Competition II

BIOL/BOT 160 – Ecology

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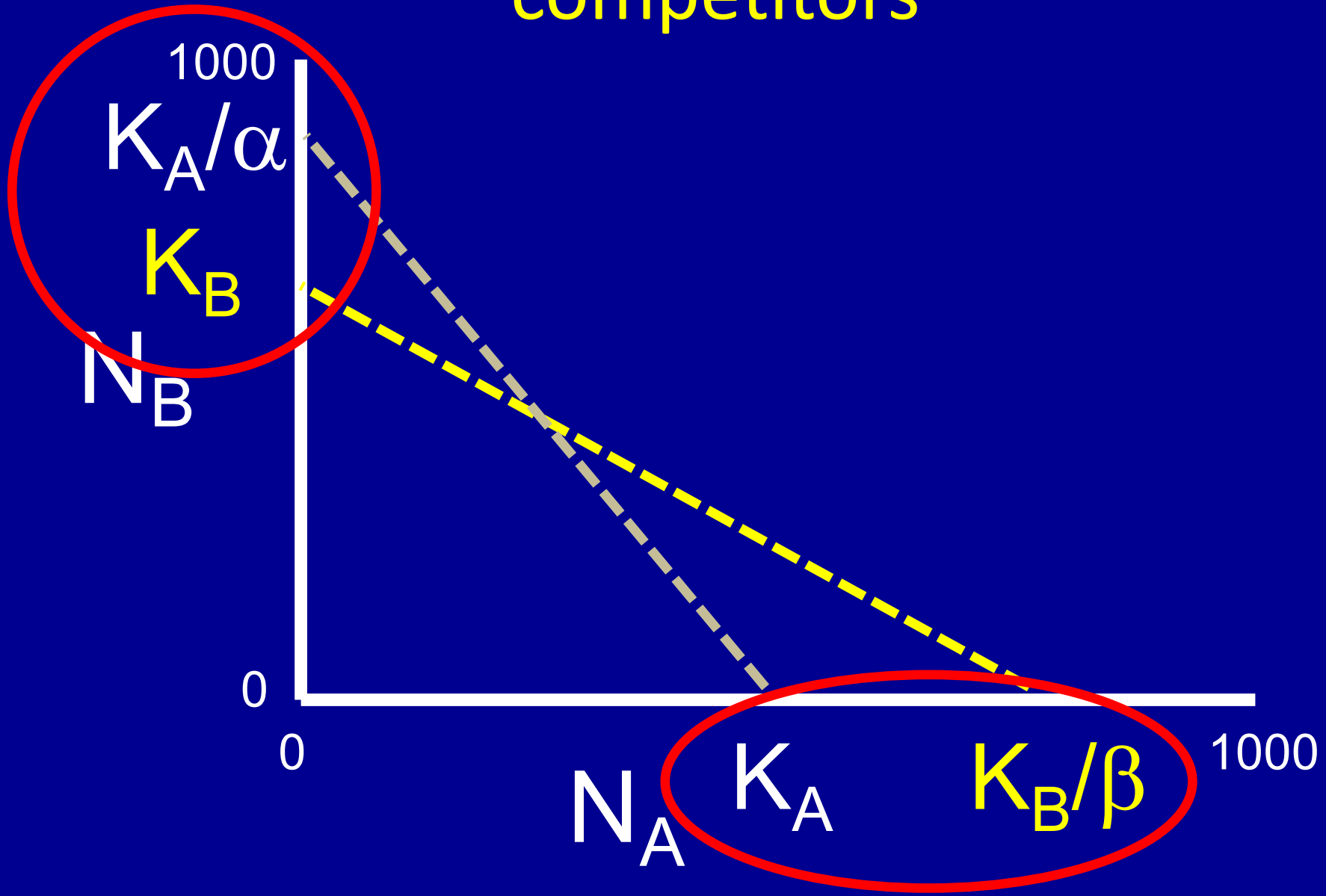
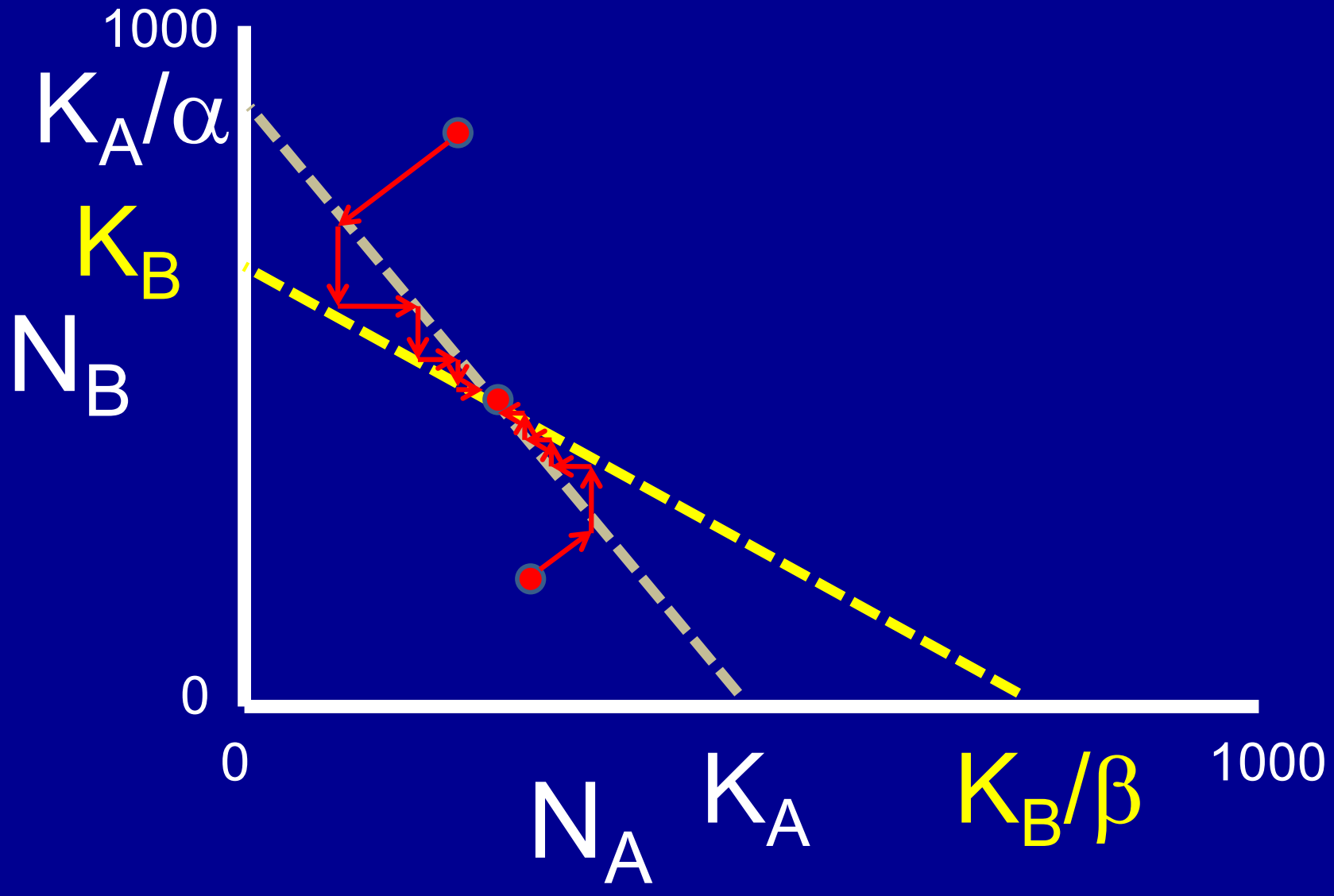
Learning objectives

