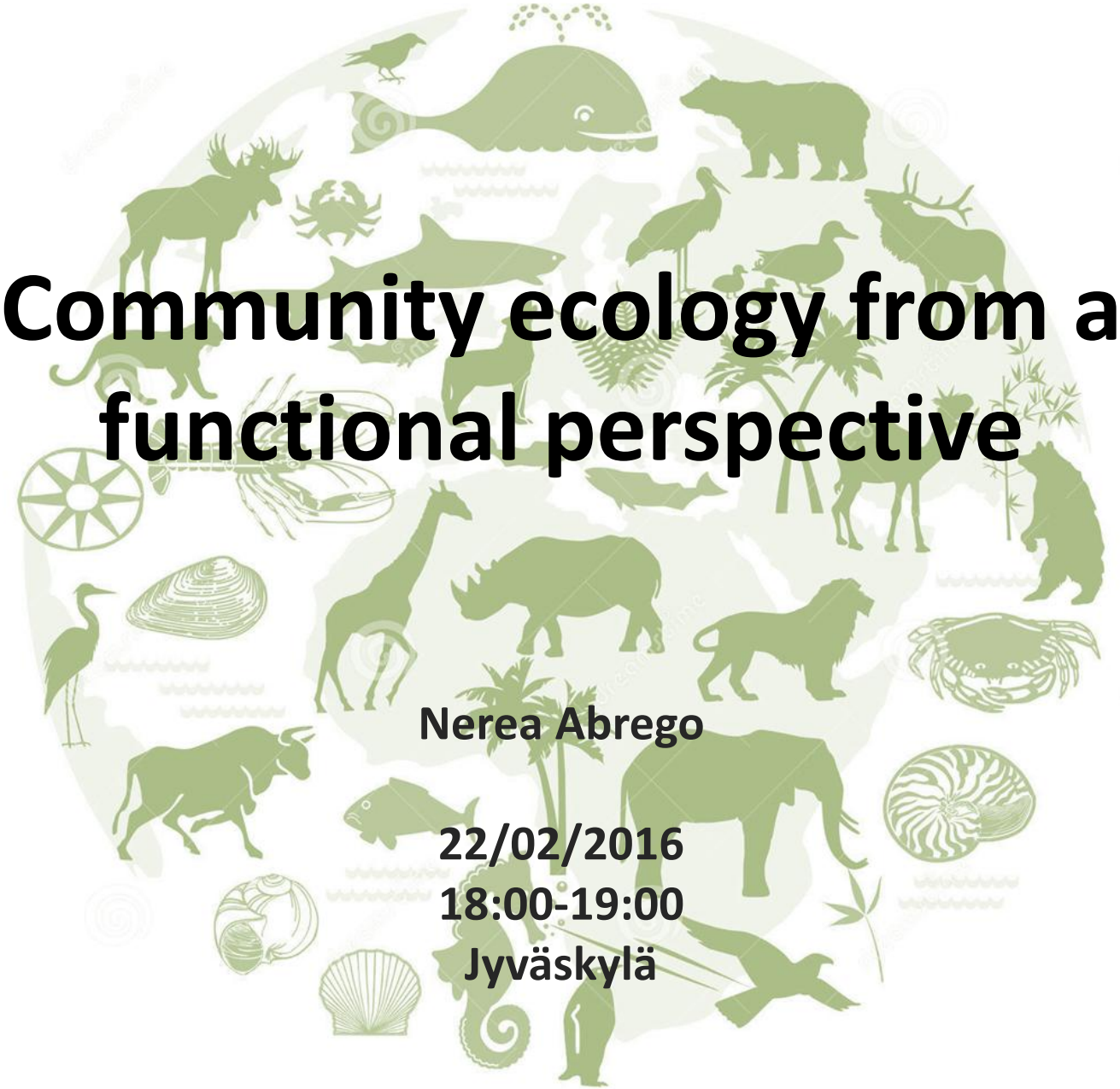

Community ecology from a functional perspective

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22/02/2016
18:00-19:00
Jyväskylä

Outline of the lecture

1. What do we study in functional community ecology (FCE)?
2. Trait-based community ecology
    1. Functional diversity: what does it tell about?
    2. Considering the phylogenetic signal: when and why should be used?
    3. Gaining an evolutionary perspective of the community: niche evolution
3. Community functioning: the role of interactions
4. FCE from an applied perspective

What do we study in functional community ecology?

