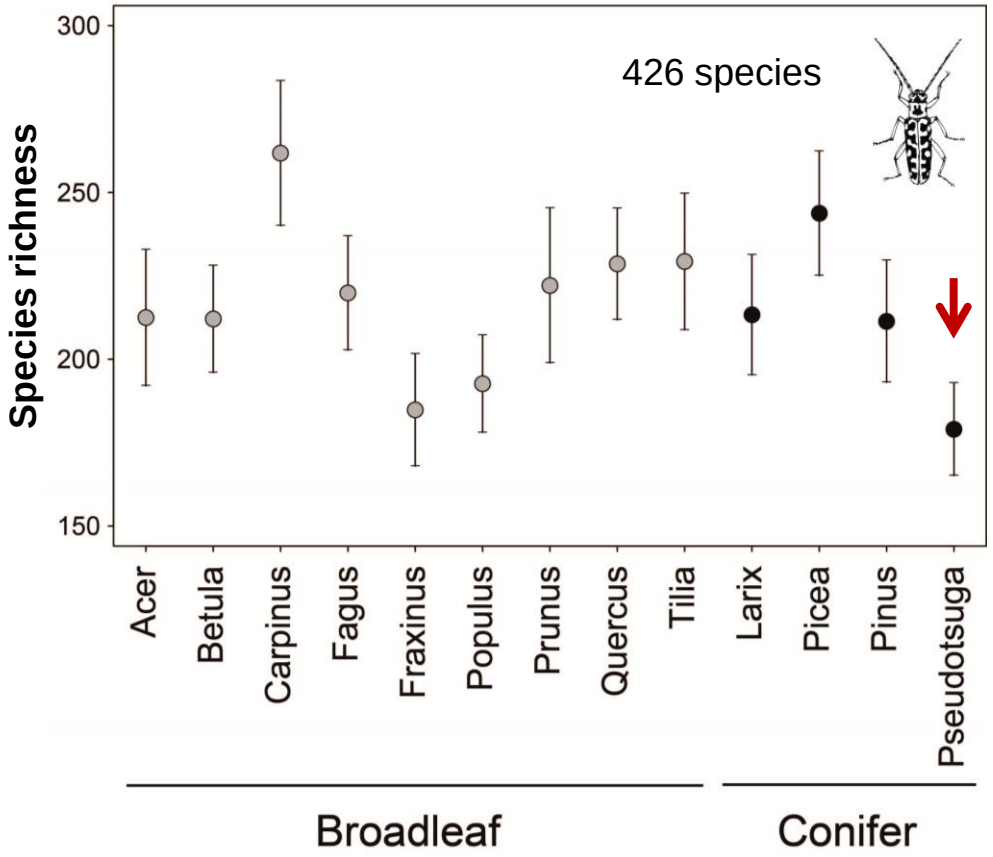
  - species specific traits

  - number of introduction events

  - phylogenetic distance to native species

Missing adaptations of native insects

- herbivores (host specialists) most severely affected (co-evolution)
- introduced tree species host less herbivores



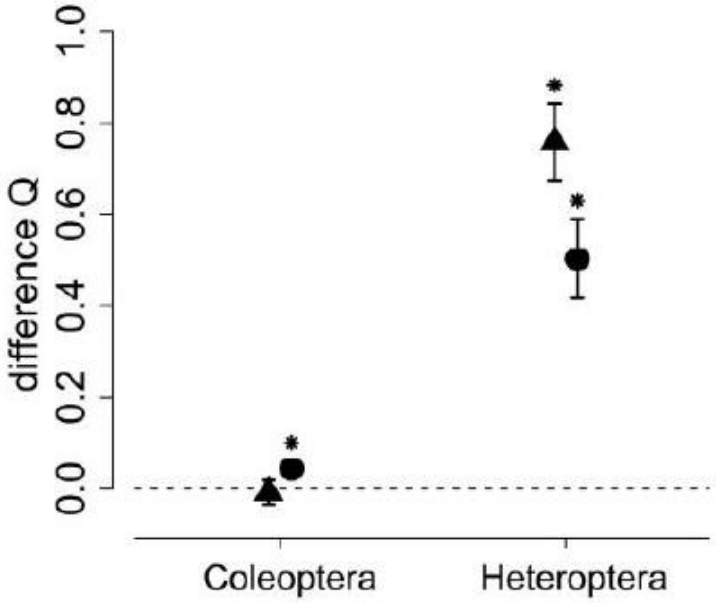
Dead wood experiment
Germany - 3 regions
2010-2012
13 tree species
>760 logs

