The Ecological Niche Part 3: Specialists vs. Generalists II

Michael Noonan

Biol 417: Evolutionary Ecology

Table of contents

Housekeeping

Housekeeping

- We move to in person next week (FIP 121).
- If you're feeling unwell or feel that in-person learning isn't safe yet, stay home. All the lecture will be hybrid and I will be recording all of the lectures so you won't miss anything.
- Office hours will continue to be over zoom for at least a week. We will revisit this on a weekly basis.

Review

Over the past two lectures we saw how the concept of the ecological niche provided us with a framework for understanding competition, competitive exclusion, and generalist vs. specialist strategies.

In particular, we focused on the relationship between resource availability niche breadth

Today we will continue to focus on the evolutionary relationships between environmental conditions and niche breadth.

Specialisation and resource abund.

Niche breadth should increase as resource availability decreases.

Resource poor env.

When resources are rare, encounters with food items are low and search times are high.

Broad dietary niches increase encounter rates and decrease search times.

Natural selection should favour a generalist strategy.

Resource rich env.

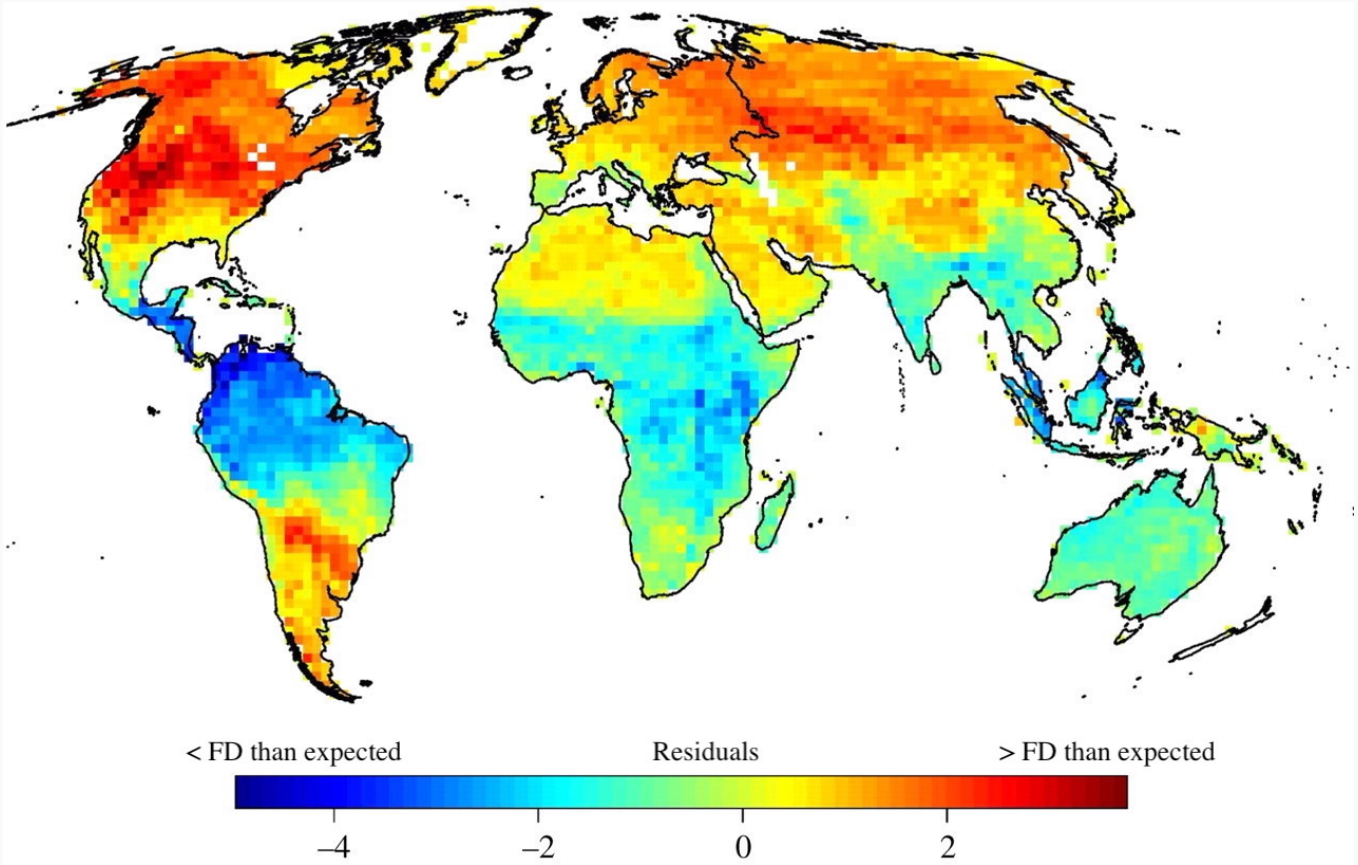
When resources are abundant, encounters with food items are high and search times are low.

