Community coalescence: Eco-evolutionary perspectives

* Niche and resource use- niche packing, adaptive radiation
* Ecosystem engineering
* Networks- Ecology to Evolution
* Testing effects of evolution on coalescence
* Future perspectives

**Introduction**

* Coalescence occurs on all scales, expected to increase with global warming, medical and technological advances. Invasive species and disease spread (negatives); cure diseases, more efficient biotechology (positives)
* Conventional invasion research focussed on singular invaders and ability of communities to resist them. Increasing interest to community coalescence and co-invasion (which can be viewed as a type of coalescence in which coalescence is occurring between an in-situ community and exotic invaders)
* Further, interest in the effects of evolution on invasion have only recently advanced and have yet to be applied to community coalescence
* Ecology and evolution are tightly interlinked for the main mechanisms associated with invasion resistance- resource use, ecosystem engineering, species networks- and need to be scaled to coalescence theory.
* Review purpose- Provide an overview of interlinking mechanisms of ecology and evolution to better predict coalescence outcomes (expand on initial proposals of Rillig et al. (2015) and Tikhonov (2016)).

Propose methods of testing these hypotheses and indicate what the results could mean for the future

**Niche/ resource use**

* Communities which exploit more resources, and more efficiently, than others should be more successful- Niche packing hypothesis
* Adaptive radiation increases number of niches filled and character displacement reduces competition between species/individuals.
* This also promotes species co-existence and should increase cohesion by reducing within-community competition in the face of between-community competition
* Local adaptation also interacts here- the niches and resources use depend on environment adapted to. Community monopolisation increases cohesion/ success against other communities- this increases with local adaptation.
* Therefore, evolutionary history should interact with community ecology when determining community success based on niche/resource use

**Ecosystem engineering**

* Species, and their communities, shape their environment which can promote resistance to invaders
* On the opposing side, invaders can shape ecosystems/communities which promote future invasions
* These effects can include priority effects, soil legacies, toxin production, pathogen build up ect.
* How changing conditions affect species will depend on specialism versus generalism, phenotypic plasticity, resistance to disturbance ect. Therefore, a species prior evolutionary history and ability to evolve quickly under stress will largely determine their success within constituent communities

**Community networks**

*Broad perspectives:*

* Network interactions (positive and negative) can increase or decrease community stability depending on their strength and direction
* Models predict that positive interactions (+/+) can destabilise communities by creating positive feedbacks (risk of co-extinction or overdominance) whereas negative interactions (+/-) create negative feedbacks- restabilising a community.
* E.g. Antagonists (parasites, predators) can provide stability by reducing interaction intensities.
* Community stability is central to the above mechanisms of invasion resistance- resource use/monopolisation, disturbance resistance ect.
* Long-term coevolution is hypothesised to increase mutualistic networks in communities (+/+), potentially increasing invasability by decreasing stability under change (increasing co-dependence, positive feedbacks)

*Finer scale interactions:*

* Invading species can interact to increase co-invasion success by altering environmental conditions, suppressing competitive species (see niche modification)
* Local adaptation with antagonists (e.g. parasites) can increase competitive ability of invaders/residents

**Testing effects of evolution on coalescence**

*Experimental evolution:*

* Microbes- ideal model systems- easily manipulated, fast generation times.

Bottom up approach challenge has been to find species which stably coexist- this has made several recent advances and other candidate models (i.e. biofilm community)

Top down approach e.g. Livingston (2013); also studies . But harder to control.

* + Microbiome models- insects with model microbiomes. Can examine host-microbiome coevolution and local adaptation.
* Plants- interactions between soil microbiome, plant ecology, pollinators and pests- complex communities which can co-invade or work as units to resist invasion. To what extent are they locally adapted?
* Invertebrates- Insects, molluscs- interactions with host and parasites, mating system dynamics, mutualists
* Vertebrates- Fish (as good experimental animals) e.g. guppies, sticklebacks- used to test predator/prey coevolution, adaptive radiation, parallel evolution and character displacement. Interact with pests, mutualists, microbiome

*Geographic mosaic models:*

* Interactions between species and their biotic and abiotic environment shape evolution and coevolution
* Between population divergences in co-selected traits can pose potential model systems for what happens when differing communities collide.

**Future perspectives**

* GW- Homogenisation of environment favours communities of generalist species, disfavouring communities locally adapted to specific abiotic and biotic conditions. Of course, no community is solely composed of generalists/specialists but co-invading groups will likely compose of generalists (consistent with invasion theory).
* Medicine- increase use of microbiomes.
* Biotechnology- bioreactors, methane production