Gossner et al. (2016): *Biological Conservation* 201: 92-102.

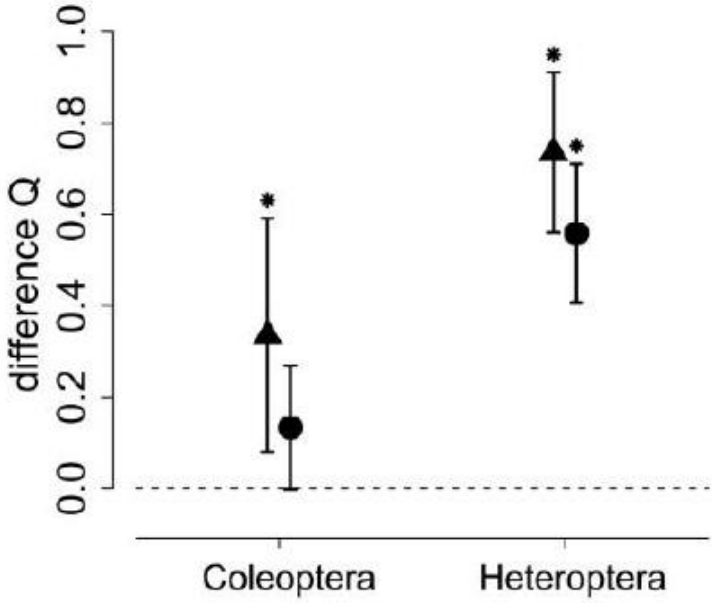
Missing adaptations of native insects

– Related species should share more species
  → “taxonomic isolation”, Conner et al. 1980
  → phylogenetic conservatism of functional plant traits

Douglas-fir



Red oak



▲ All species ● Dominant species

Gossner et al. (2009)

Conner et al. (1980): *Ecological Entomology* 5: 205-211; Gossner et al. (2009): *American Naturalist* 173: 599-614.

Missing adaptations of native insects

Conclusion

The probability of an introduced tree species to be colonized by native insects depends on

- tree-specific physical, chemical and phenological traits
- taxonomic isolation of the introduced species
- its abundance in the introduced range*
- the time since introduction*
- surrounding tree species effects#

*Kennedy & Southwood (1984): *Ecological Entomology* 5: 205-211; *Frenzel et al. (2000): *Proceedings IAVS Symposium*: 223-225, *Gossner et al. (2004): *Neobiota* 5: 1-324, # Gossner et al. (2009): American Naturalist 173: 599-614.