Broad dietary niches don't necessarily increase encounter rates and decrease search times.

Natural selection should favour specialist strategies that decrease handling times.

Mammalian diversity cont.

Safi *et al.* (2011) found lower than expected functional diversity in the tropics (i.e., species have smaller niche spaces on average) and vice versa in the global north.



Source: Safi *et al.* (2011)

Stochasticity and Specialisation

Stochasticity and specialisation

Predictability will also influence the extent to which specialisation is favoured.

Stable env.

When resources are predictable, flexible acquisition strategies are not necessary.

Devoting resources to maintaining a broad niche is wasteful.

Natural selection should favour specialist strategies.

Stochastic env.

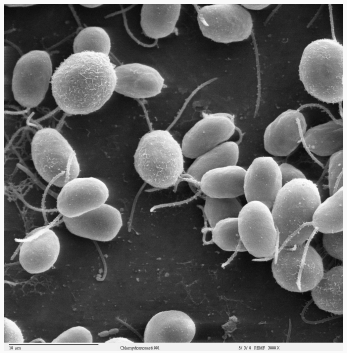
When resources are stochastic, flexible acquisition strategies are beneficial.

Devoting resources to maintaining a broad niche can maximise resource acquisition.

Natural selection should favour generalist strategies.

Chlamydomonas reinhardtii

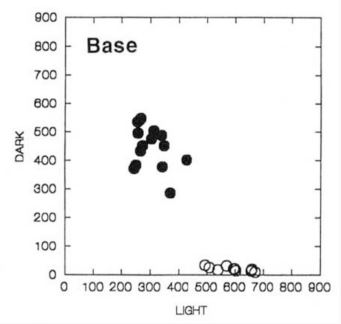
C. reinhardtii is a species of algae that can feed via both photosynthesis and heterotrophy.



Source: Wikipedia

Reboud & Bell (1997) reared *C. reinhardtii* in two conditions: light vs. dark for 1000 generations. Result?

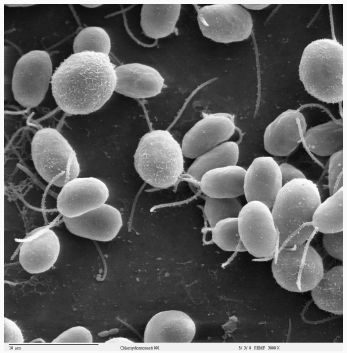
Led to the evolution of light-specialists and dark specialists in each pop.



Reboud & Bell (1997)

Chlamydomonas reinhardtii

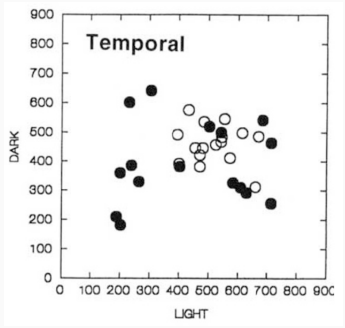
C. reinhardtii is a species of algae that can feed via both photosynthesis and heterotrophy.



Source: Wikipedia

They then reared each pop under temporal variation in light/dark for 200 generations. Result?

Temporal variation in resource availability led to the evolution of a pop. of generalists



