

Why do Plants coexist?



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Current Perspective of Plant Coexistence (Textbook)

Plants can coexist when inter-specific competition is less than intra-specific competition.

→ niche separation (i.e. minimal overlap of limiting resources → competitive equilibrium

Competition and competitive exclusion are the determining forces behind the composition of plant communities.

Getting more limiting resources will increase individual fitness.



→ ongoing battle situation



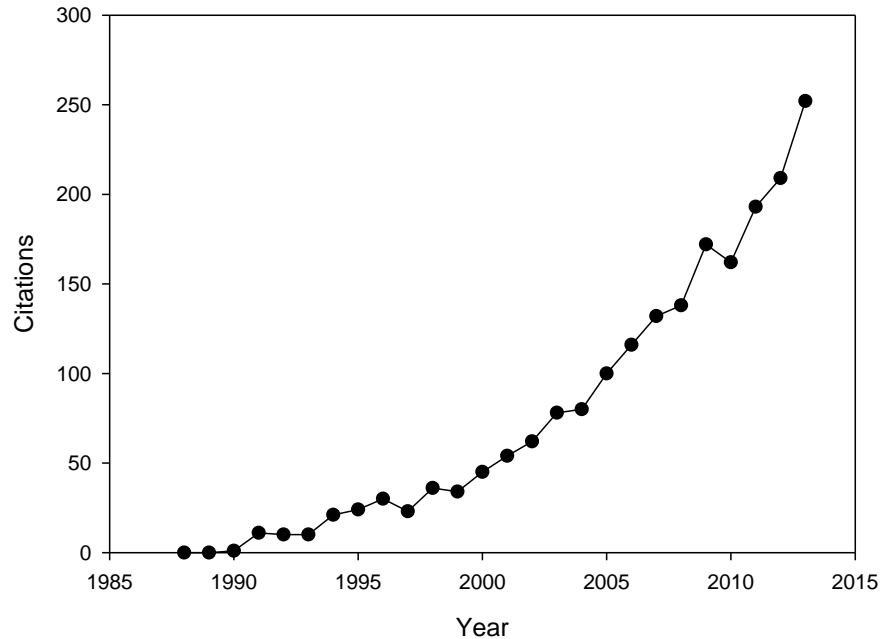
Getting more limiting resources will increase individual fitness
 ????



Sagebrush Steppe, Western USA

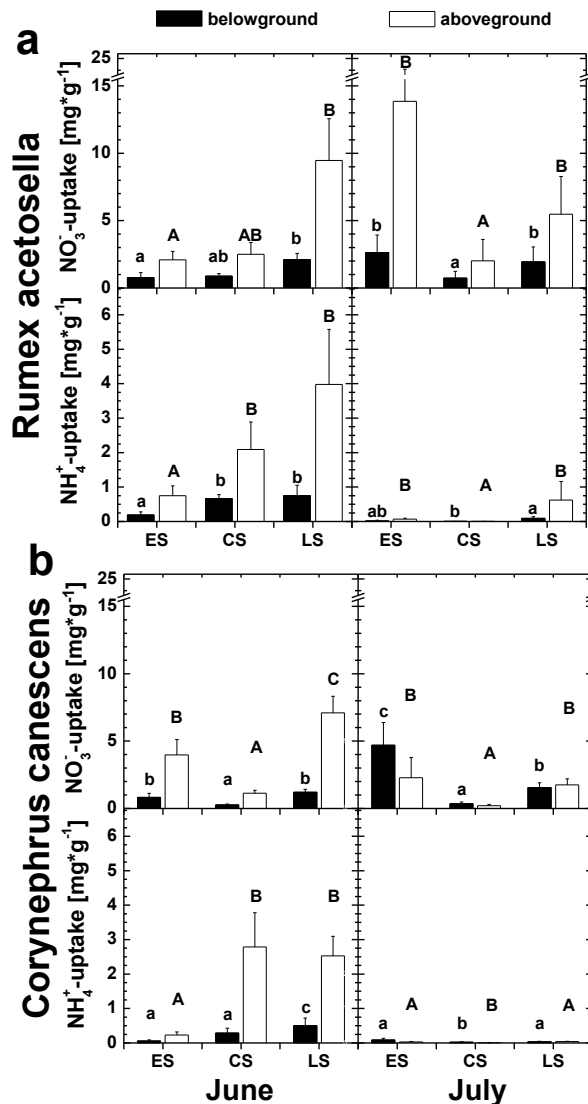
- In contrast to the natural-selection-by-competitive-exclusion-paradigm, facilitation (cooperation) among plant species seems to be a rather widespread phenomenon.

Web of Science
Search: "facilitation" AND "plant"



Why would a plant species benefit (i.e. increase the fitness of) another species? Is this altruism?





Stahl V.M., Beyschlag W.,
Werner C. (2011)
Dynamic niche sharing in dry
acidic grasslands. - A ^{15}N -
labeling experiment
Plant and Soil 344:389-400



An increasing number of experimental field studies reveals:
Different species frequently use the same limiting resources simultaneously.
→ Niche sharing (niche overlap) instead of niche separation



Diversity-Stability Hypothesis: Stability is linked with diversity

Many exceptions:

- Many stable plant communities with rather low species numbers.
- Even extremely stable monocultures (e.g. Phragmites stands) (normally a result of special site conditions rather than of competitive interactions.)