Tree structural differences to native tree species

i.e. bark, needle and crown structure

→ affects the number and type of available niches

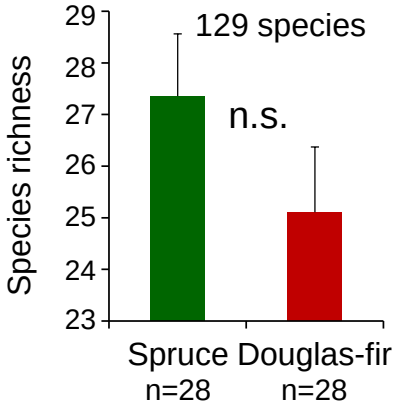
→ affects prey availability

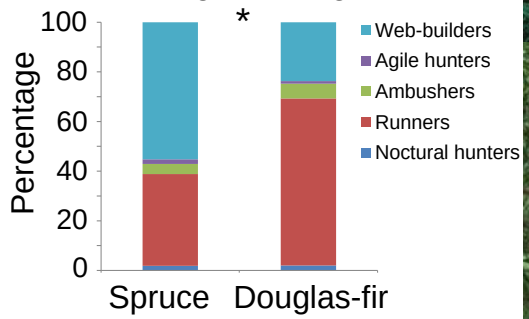
→ affects animal behavior

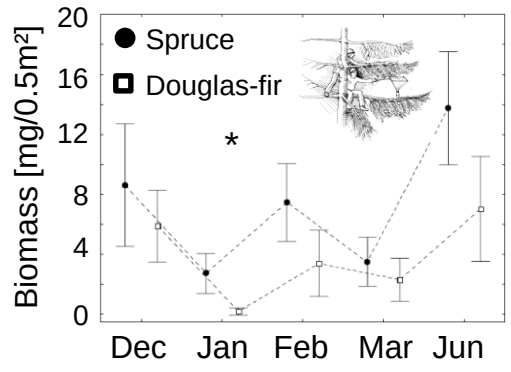
e.g. prey capture guilds

Hatley & MacMahon (1980)

→ affects microclimatic conditions

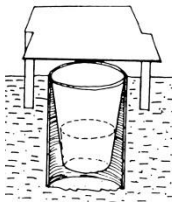




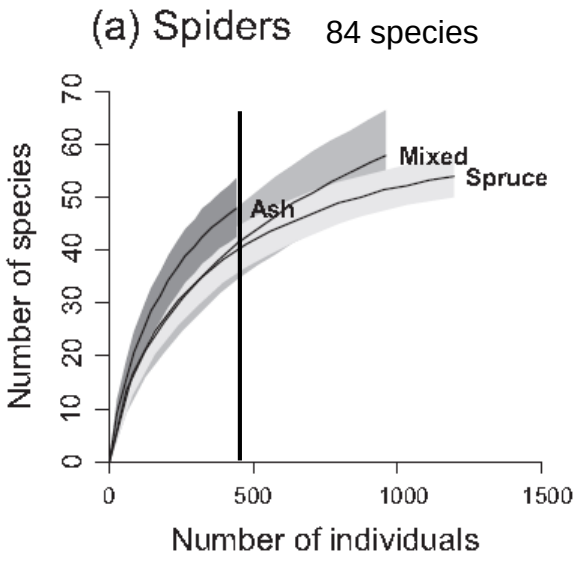


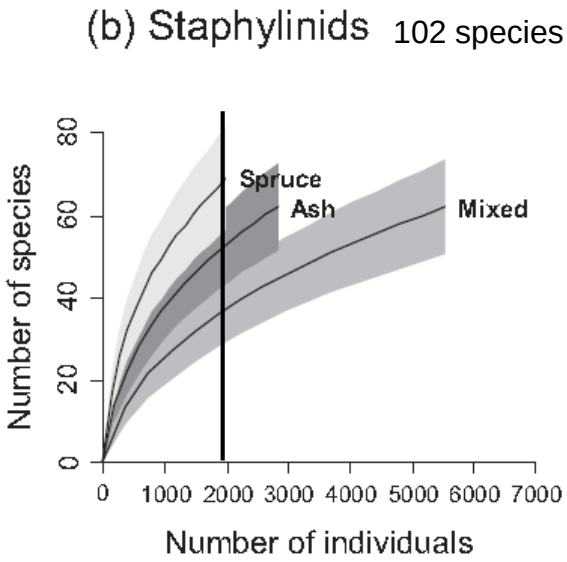
Gossner (2004): *Neobiota* 5: 1-324, Hatley & MacMahon (1980): Environmental Entomology 9:632-639, Blick & Gossner (2006): *Arachnologische Mitteilungen* 31: 23-39, Gossner & Utschick (2004): *Neobiota* 3: 105-122.