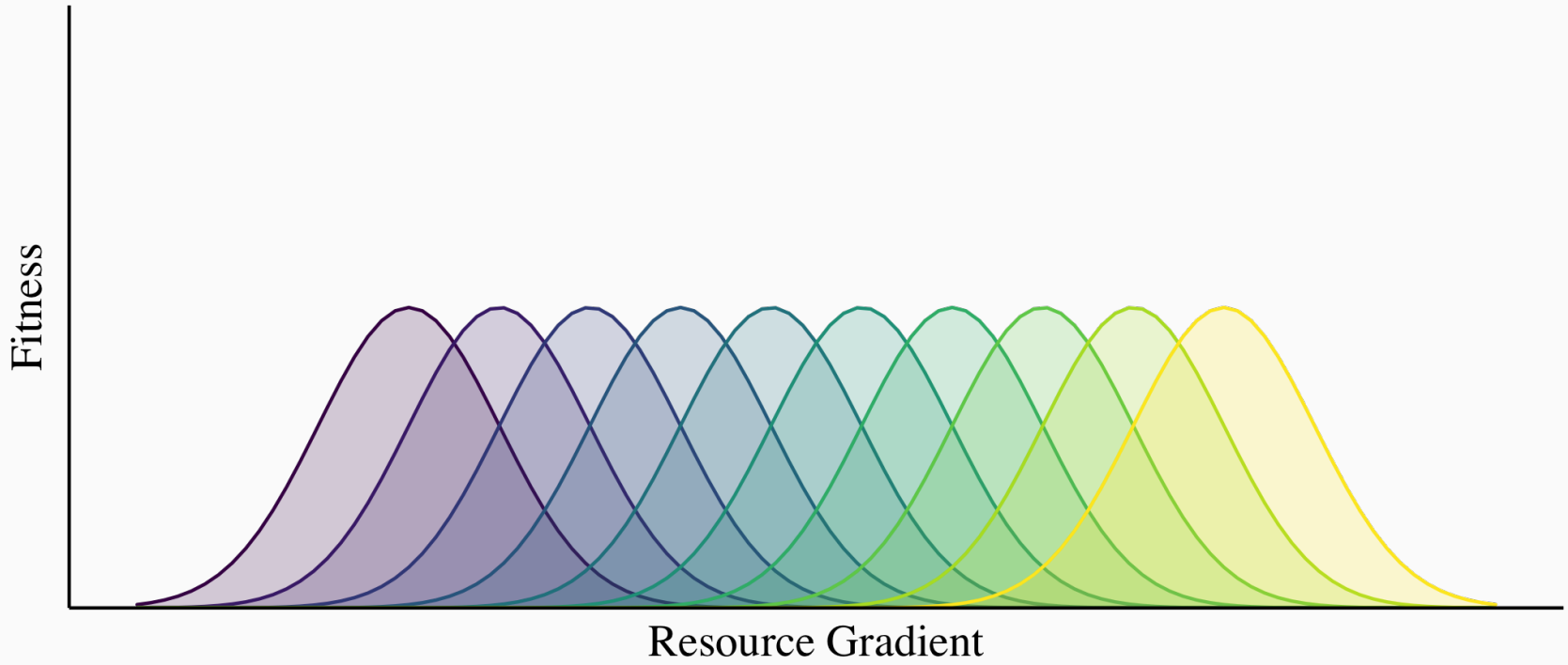
Reboud & Bell (1997)

Competition and specialisation

Niche compression

By governing resource availability, intense competition should favour specialisation.

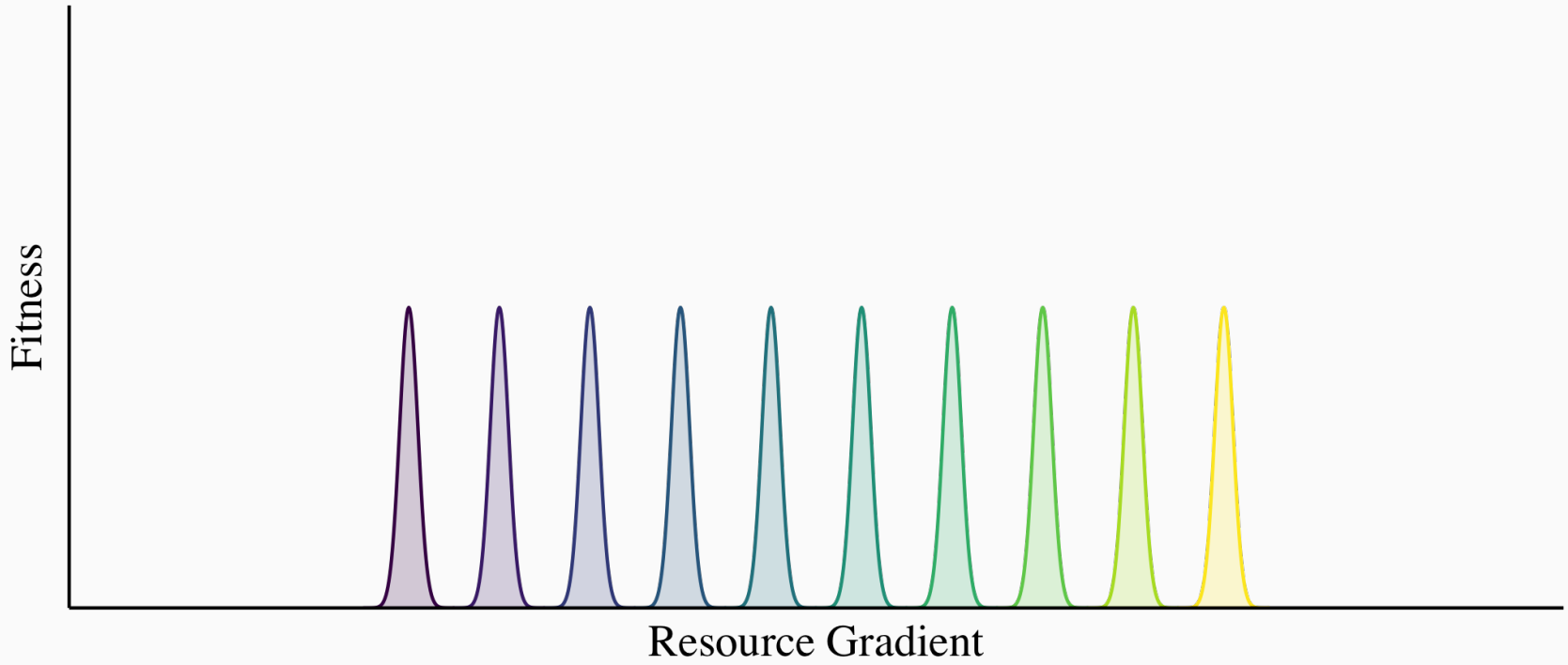
Species will be outcompeted at the tail ends of their niches