A new concept is needed

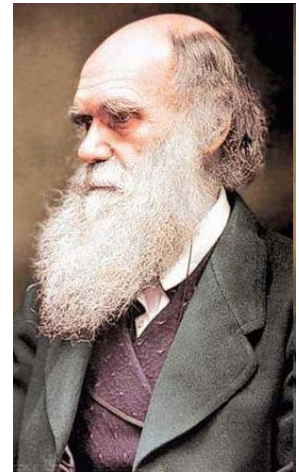
Two premises:

1. Plants modify their environment.

(evidence exists for soil moisture, nutrient dynamics, soil microbes, soil stability, microclimate, disturbance regimes, and others)

Individual species modify environment differently (based on resource use, structure etc.)

2. Natural selection works at the individual level (Darwin).



Implications

Through natural selection species individuals evolve to have highest fitness under the environment to which they are exposed.

This environment includes individuals from other species and related environmental modifications. So within assemblages species evolve simultaneously with other species (“co-evolution”).

Individual species become dependent on presence of other species for high fitness → facilitation.

Novel disturbances:

- create novel conditions
- lower fitness
- reduce stability

How about “Niche Overlap”?

Resource availability is a function of the community composition.

All individuals have the highest fitness at the particular resource availability in the community.

→ "Competitive response" rather than "competitive effect"

How about Competition?



In a co-evolved stable plant community there is hardly any negative effect of interspecific competition.

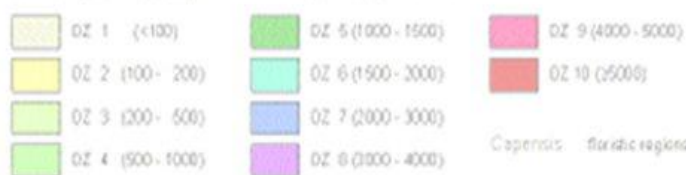
Within a species: continuous selection process for the individuals which are best adapted to the particular conditions of this particular community (intraspecific competition).

How about the Diversity-Stability Problem??

- The stability of a community is a function of the degree of co-evolution, and not of the number of the species involved. So species poor systems can exhibit a similar or even greater stability as species rich systems.
- The controversial results of many biodiversity experiments may have something to do with the fact, that species assemblages rather than co-evolved species communities were investigated.

Robinson Projection
Standard Parallels 36°N and 36°S
Scale 1: 95000000

Diversity Zones (DZ): Number of species per 10.000km²



sea surface temperature



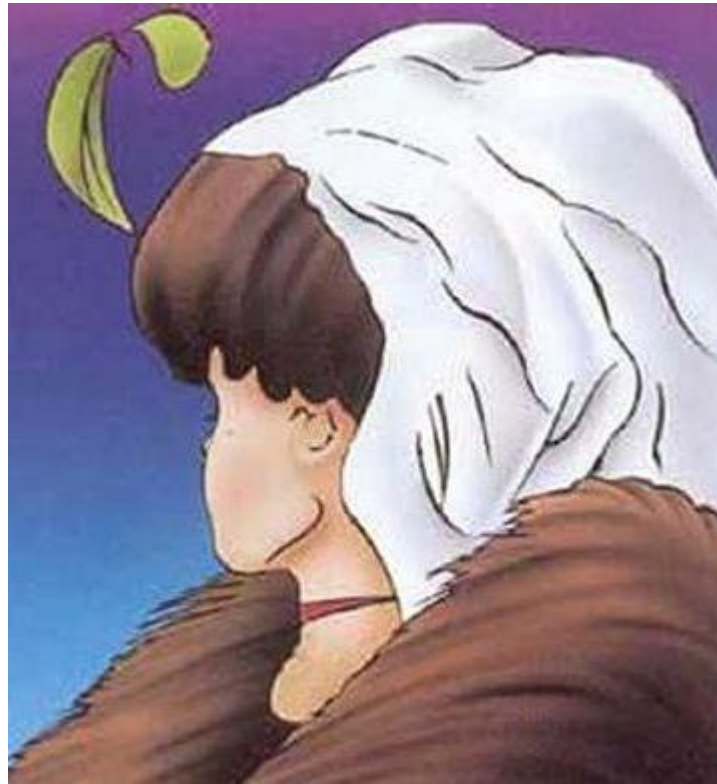
 cold currents

W. Barthlott, N. Biedinger, O. Braun,
F. Feig, G. Her, W. Lauer & J. Matke 1997
modified after
W. Barthlott, W. Lauer & A. Pledel 1996
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Cartography: M. Graf
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Thank you !



How about Succession??

Succession is a series of assemblages that alter environments in a way that they are better suited for the subsequent species assemblages.

The whole seral progression represents a coevolved community. For instance: The fitness of the early successional species is dependent on the disturbance regime characterized by the endpoint community.

Typically, early successional species are not lost during succession.