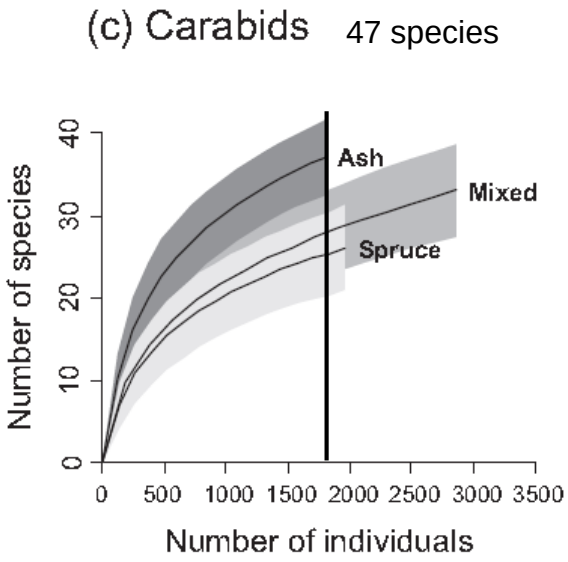
Alterations of the abiotic environment of forests



Oxbrough et al. (2016)







Oxbrough et al. (2016): *Forest Ecology and Management* 367: 21-29

Tree structure and stand abiotic environment

Conclusion

Tree structure and stand-level effects of introduced tree species depends on

- tree-species identity
- management (tree species mixture, thinning)

→ affecting

biotic (plant and litter composition)

and abiotic (microclimate, chemical and physical environment)

stand conditions

Consequences for ecosystem processes

Herbivory

"**Enemy Release Hypothesis**" (Keane and Crawley 2002; Liu and Stiling 2006)

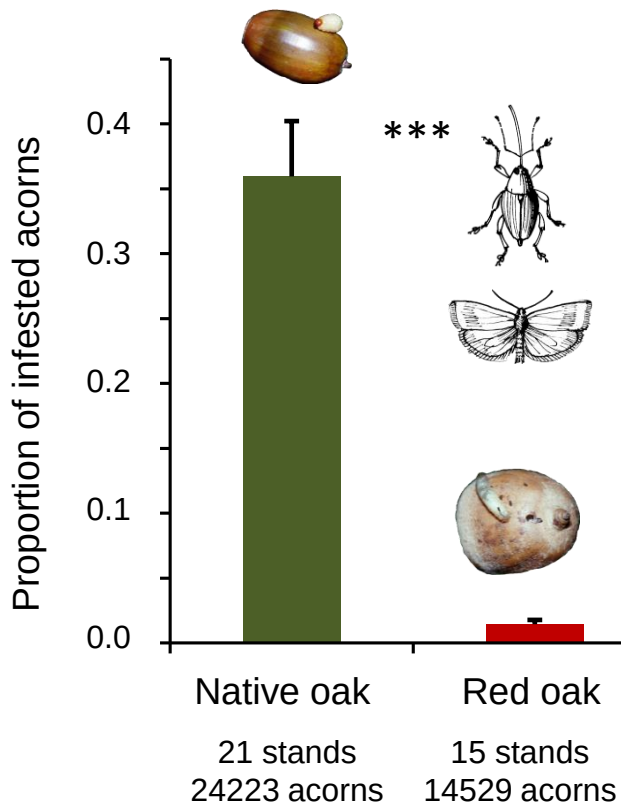
- exotic plants introduced in a new region are less regulated by herbivores
  → increase rapidly in distribution and abundance
- most likely occurs when regeneration is increased
  → due to reduced seed predation
  → when reduced herbivory increases competitive ability over native tree species

Keane and Crawley (2002): *Trends in Ecology & Evolution* 17: 164-170, Liu & Stiling (2006): *Biological Invasions* 8: 1535-1545 .