Niche compression

By governing resource availability, intense competition should favour specialisation.

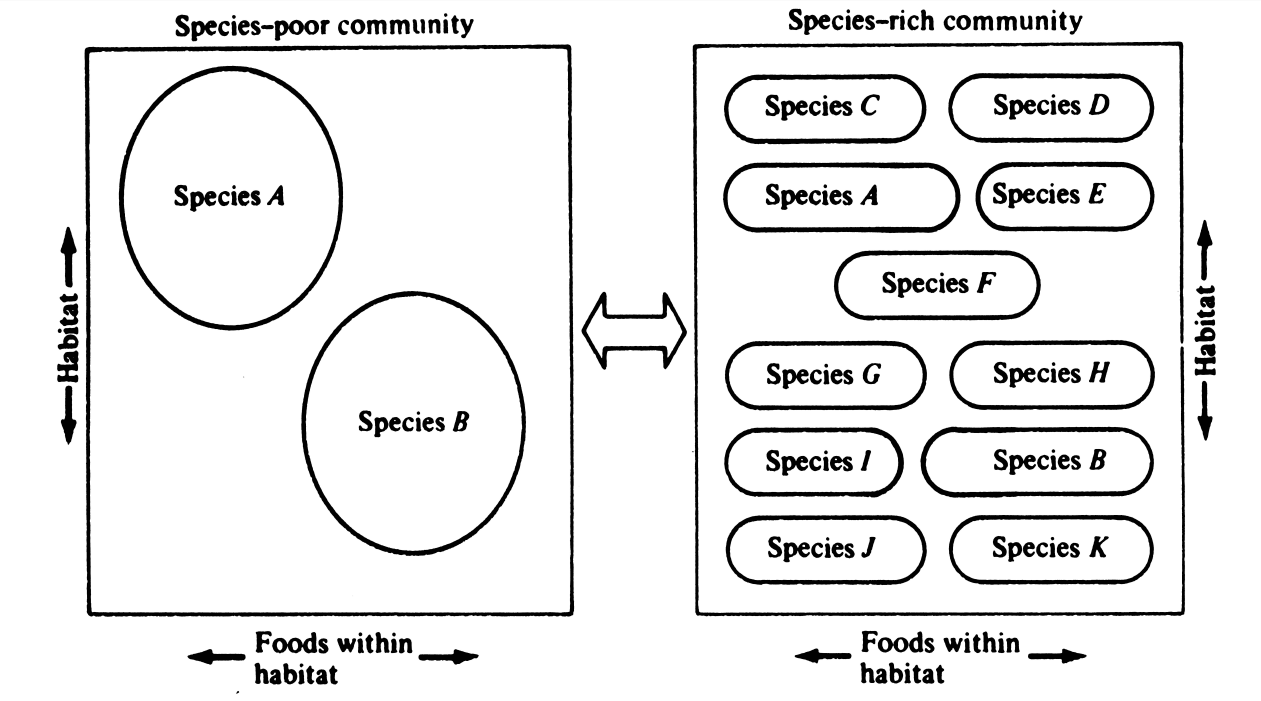
Niche breadth should reduce to minimise overlap and competition.



Niche compression cont.

Over **ecological** timescales behavioural modifications that decrease competition will be favoured.

Over **evolutionary** timescales physiological, morphological, etc.. modifications that decrease competition will be favoured.