- Students should be able to
  - Analyze competition coefficients and carrying capacities to predict the outcome of competition between 2 species
  - Describe the design of experiments to test for the outcomes of competition between pairs of real species
  - Explain how environmental variability may affect coexistence
  - Explain a mechanism by which strong competitors might become weak competitors over long time periods

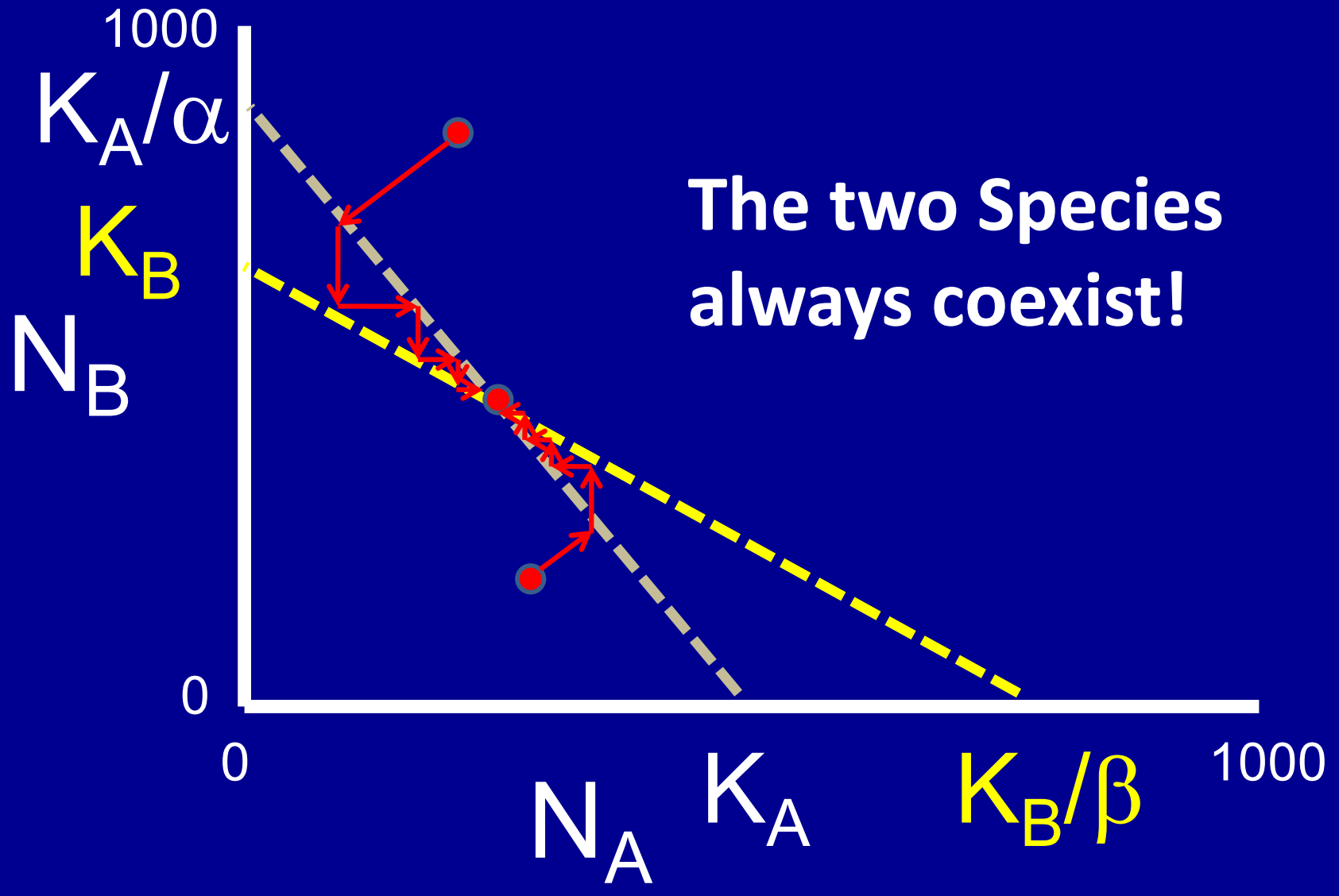
Vector Plot - Let's look at two weak competitors



Vector Plot - Let's look at two weak competitors



Vector Plot - Let's look at two weak competitors



The two Species always coexist!

Think-pair-share

- Suppose you design an experiment to test the strength of competition between three different species of bacteria, A, B, and C. You observe that:
  - when A is introduced before B, species A always dominates, but when B is introduced before A, B always dominates. Are A and B both strong competitors, weak competitors, or is one strong and one weak?
  - when B & C are combined, they are always present in roughly the same quantities at the end of the experiment, regardless of which is added first. Are B and C both strong competitors, weak competitors, or is one strong and one weak?
  - Can you make any prediction about competition between A & C based on the first two experiments?

To summarize competition models

- Species A is a strong competitor if $K_A > K_B/\beta$
- We have 4 distinct situations for any two species A & B
  - A is strong, B is weak -> A always wins
  - A is weak, B is strong -> B always wins
  - A is strong, B is strong -> depends on starting configuration
  - A is weak, B is weak -> coexist!

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  - A is weak, B is weak -> coexist!
- Put another way, this means that *interspecific* competition must be weak relative to *intraspecific* competition in order for stable coexistence between species to occur

What about real communities?

What about real communities?

How do real communities of organisms coexist? What factors influence the specific number of species we observe in a particular time and place?

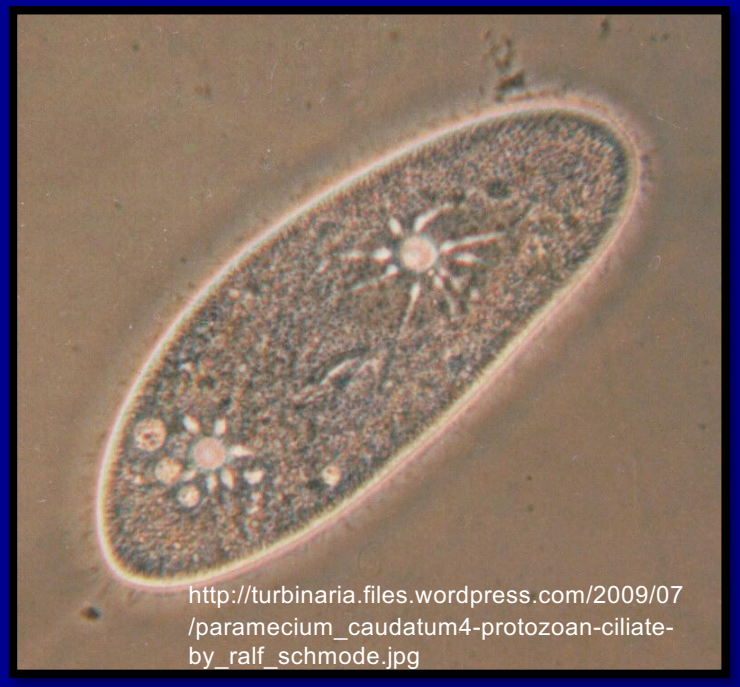
Two main approaches to measuring competition