- The performance of the species (or individuals) composing a community influences **ecosystem functioning**

- Thus, in functional community ecology we study how the changes in the performance of the species (or individuals) influence the ecosystem functioning

- The functional role of the species in the ecosystem is usually measured by **functional traits.** Functional traits are a measurable property of organisms measured at the species or individual level that is known to strongly influence organismal performance. Functional traits determine the responses of individuals and species to biotic and abiotic variation and thus influence the ability of organisms to adapt to particular environmental characteristics (e.g. McGill et al 2006, Gallagher et al 2013)

- Thus in functional community ecology functional traits are used comparatively across species

What do we study in functional community ecology?

- Traits that influence the responses of species to changes in environmental conditions are called **response-traits**. The identification of response-traits can provide functional, mechanistic and predictive perspectives on processes shaping the assembly and dynamics of ecological communities (Moretti & Legg 2009)

- Thus, the identification of response-traits has gained much attention in the field of functional community ecology

Using species traits to investigate ecological communities

Example: Hummingbirds in breeding season

- ✓ Hummingbirds meet large daily energy expenditures by acquiring nectar.
- ✓ Body size is the trait that is the best single predictor of basal metabolism and also of costs of flying and maintaining body temperature at night.
- ✓ Flower densities and their nectar yields define fundamental niches, and vary along altitudinal gradients.
- ✓ Larger hummingbird species are behaviorally dominant for the purpose of defending territories and the flowers in them, but also require higher nectar-yield flowers to support themselves; therefore, not all available territories can support a large-bodied individual.
- ✓ Nectar can also accumulate in lower yield flowers and be available to smaller bodied species.
- ✓ Thus, species of different body mass can coexist along a tradeoff from behavioral dominance to tolerance for low resources, defined mainly by body mass in relation to the resource supply.

McGill et al (2006)

Using species traits to investigate ecological communities

Example: Herbaceous plants in cold-temperate lakeshore communities

- ✓ All species in the community grow best at sites that have sediment that is rich in mineral nutrients and rarely disturbed. Other sites are less favorable for several reasons, including lower nutrients (sand or cobbles), exposure to strong wave action, or frequent damage by shifting ice.
- ✓ Different species have wider tolerance (i.e. can maintain positive growth) along these different dimensions of unfavorability.
- ✓ Competitive dominance is best predicted by the stature of the species as an adult, because height confers prior access to light. Taller species tend to be less tolerant of the different kinds of unfavorability owing to allocation of resources to growth rather than to resilience.

McGill et al (2006)

Functional diversity

By measuring functional diversity, it is possible to quantify the functional aspect of biodiversity.

A bunch of indices for measuring different properties of the functional diversity exist (in Mouchet et al 2011 the different indices and properties are nicely explained)

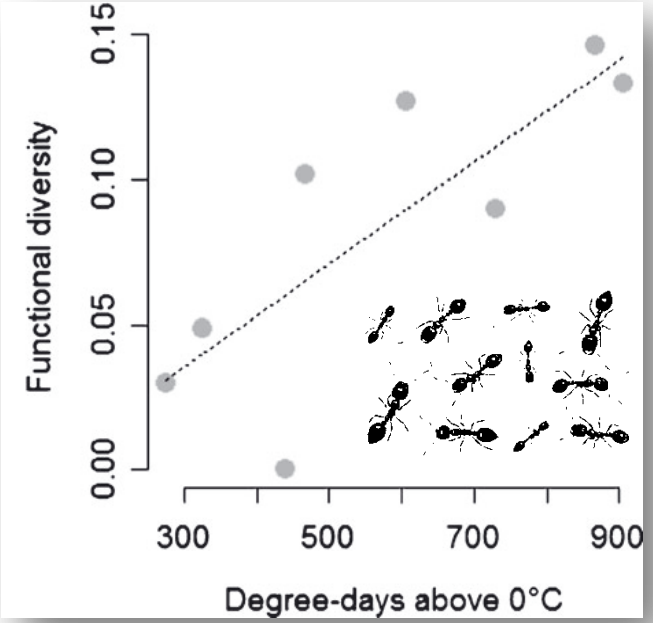
The functional diversity can give us important insights on the processes molding the communities:

- ✓For example, if under different environmental conditions we find different levels of functional diversity, it suggests that environmental filters may play a big role on shaping the communities

Functional diversity

Example: functional diversity decreases with altitude in ant communities (Reymond et al 2013)

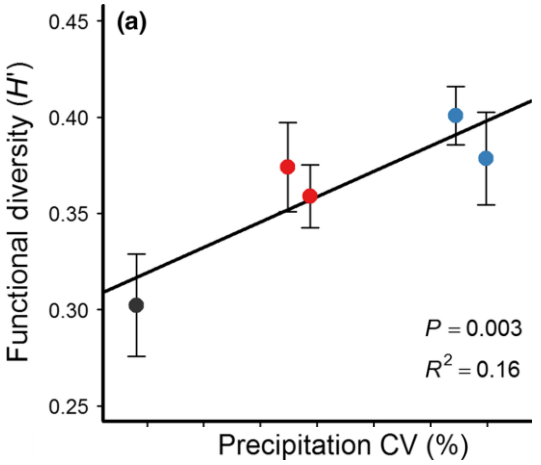
✓Functional diversity decreased with decreasing temperature.
✓Species found in colder habitats tended to live in subterranean nests rather than in mounds.
✓Mounds are more thermally insulated against the cold compared with soil. The absence of a mound-building ant from high elevations probably results from a reduction in the amount of vegetal materials provided by coniferous trees.
✓More severe abiotic conditions at higher elevations act as a filter on ant assemblages, directly through physiological tolerances to the abiotic conditions and indirectly as the vegetation necessary for nest building shifts with elevation.



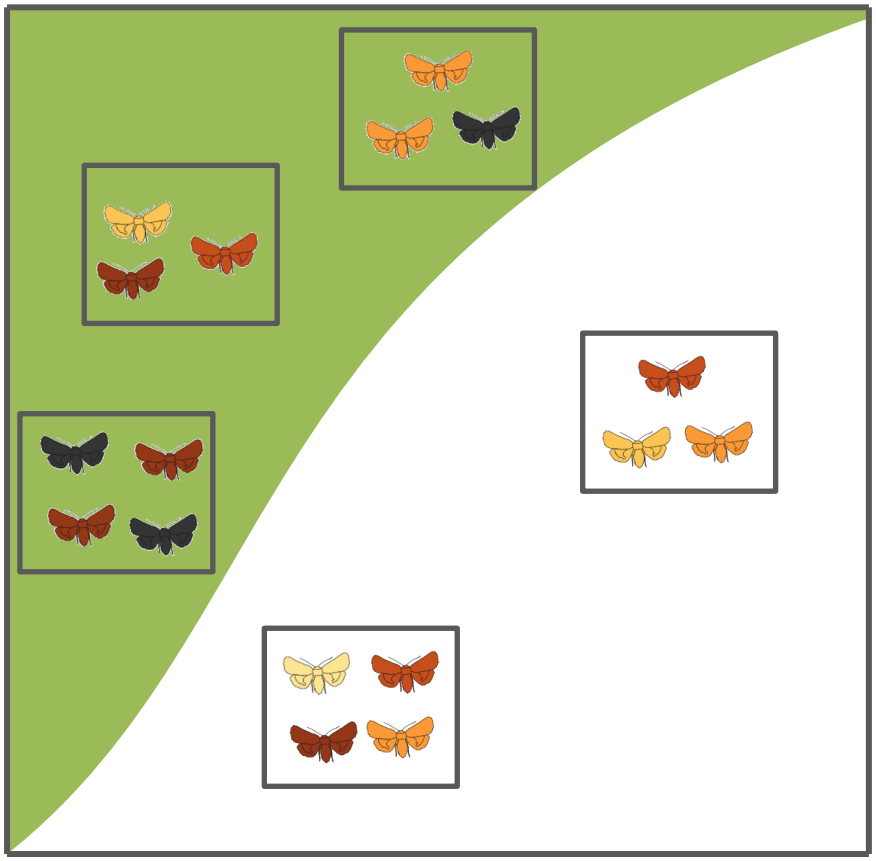
Functional diversity

Example: functional grass diversity increases with increasing precipitation variation (Gherardi & Sala 2015)

✓Interannual precipitation variability effects on functional diversity and its consequences for ecosystem functioning are assessed here using a 6-year rainfall manipulation experiment.
✓Five precipitation treatments were switched annually resulting in increased levels of precipitation variability while maintaining average precipitation constant.
✓Functional diversity showed a positive response to increased variability in annual precipitation.
✓Increased interannual precipitation variability increased functional diversity as a result of nonlinear responses of plant functional types to annual precipitation.