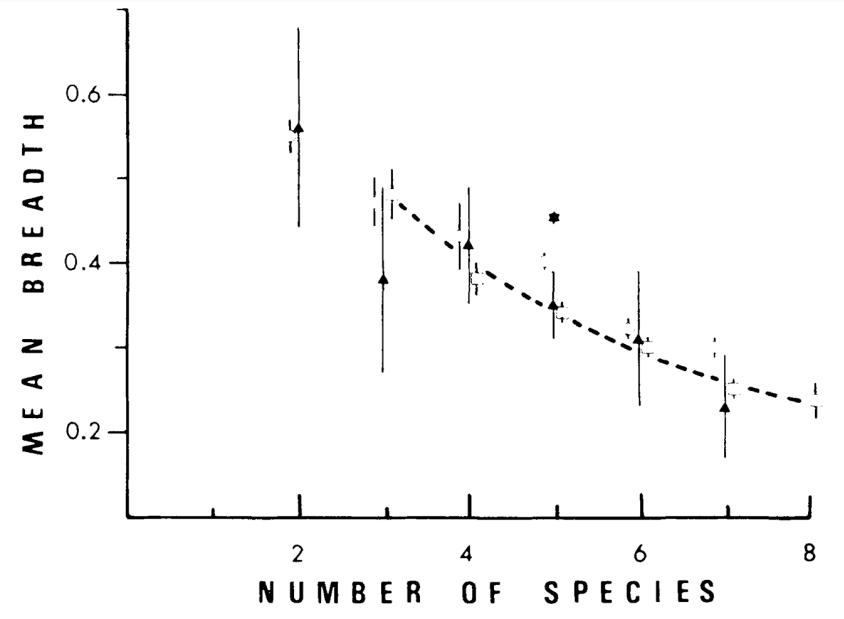


Source: Pianka (2000)

Niche compression example

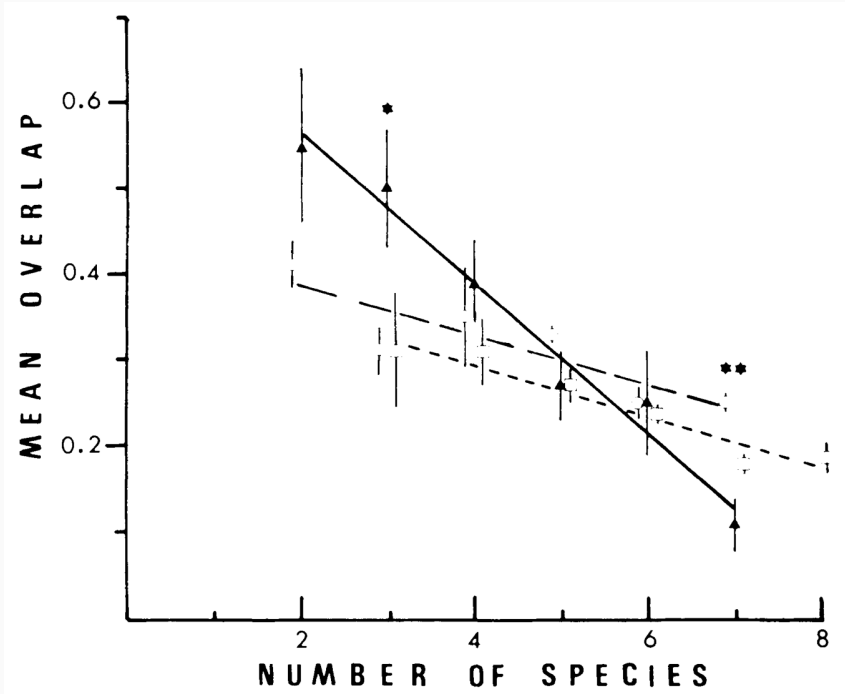
Fox (1981) looked at niche breadth (spatial), overlap (spatial), and richness in 9 species of ground-dwelling small mammals in eastern Australia.

Breadth



Source: Fox (1981)