Consequences for ecosystem processes

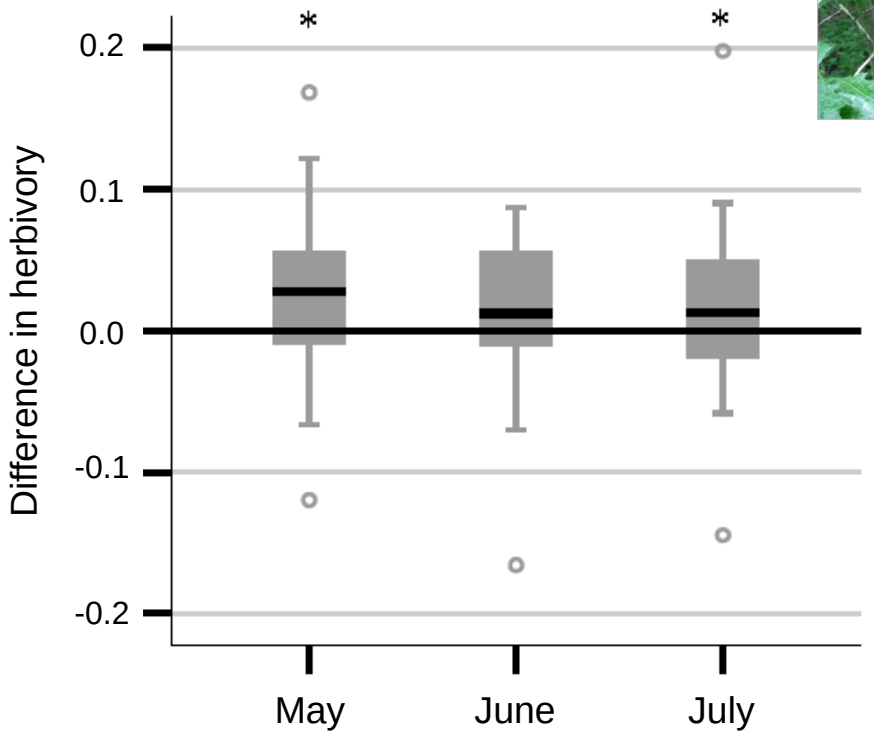
Herbivory

Insect seed predation



Gossner & Simon (2005)

Insect leaf herbivory



30 pairs of native *Q. robur* and introduced *Q. rubra*

Ruff (2008)

Higher on native oak (2.2-3.1%)

Higher on introduced oak (Red oak < 1%)

Gossner & Simon (2005): *Neobiota* 6: 98-109, Ruff (2008): *Diploma thesis*, Technische Universität München

Consequences for ecosystem processes

Conclusion

Change in community composition of arthropods by the introduction of tree species

→ change in trophic interactions

→ alteration of ecosystem processes
- herbivory
- leaf- and wood decomposition

  (e.g. Gossner et al. 2016/Kahl et. al. subm.)
- nutrient cycling
- pest control (Buxton 1990)

Gossner et al. (2016): *Biological Conservation* 201: 92-102, Kahl et al. (subm.): *Forest Ecology and Management*: under review

Take-home message

Effects of introduced tree species on organismic communities and related processes

- multifaceted (depends on tree species, tree species mixture, arthropod taxon etc.)
- shaped by arthropod species plasticity
- shaped by arthropod species adaptations
- affected by global change

→ cautious use of introduced tree species
from a ***nature conservation*** as well as
from an ***economic*** point of view