- Experimental -> manipulate species composition of environment and measure outcomes

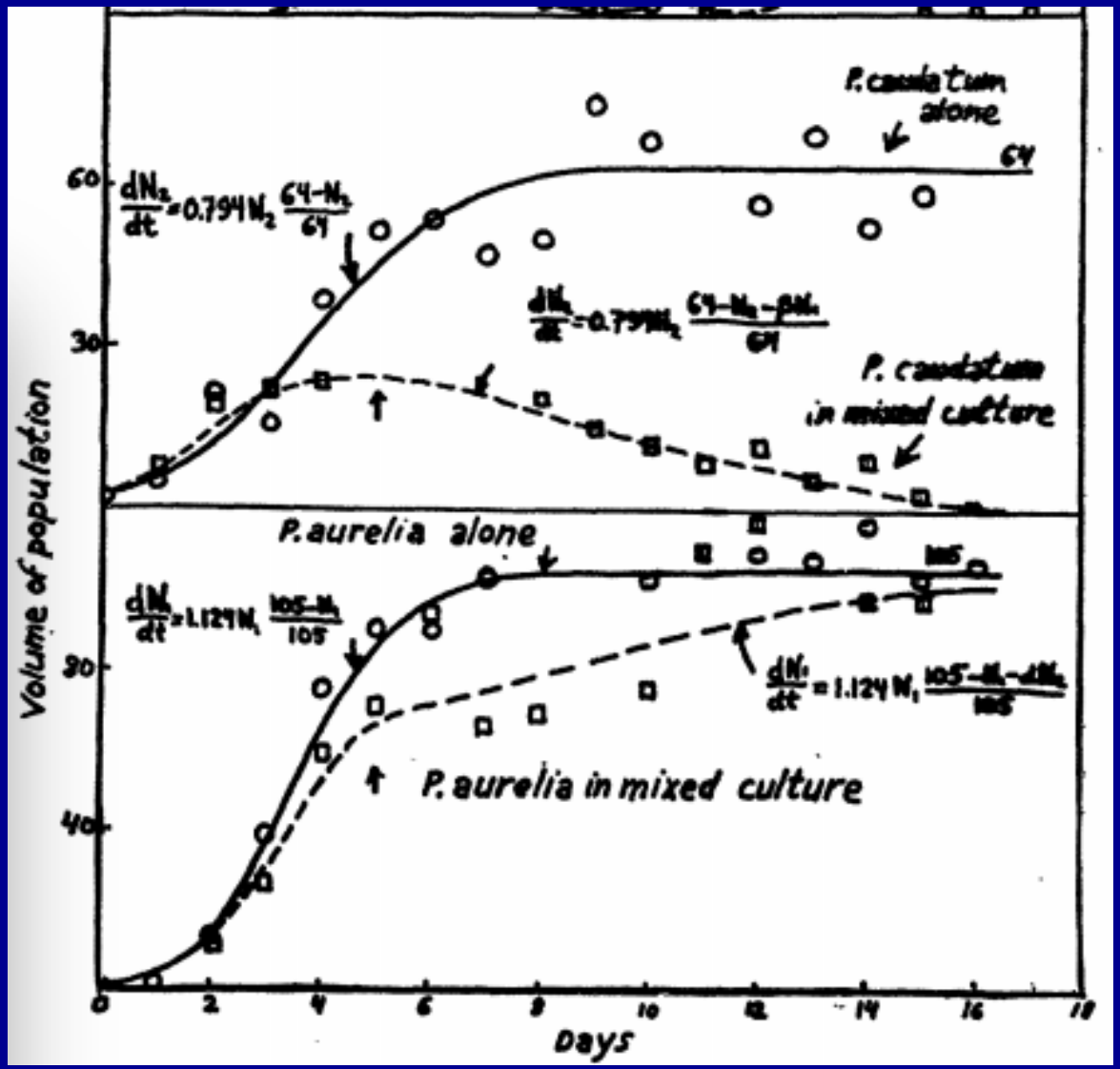
- Observational -> measure species distributions in space and time in nature to test hypotheses or compare models

Do these models reflect reality?

- G. F. Gause (Russian) 1930s
  - – *Paramecium aurelia* vs *Paramecium caudatum*



Gause competition experiments



Competitive Exclusion Principle

- Complete (i.e. strong) competitors CANNOT coexist!