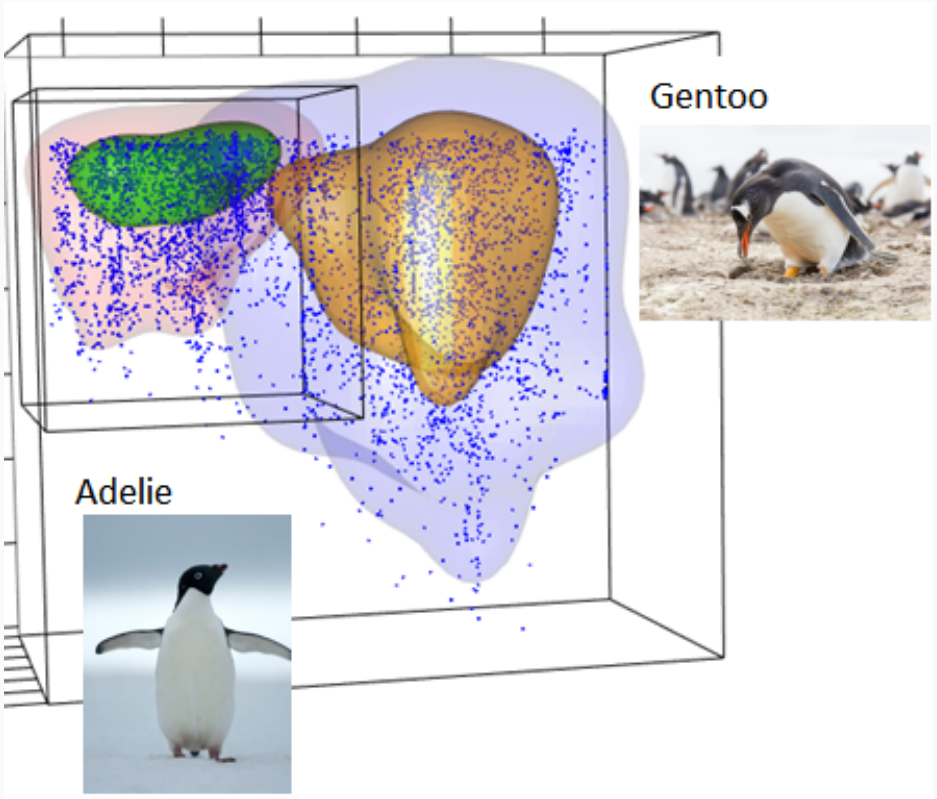
Overlap



Source: Fox (1981)

Niche partitioning

Gentoo (*P. papua*) and Adélie (*P. adeliae*) penguins are ecologically similar and feed primarily on Antarctic krill (*E. superba*). Spatially distinct foraging niches permit co-existence.

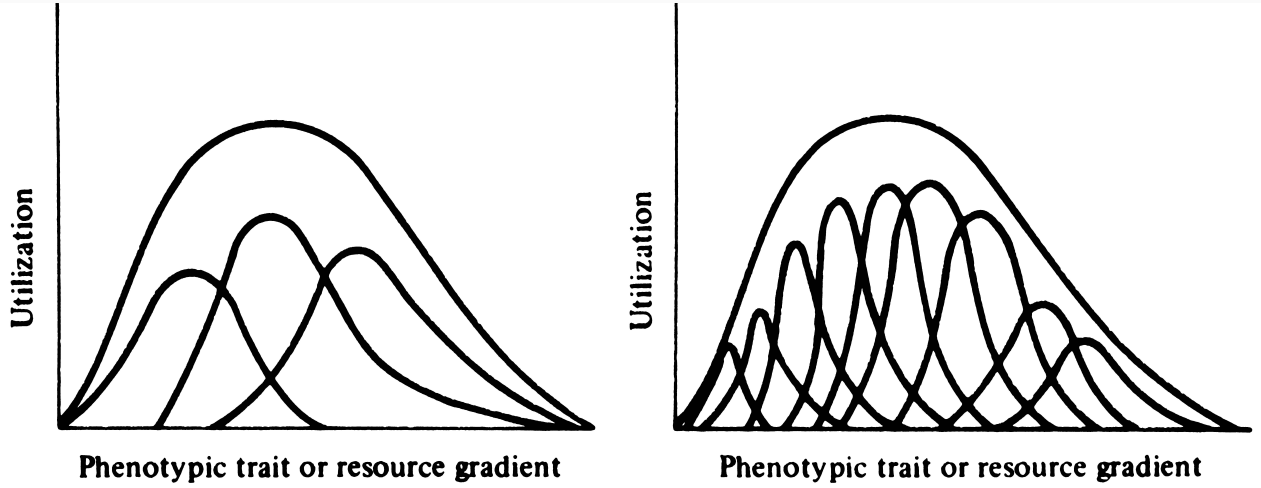


Source: Pickett *et al.* (2018)

Intra-specific niche breadth

The niche breadth of a population is governed by the individual niches of the individuals that make up the population.

The same factors that govern interspecific dynamics in niche breadth play out intra-specifically as well.



Source: Pianka (2000)