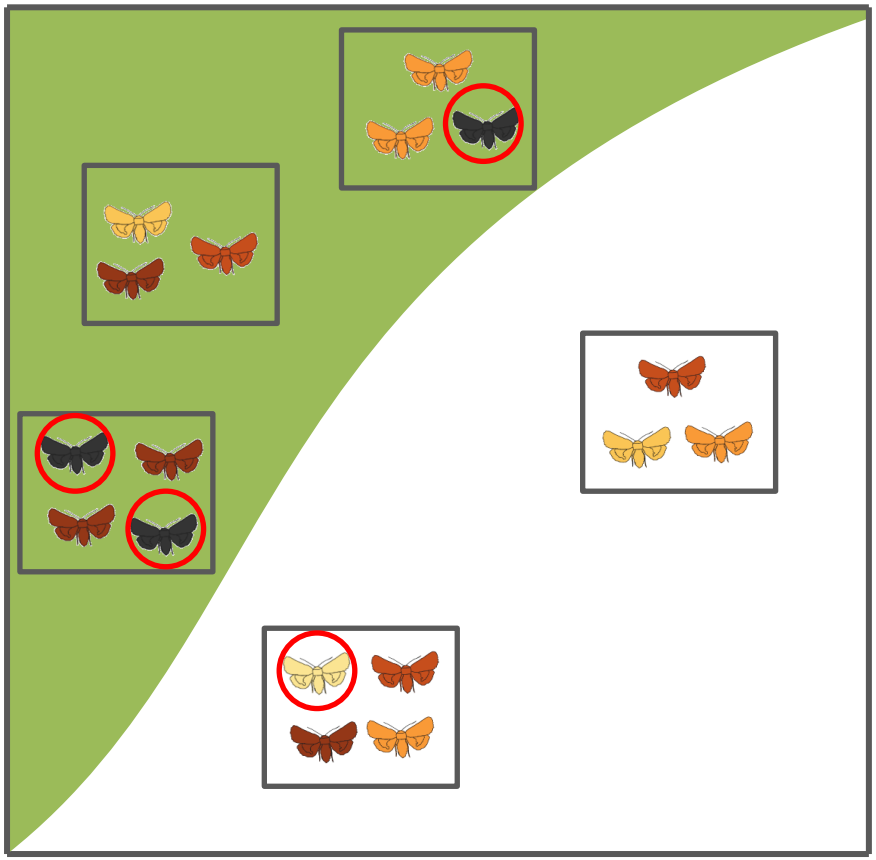


Identifying the effects of traits on species responses



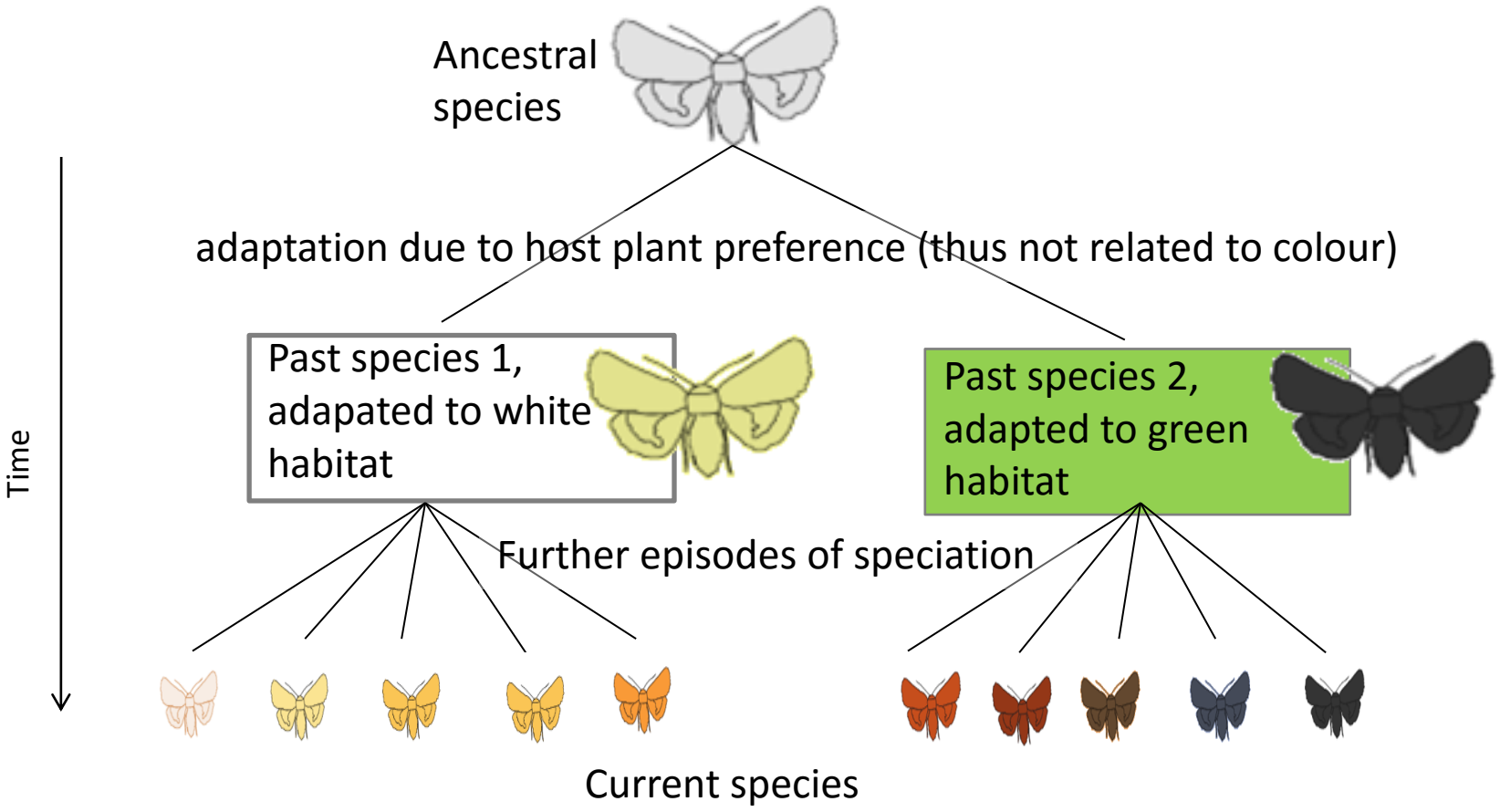
- ✓ Let's assume that we hypothesize that the colour of butterfly species is related to the habitat preference
- ✓ We go to the field and record the species, their abundances and colour of each of them in a number of sampling units randomly located across different habitat types (white and green)

Identifying the effects of traits on species responses



- ✓ Black butterflies are found only in green habitats and white (cream coloured) ones only in white habitats.
- ✓ The colour of the butterflies seems to influences the habitat preference of the species.