Gause competition experiments - 2

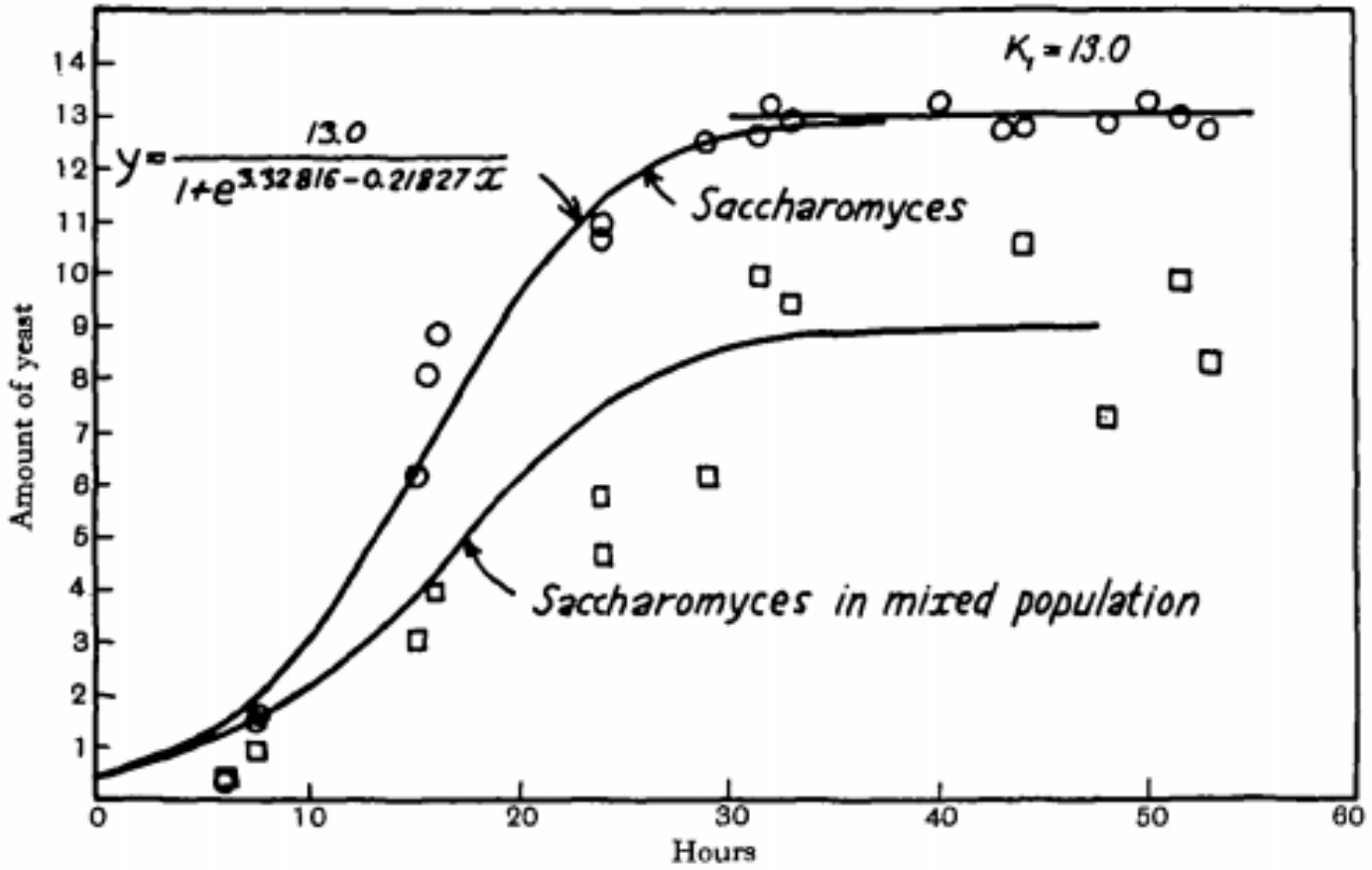


Fig. 2. The growth of the volume of *Saccharomyces cerevisiae* cultivated separately and in the mixed population according to the first and second series of experiments.

Gause competition experiments - 2

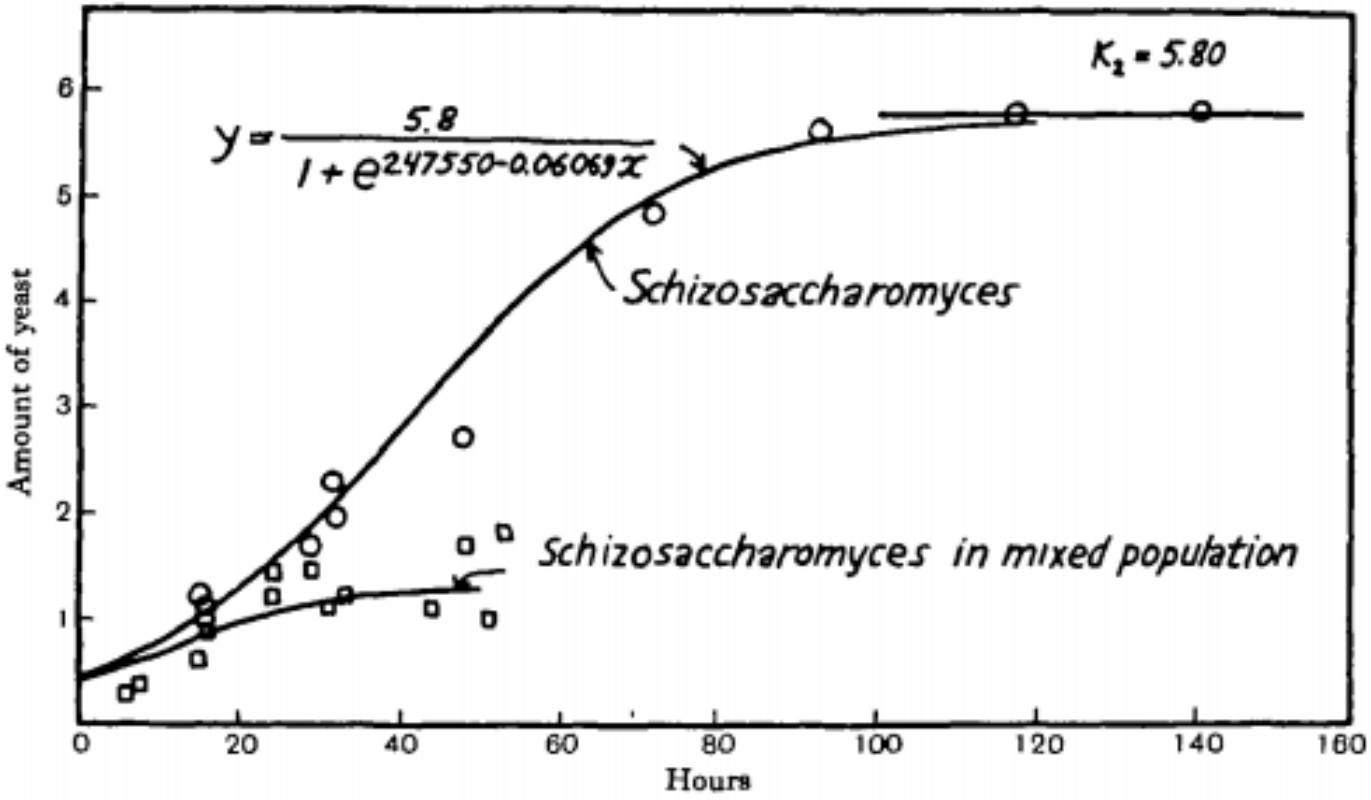
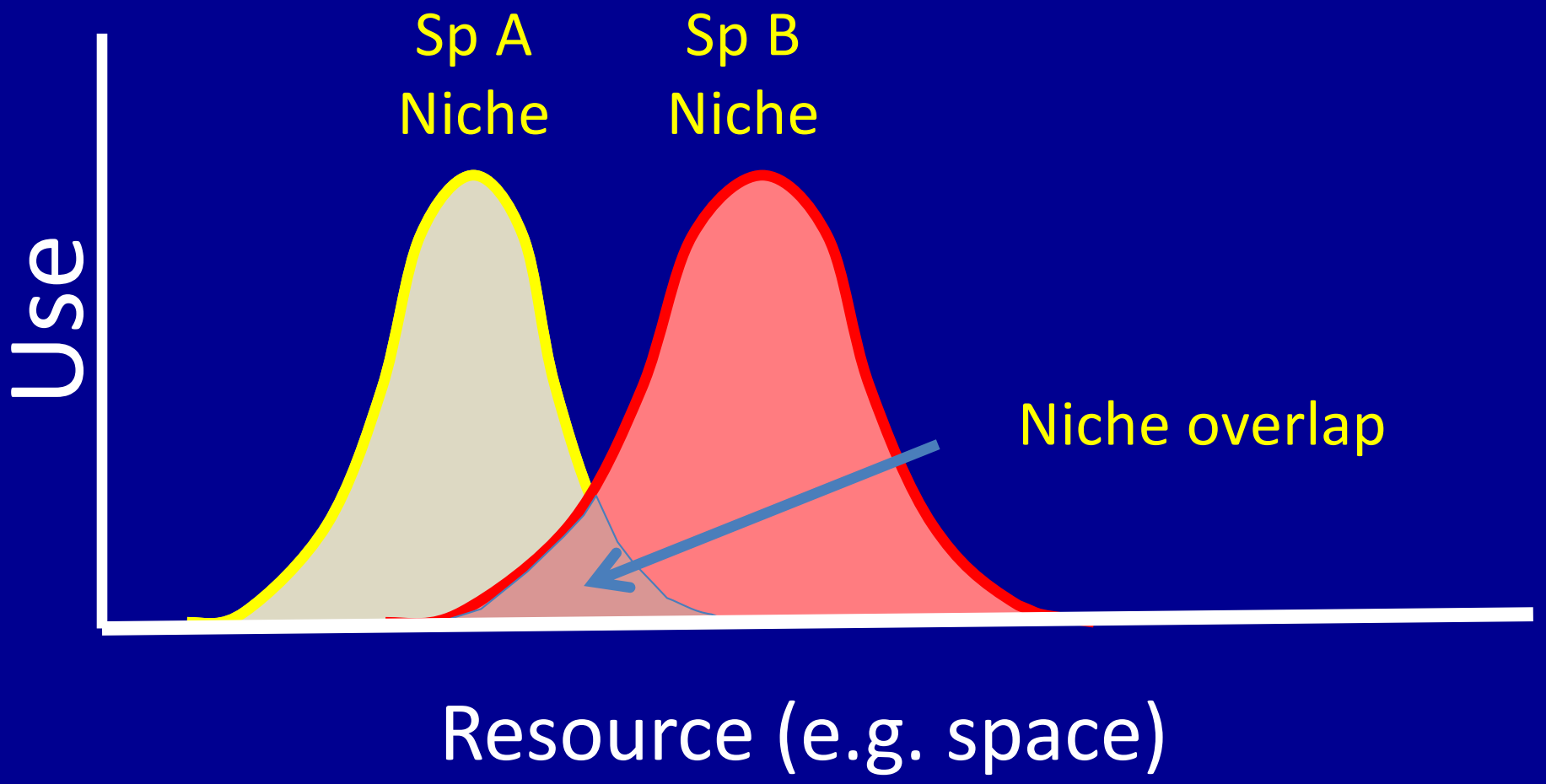


