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

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Forests in Europe

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

Extensive plantations of economic valuable trees outside natural distributional ranges (Schelhaas et al. 2003)
Forests in Europe

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

Damage caused by Spruce Bark beetle (m³)
(St. Gallen)

- Wood used in summer
- Wood used in the following winter
- Dead trees left

http://www.wald.sg.ch

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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

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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)
Effects of non-native insect species

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

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

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

Missing adaptations of native insects

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

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#

Tree structural differences to native tree species

- 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

Alterations of the abiotic environment of forests


(a) Spiders  84 species

(b) Staphylinids  102 species

(c) Carabids  47 species

Oxbrough et al. (2016)
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

Consequences for ecosystem processes

Herbivory

Insect seed predation

Insect leaf herbivory

Higher on native oak (2.2-3.1%)

Higher on introduced oak (Red oak < 1%)

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)

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
Thanks!!!
Results

Consequences for ecosystem processes

Decay rate ($y^{-1}$)
Alterations of the abiotic environment of forests