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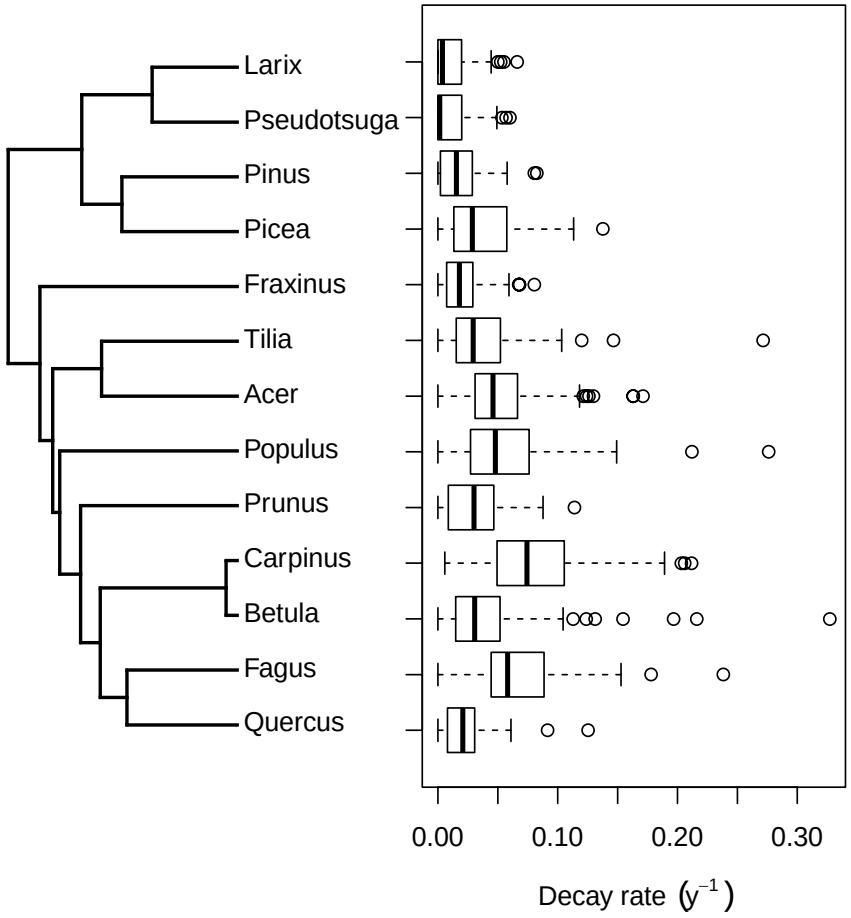
BfN Federal Agency for Nature Conservation