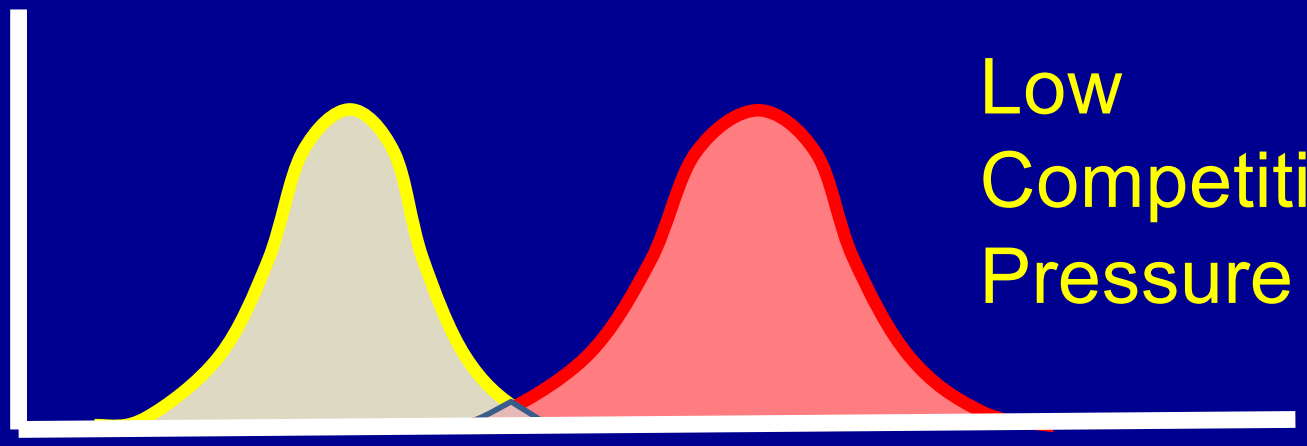
Fig. 3. The growth of the volume of *Schizosaccharomyces kefir* cultivated separately and in the mixed population according to the first and second series of experiments.

The niche and competition



Niche overlap and Competition

- So, if resources are limited, the greater the overlap, the stronger the overall competitive interaction