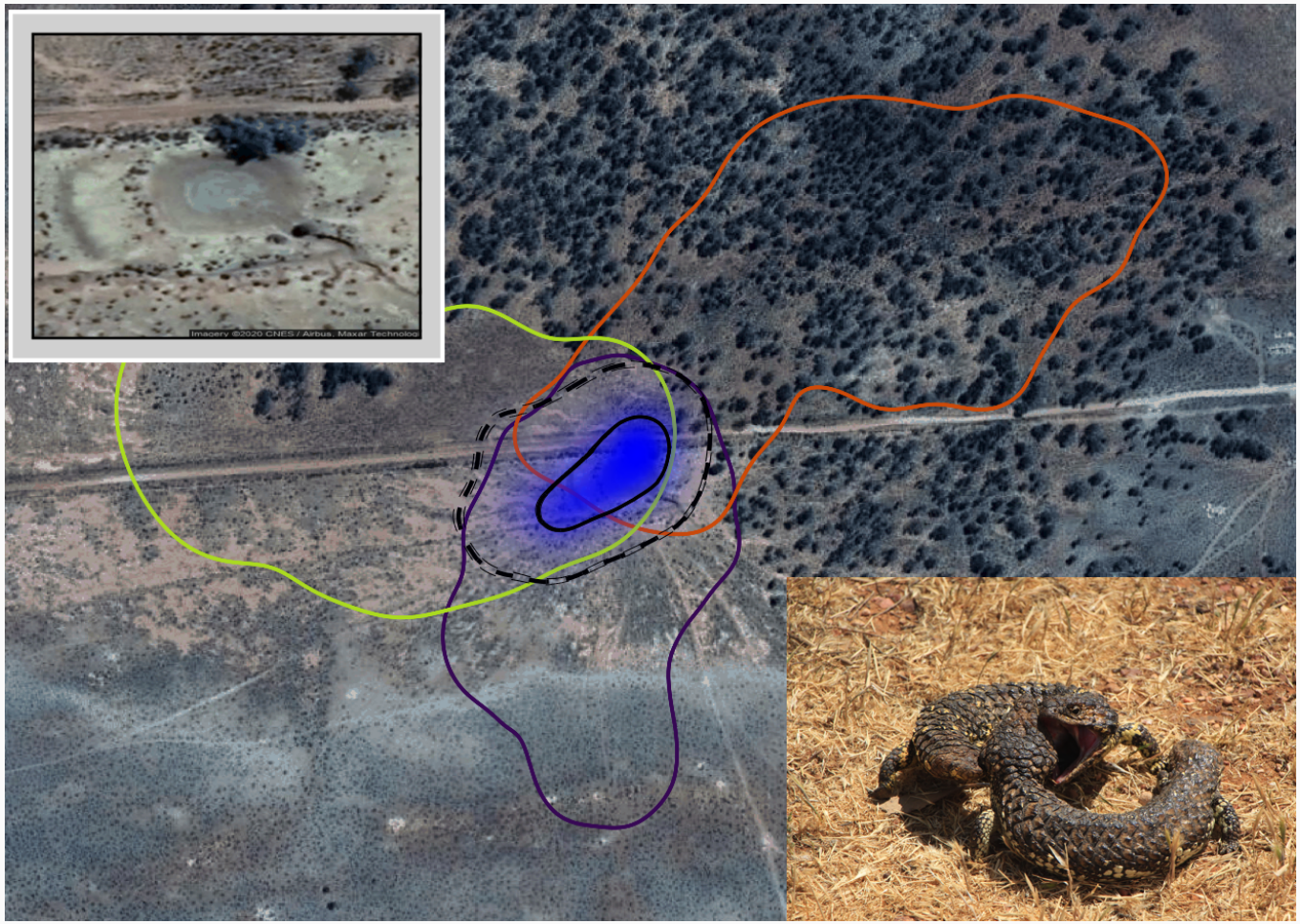
Intra-specific competition

Lowland tapirs (*Tapirus terrestris*) in the Brazilian Pantanal have home ranges with substantial overlap.

Source: Medici *et al.* (2021)