- ✓ But is the colour of the butterflies and adaptive response to the habitat type??

Identifying the effects of traits on species responses – drift/selection

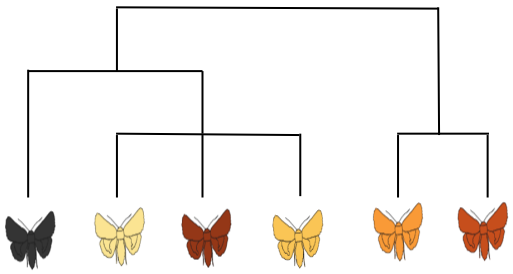


We find many light-colored species from white habitats and many dark-coloured from green habitats, but this is not because of adaptation of colours. The species are not independent datapoints.

See e.g. Karhunen et al 2014

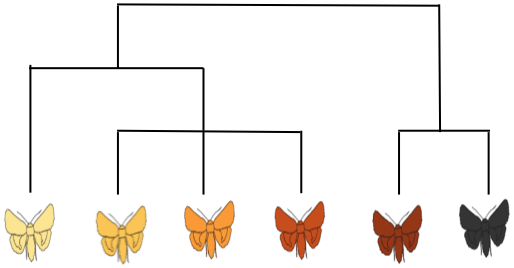
Identifying the effects of traits on species responses – the phylogenetic signal

✓If we want to test whether the colouring of the species is an adaptive response to the habitat type, we must look at the phylogenetic signal of the data.