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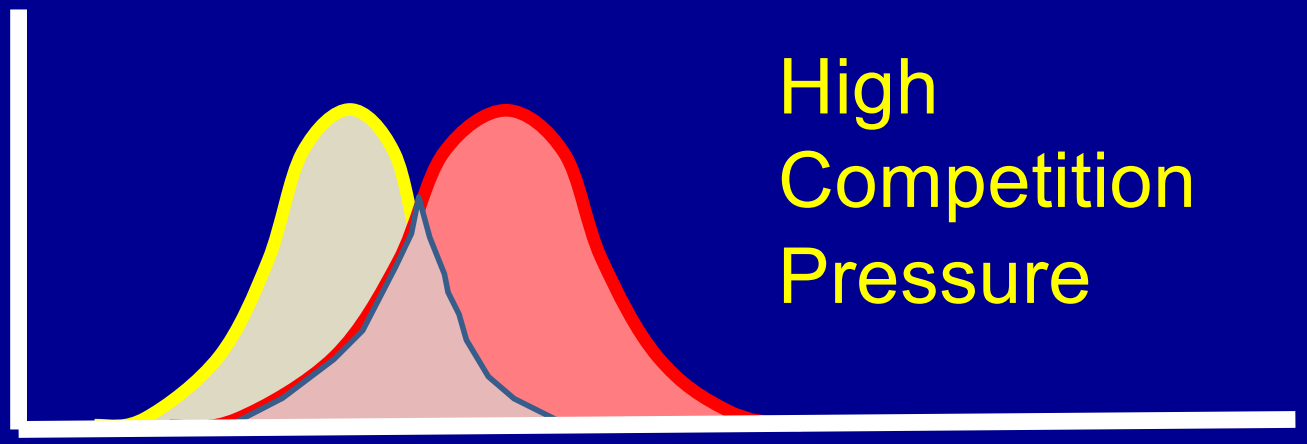
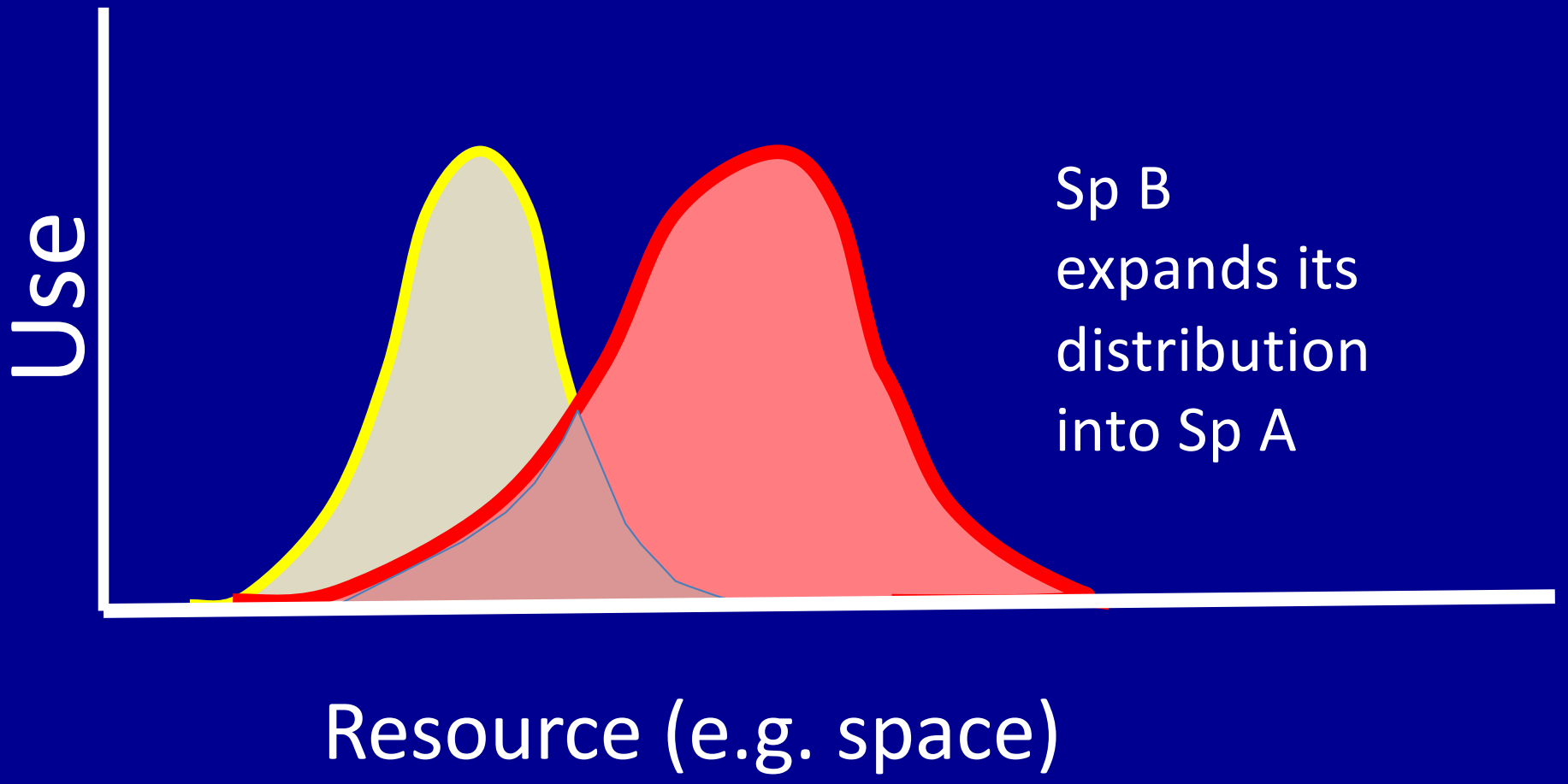
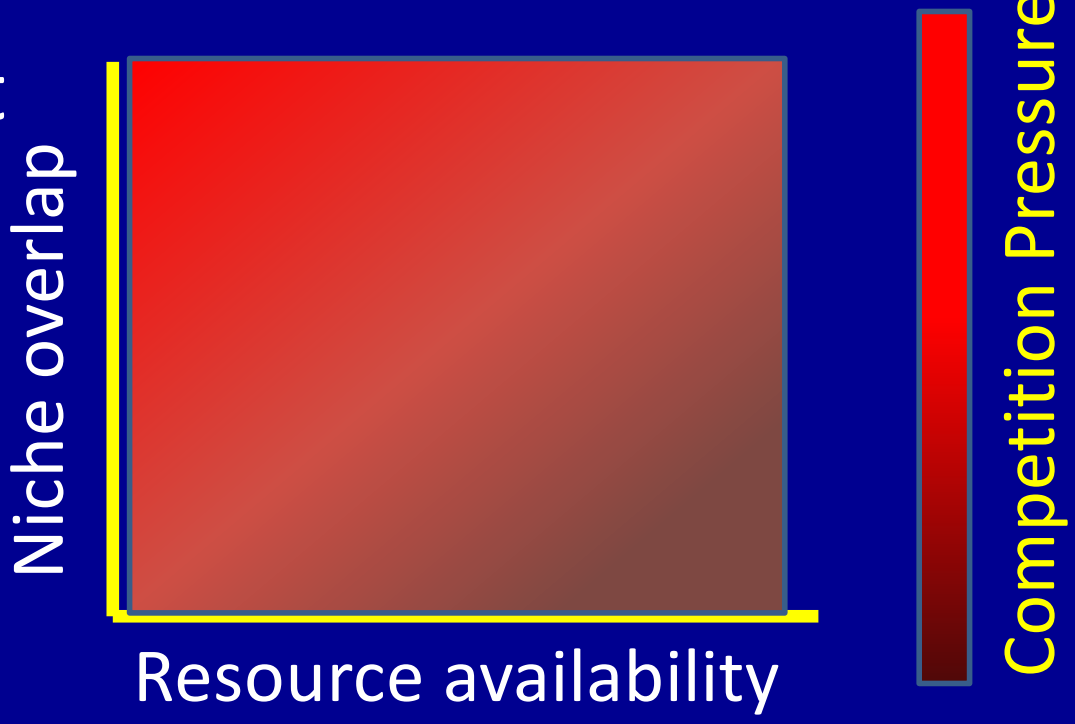


How would a competitor become a strong competitor?



Competition, the niche and amount of resources

- Remember resources must be limited to have competition



Invasive species are often good competitors

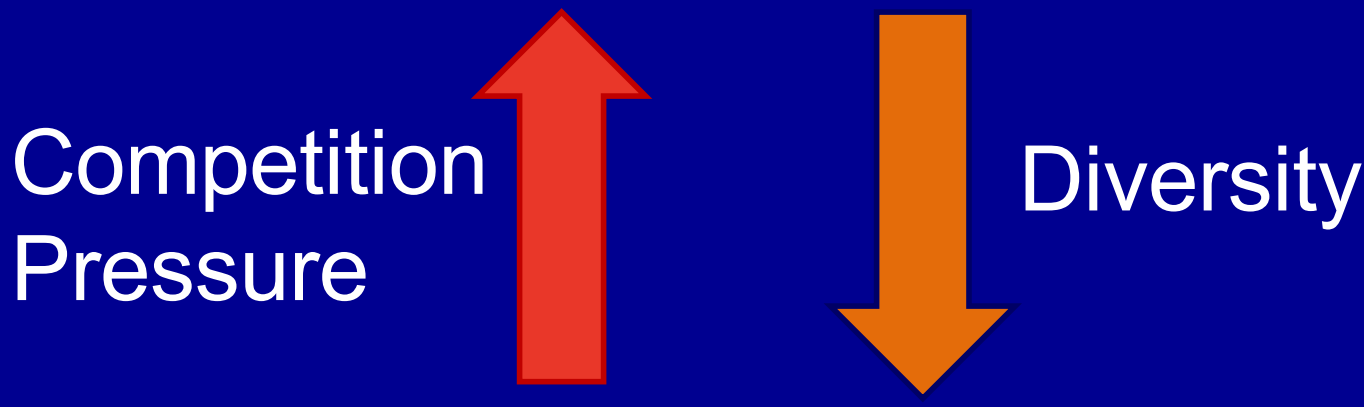
http://www.growingsolutions.org/Summerland%20Greenwell%20Preserve_files/CoastalScrubOpt.jpg

Pampas grass

Why might they be successful at outcompeting the natives?

Competition and the number of species

- What is the net effect on species diversity for all of the models we have examined so far?