Intra-specific competition

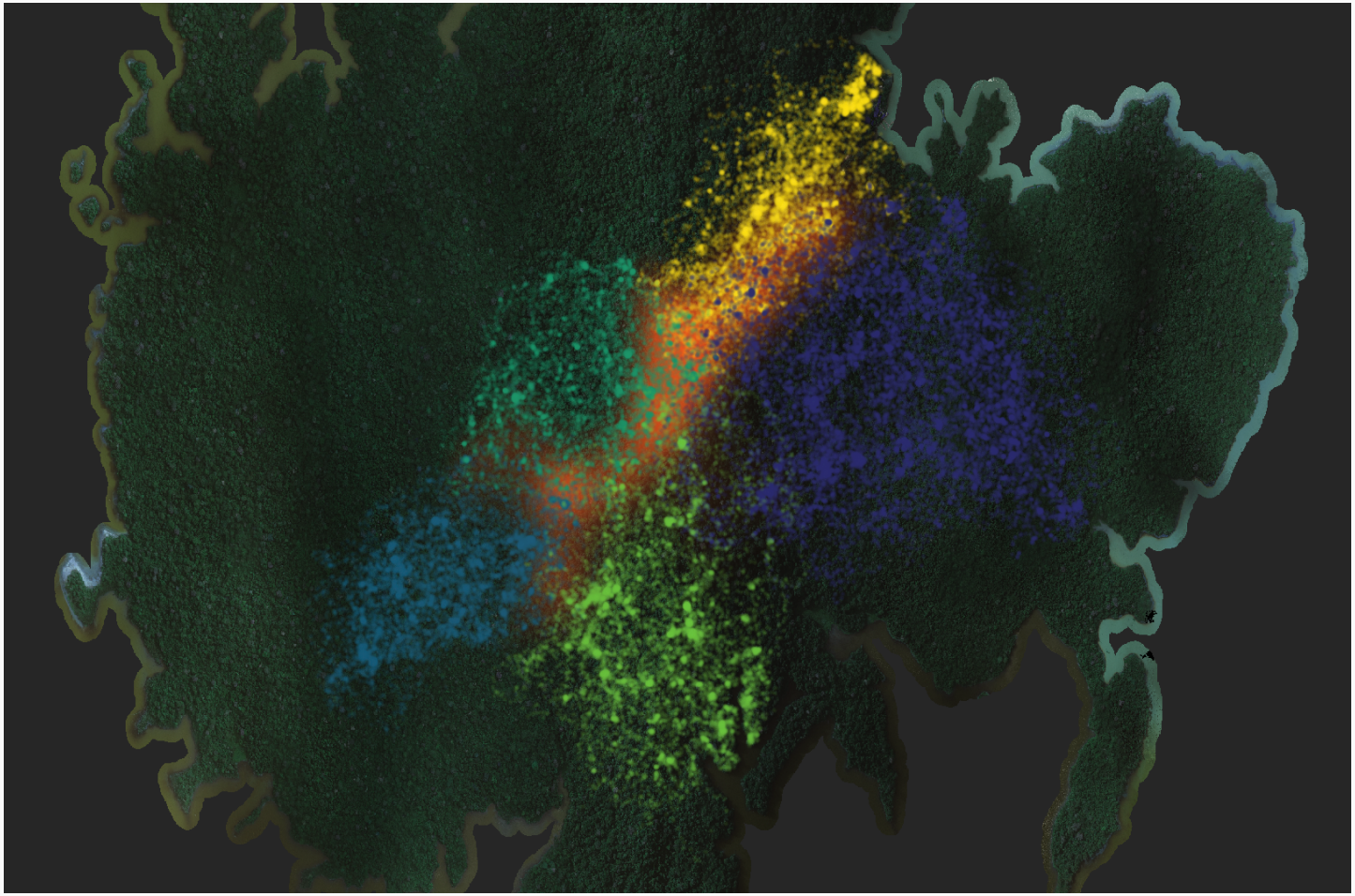
Sleepy lizards (*Tiliqua rugosa*) in Australia have home ranges that overlap at key resources.



Source: Noonan *et al.* (2021)

Intra-specific competition

White-faced capuchins (*Cebus capucinus*) in Panama have home ranges that do not overlap neighbouring groups.



Source: Noonan *et al.* (2021)

Take home messages

The niche concept provides a framework for understanding species' place in the natural world, how species exist and co-exist, and for making testable predictions about response to competition, habitat quality, environmental change, specialisation, etc...

Resource availability (μ) and predictability (σ^2) are expected to govern when specialist vs. generalist strategies are favourable.

Individual niches are nested in population niches, which are nested in species niches, etc... So scale is important.

References

Fox, B.J. (1981). Niche parameters and species richness. *Ecology*, 62, 1415–1425.

Medici, E., Mezzini, S., Fleming, C., Calabrese, J. & Noonan, M. (2021). Movement ecology of vulnerable lowland tapirs across a gradient of human disturbance. *bioRxiv*.

Noonan, M.J., Martinez-Garcia, R., Davis, G.H., Crofoot, M.C., Kays, R., Hirsch, B.T., Caillaud, D., Payne, E., Sih, A., Sinn, D.L. *et al.* (2021). Estimating encounter location distributions from animal tracking data. *Methods in Ecology and Evolution*, 12, 1158–1173.

Pianka, E.R. (2000). *Evolutionary Ecology*. 6th edn. Benjamin/Cummings, San Francisco.

Pickett, E.P., Fraser, W.R., Patterson-Fraser, D.L., Cimino, M.A., Torres, L.G. & Friedlaender, A.S. (2018). Spatial niche partitioning may promote coexistence of pygoscelis penguins as climate-induced sympatry occurs. *Ecology and evolution*, 8, 9764–9778.

Reboud, X. & Bell, G. (1997). Experimental evolution in chlamydomonas. iii. evolution of specialist and generalist types in environments that vary in space and time. *Heredity*, 78, 507–514.

Safi, K., Cianciaruso, M.V., Loyola, R.D., Brito, D., Armour-Marshall, K. & Diniz-Filho, J.A.F. (2011). Understanding global patterns of mammalian functional and phylogenetic diversity. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366, 2536–2544.