✓In this case, the colour of the butterflies is randomly associated with phylogeny

✓If this is the case and we see that colour of the butterflies is non-randomly distributed among habitats, the colouring is likely to be an adaptive response of the species to the habitat (it suggests selection)



✓If those species with similar colours are phylogenetically related (the phylogenetic signal is very high), it's more difficult to disentangle whether the association between colour and habitat is result of drift or selection

e.g. Pavoine et al 2013, Dray et al 2014

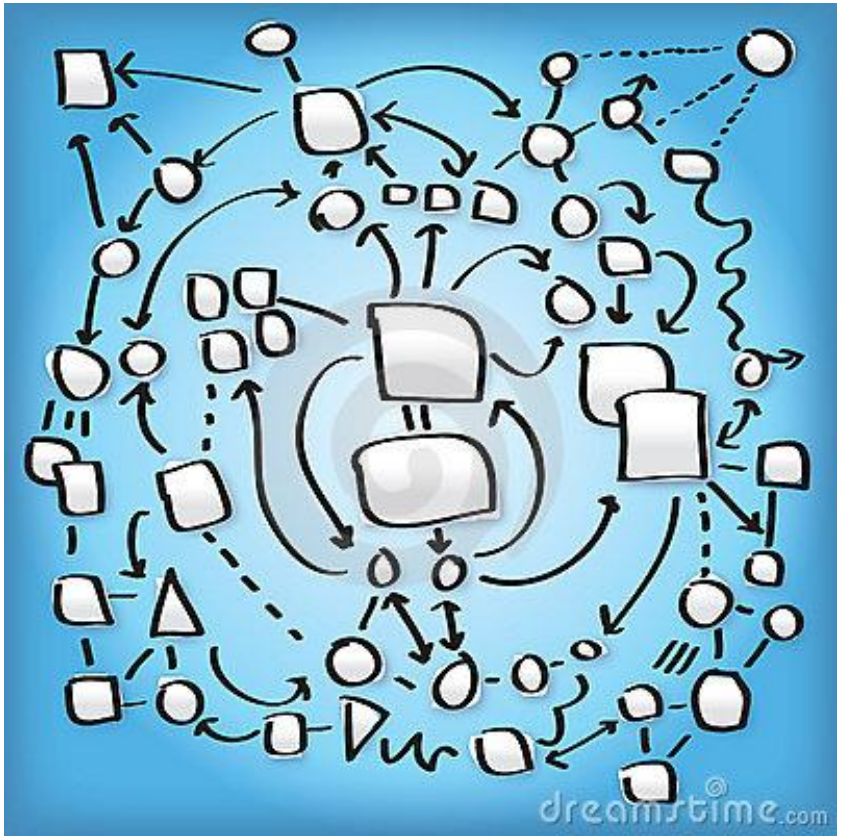
Gaining an evolutionary perspective of the community: niche evolution

Niche conservatism: environmental niches are conserved over evolutionary time scales. Species that share a common ancestor and thus had originally similar niches (i.e., similar traits), have still currently similar niches.

Divergent niche evolution environmental niches are not conserved over evolutionary time scales. Species that share a common ancestor and thus had originally similar niches have become dissimilar in their current niches.

Convergent niche evolution is when two species, that are not related via a recent common ancestor, have evolved similar traits. Consider two geographical locations which are so far away from each other that their original species communities are unrelated (say, Europe and America). If a similar niche (say, similar climatic conditions) become available in both locations, one of the species is likely to fill that niche. Thus, as time passes, the adaptations that make the species successful in that niche in that particular environment add up producing similar traits for two species that are unrelated.