So, why are there so many species

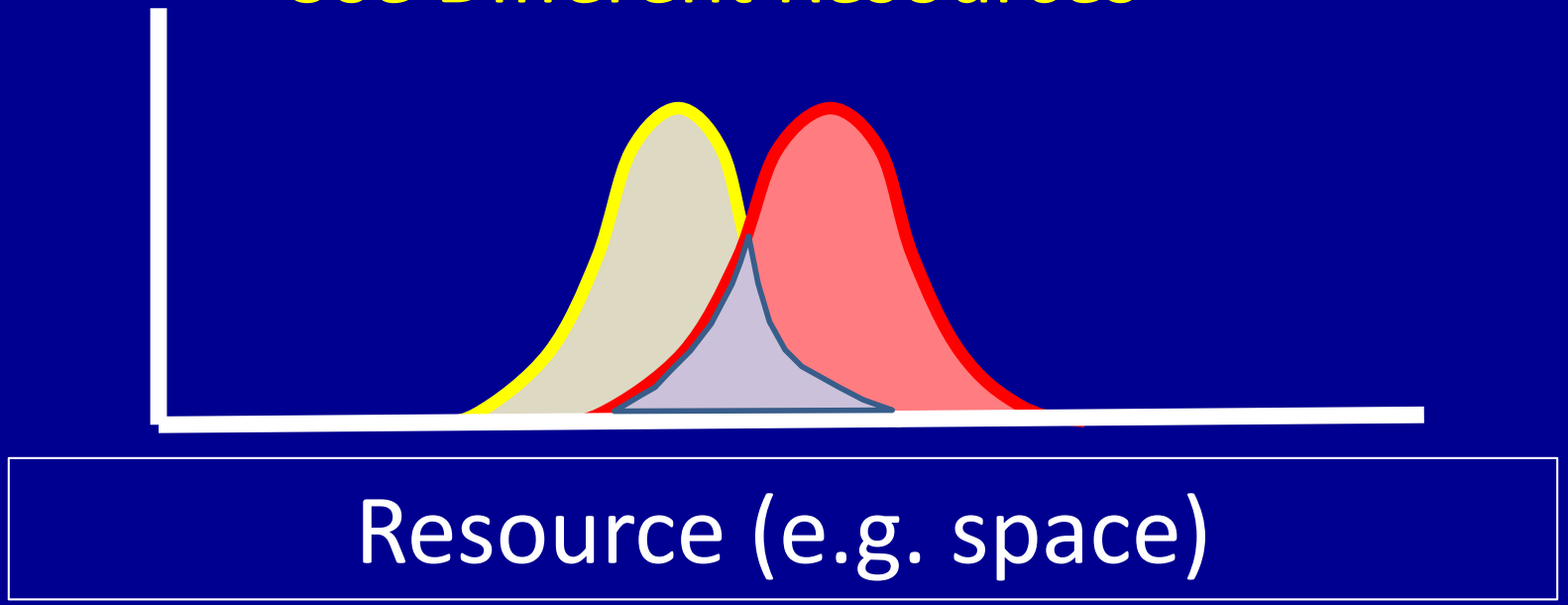
Maybe species that we observe are primarily weak competitors

- We can restate Gause' exclusion princple (Complete (i.e. strong) competitors CANNOT coexist!) as

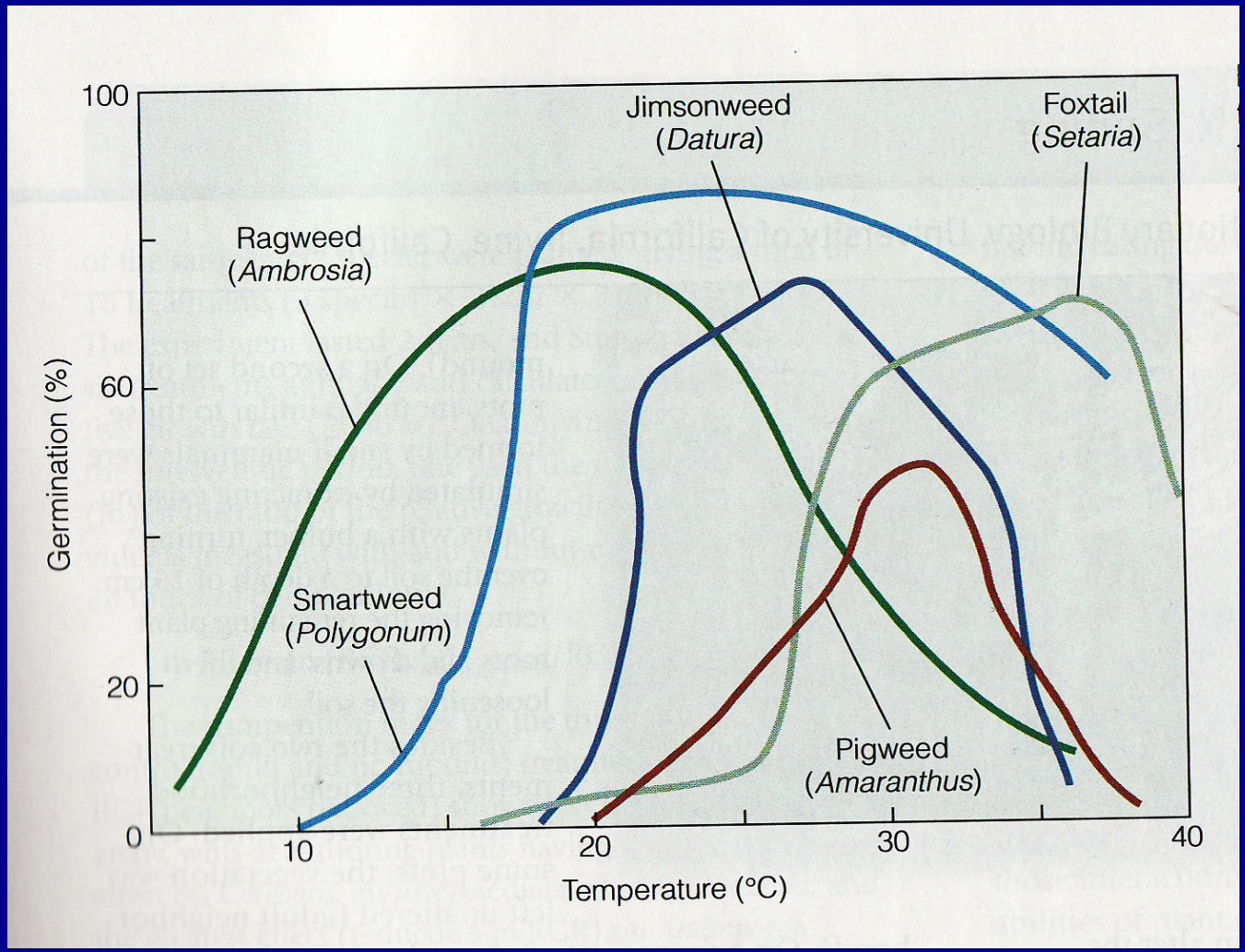
"When we observe species in stable coexistence, they are likely to be weak competitors"

How would strong competitors become weak competitors?

