

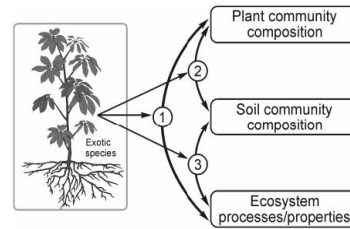
What's new in plant invasion biology?

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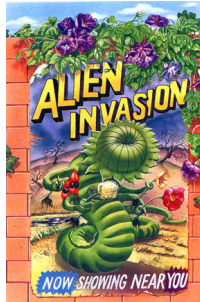
Soil communities & exotic plant invasion

BE Wolfe & JN Klironomos 2005 Breaking new ground: soil communities and exotic plant invasion. *Bioscience* 55, 477-487.



Invasion of natural communities

- significant threat to biodiversity globally
- major component of global change, along with climate change & habitat loss



Exotic invasive plants can...

- reduce native diversity & abundance
- change soil nutrient status
- change fire regime
- change catchment hydrology



Gamba grass fire, NT



Athel pine (*Tamarix aphylla*) in central Australia



Myrica faya in Hawaii

Invasion biology research so far...

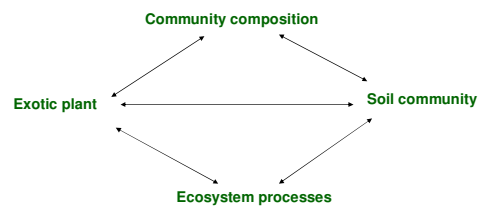
effects on native plant & animal communities
attributes of invading species
attributes of invaded communities

BUT focus on aboveground flora & fauna



Emerging area of research

- interactions between exotic plants & soil organisms
- links between above- & belowground communities
- availability of new tools to characterize soil communities (fatty acid analysis, nucleic acid analysis, enzyme activity, carbon substrate utilization, community-level physiological profiling)



Role of soil communities in ecosystems

Biogeochemical cycling

- mineralization
- decomposition
- N-fixation

Direct effects on plant growth

- negative effects of pathogens & herbivores
- positive effects of mutualists

Soil structure

- aeration & turnover
- aggregation

1. Influence of exotic plant invasions on soil communities - some examples

<i>Alliaria petiolata</i> (Garlic mustard)	Decrease in arbuscular mycorrhizal fungi (AMF)	Decrease in growth of native tree seedlings	Roberts & Anderson 2001
<i>Berberis thunbergii</i> (Jap barberry) & <i>Microstegium vimineum</i> (Jap silt grass)	Decrease in total fungal abundance (Bt) Increase in abundance of AMF (Mv)	Altered soil enzyme activity & soil respiration	Kourtev et al. 2002, 2003
<i>Bromus tectorum</i> (cheatgrass)	Composition changes	Decrease in N-mineralization	Belnap & Phillips 2001, Kuske et al. 2002
<i>Bromus hordeaceus</i> (soft brome) & <i>Avena barbata</i> (slender oat)	Changed composition of AMF	Increased nitrification	C. Hawkes 2004 pers comm cited in Wolfe & Klironomos 2005

BUT

- few studies
- effects variable across spp, communities
- temporal scale unknown
- few link changes to soil composition with soil function
- fewer link changes in soil function to feedback to changes in aboveground vegetation
- may be multiple exotic invaders

→ Potentially important but more data, better tools will enable a better mechanistic understanding

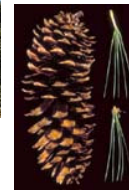
2. Influence of soil organisms on exotic plant invasions

Direct effect of specific organisms

- eg facilitation of *Pinus* invasion by ectomycorrhizal fungi



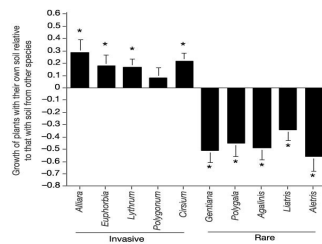
Source: Moira William's website



2. Influence of soil organisms on exotic plant invasions

Feedbacks between exotic plants & soil biota Klironomos 2002

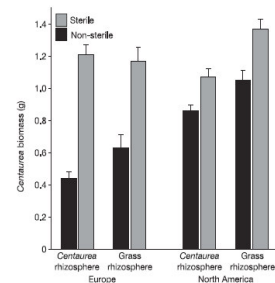
- 5 invasive vs 5 rare plant spp
- grown from seed in pots for 10 weeks with soil from that spp or soil from a different species
- the 5 rare spp had strong negative feedback (reduced growth in their own soil rel. to other soil)
- the 5 invasive spp had net positive feedback (increased growth in their own soil relative to soil of other spp)



2. Influence of soil organisms on exotic plant invasions

Feedbacks between exotic plants & soil biota eg Spotted knapweed *Centaurea maculosa* (Callaway et al. 2004)

- 4 populations of *C. maculosa* from native range in western Europe
- 6 populations of *C. maculosa* from invaded range in NW US
- sterilization of European soils → 166% increase in biomass
- sterilization of US soils → 24% increase in biomass



Exotic plants may escape the negative effects of soil pathogens in their home ranges → support for the enemy-release hypothesis

BUT...

- need to incorporate new tools, scale up from glasshouse to field & from short-term to longer timescales
- consistent across regions? communities? species?
- what is the relative effect of soil biota compared with disturbance, propagule pressure, competitive interactions, etc?

3. Soil communities and ecological restoration

Traditionally ecological restoration has focused on the aboveground community

Does restoration of the soil community 'go along' with restoration of the aboveground community?

Should certain soil organisms (eg mycorrhizae) be reintroduced if they were detrimentally affected by the invader?



Soil communities & exotic plant invasion

- the role of soil organisms in exotic plant invasion has been overlooked
- evidence of its importance for some species in some communities
- likely that a better understanding of the mechanisms of aboveground-belowground interactions may progress invasion biology
- how general are these relationships?
- developing quick & easy technologies