BAYERISCHE FORSTVERWALTUNG

Results

Consequences for ecosystem processes

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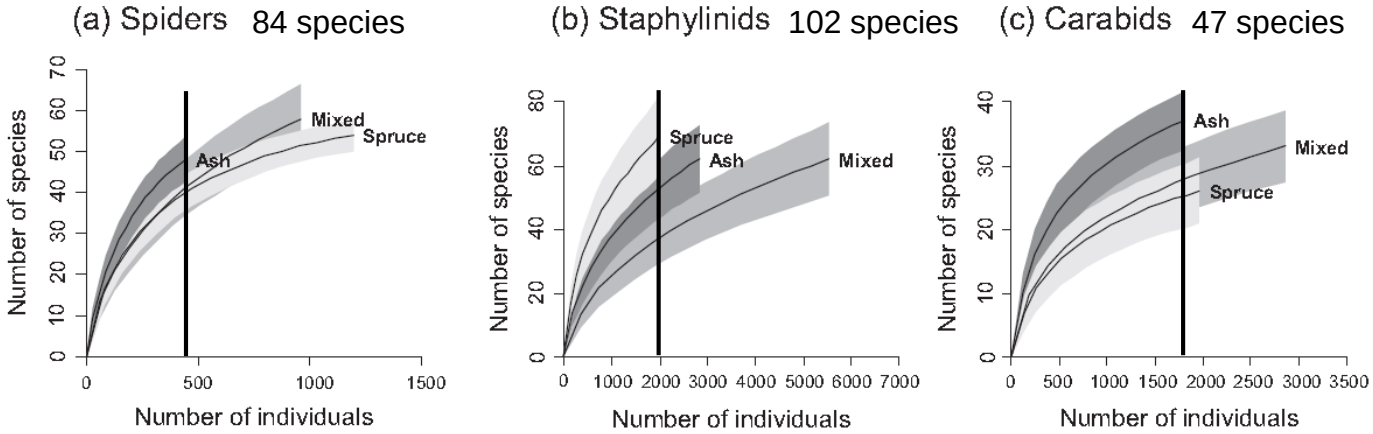
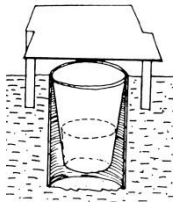
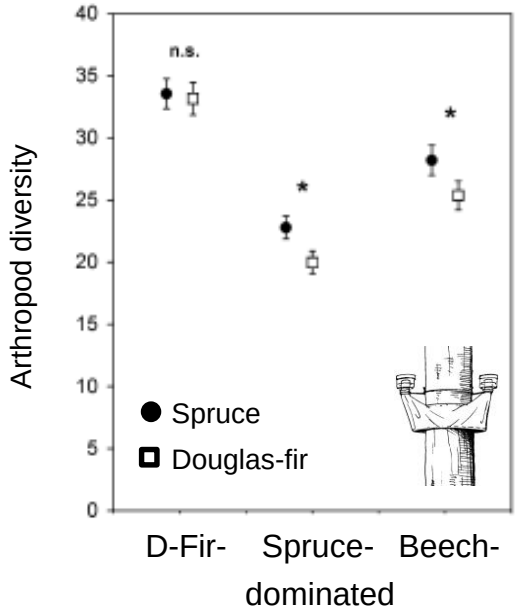
Alterations of the abiotic environment of forests

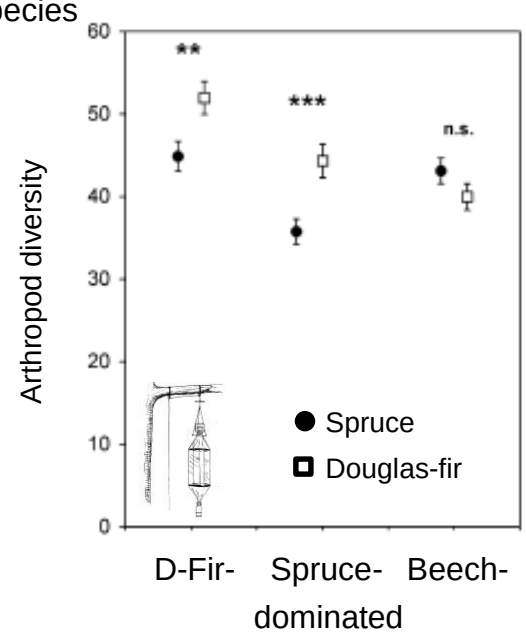


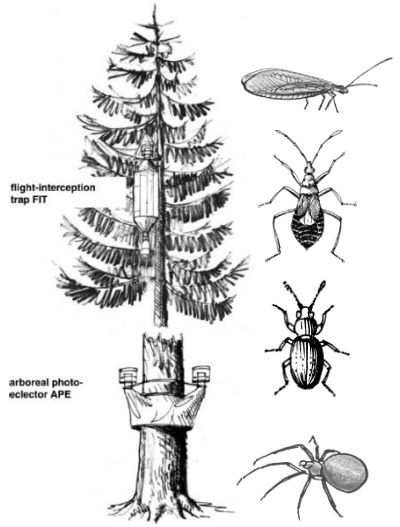


Oxbrough et al. (2016)

555 species







Gossner & Ammer (2006)

Oxbrough et al. (2016): *Forest Ecology and Management* 367: 21-29, Gossner & Ammer (2006): *European Journal of Forest Research* 125: 221-235