Community functioning: the role of interactions

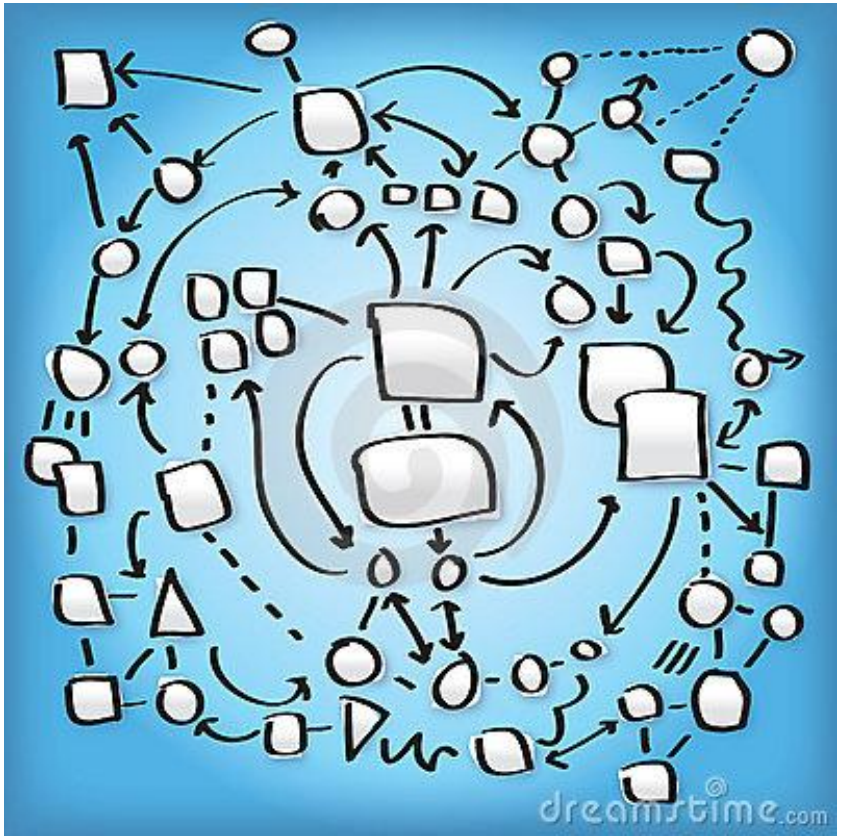


✓Interactive networks are essential components structuring communities, and thus the functions that the communities provide.

✓The influence of interspecific interactions on the occurrence of a given species are not only direct, but they can also be indirect.

✓Thus the loss of a given species in the community it will have direct and indirect (cascading) effects on other species as well.

Community functioning: the role of interactions



✓In modular networks subsets of species are internally tightly connected, but poorly connected to other subsets of species (Olesen et al. 2007)

✓Nested networks are characterized by subsets of specialist species interacting within a larger subset of more generalistic species (Almeida-Neto et al. 2008)

Community functioning: the role of interactions

Example: loss of pollinator insect species carries losses of insect-pollinated plant species (Biesmeijer et al 2006).

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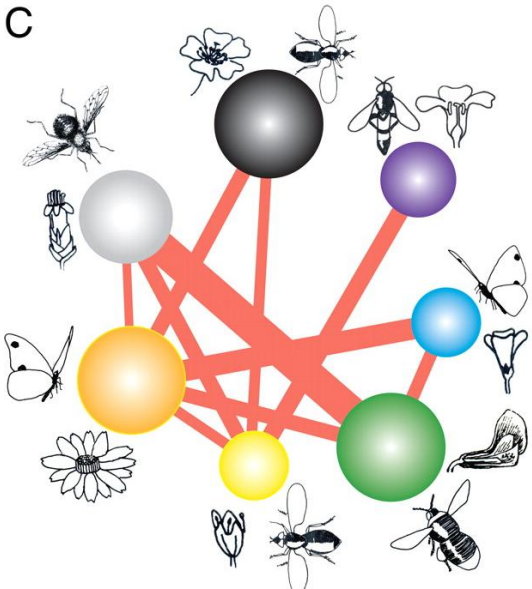

✓They analysed the pollinator communities before and after 1980 in UK and the Netherlands, and they observed drastic declines especially after the date.

✓Plant species that are known to be pollinated by the pollinators that have declined also declined in relation to other plant species.

FCE from an applied perspective

How does what we have learnt today link to what we want to study as applied ecologists?

- The goal of conservation and restoration activities is to maintain biological diversity and the ecosystem services that this diversity provides. How diversity influences ecosystem function depends on the traits and niches filled by species (Cadotte et al 2011).

FCE from an applied perspective

How does what we have learnt today link to what we want to study as applied ecologists?

- It is important to detect the traits that characterize vulnerable species/communities to environmental change

FCE from an applied perspective

How does what we have learnt today link to what we want to study as applied ecologists?

- From a conservation perspective, for maintaining all the ecosystem services that the communities provide (or even a single species), it is important to understand and maintain the interactive networks.

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