Use Different Resources



Temperature



Time of year

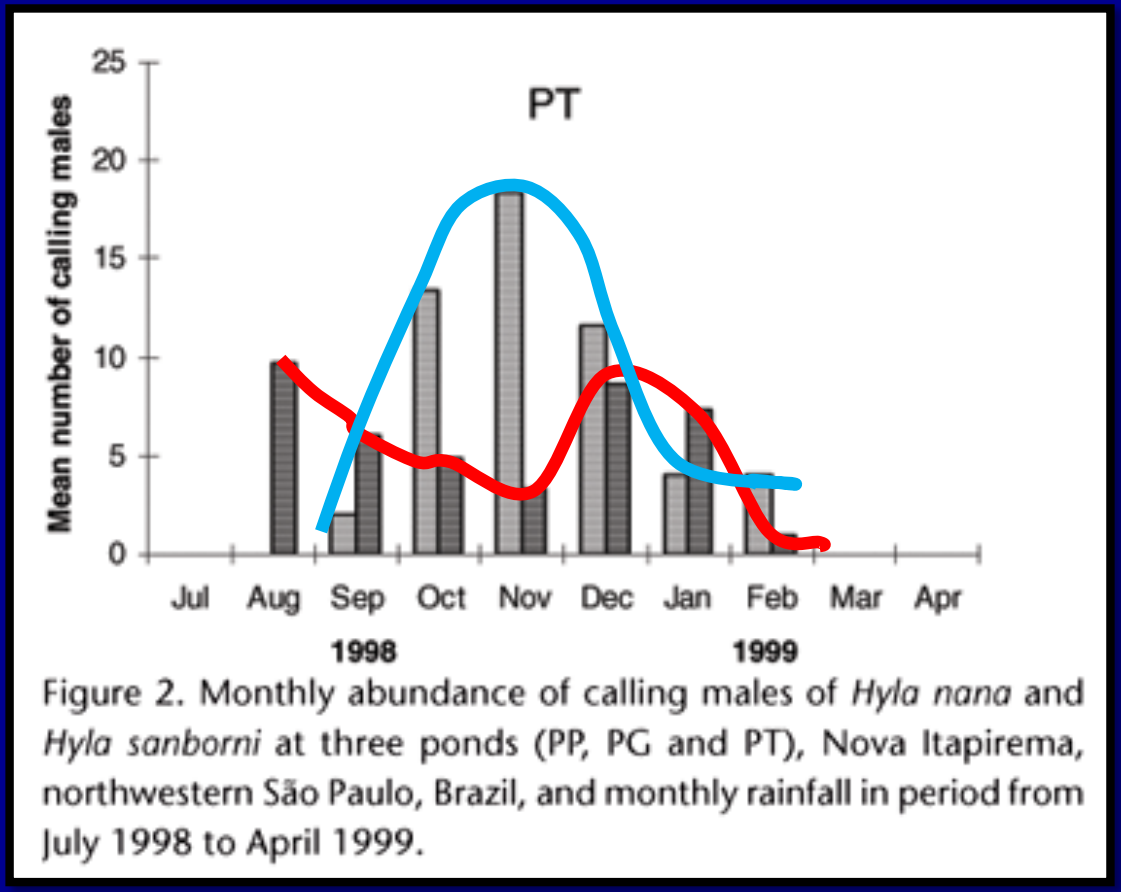
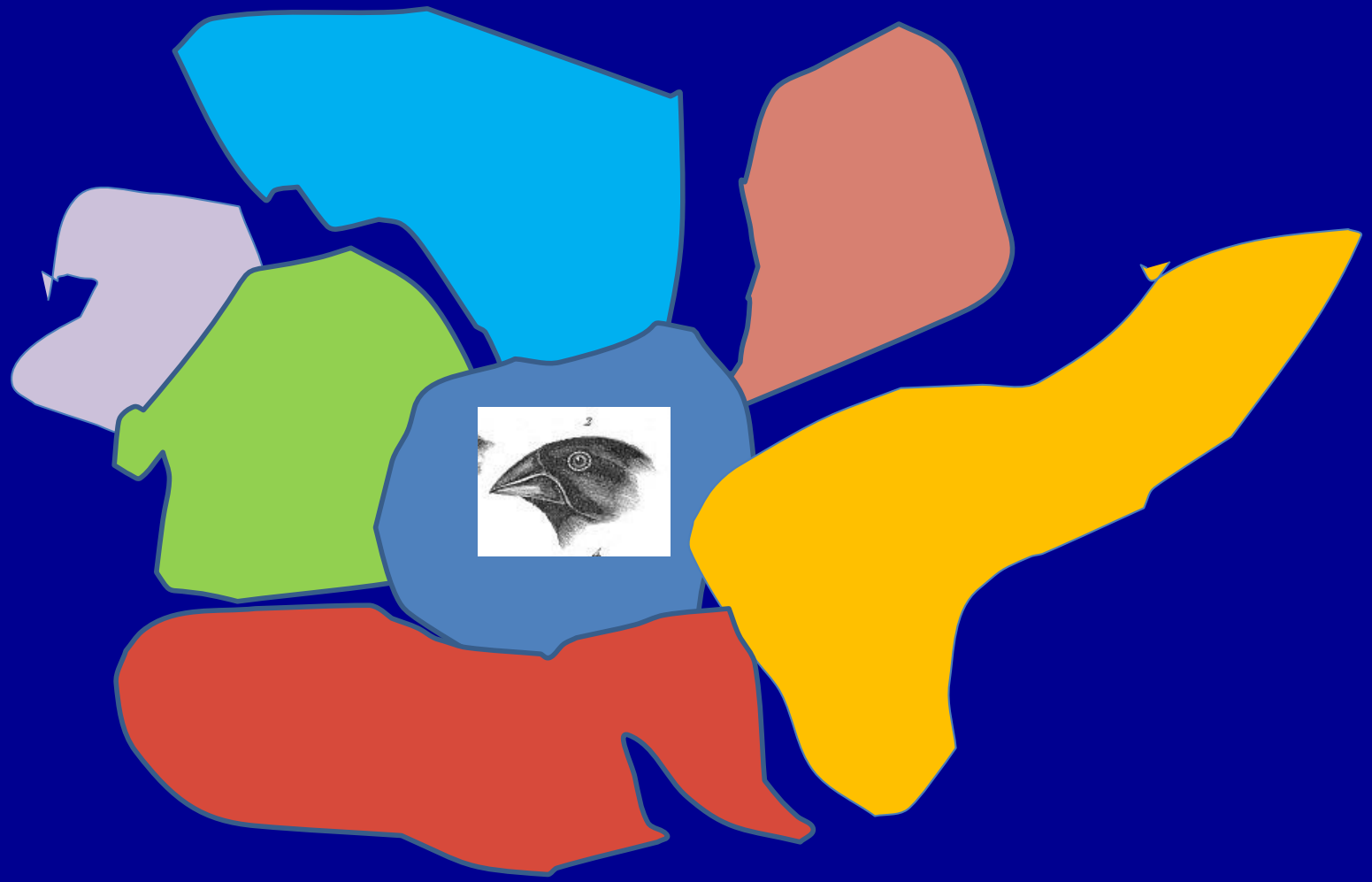


Figure 2. Monthly abundance of calling males of *Hyla nana* and *Hyla sanborni* at three ponds (PP, PG and PT), Nova Itapirema, northwestern São Paulo, Brazil, and monthly rainfall in period from July 1998 to April 1999.

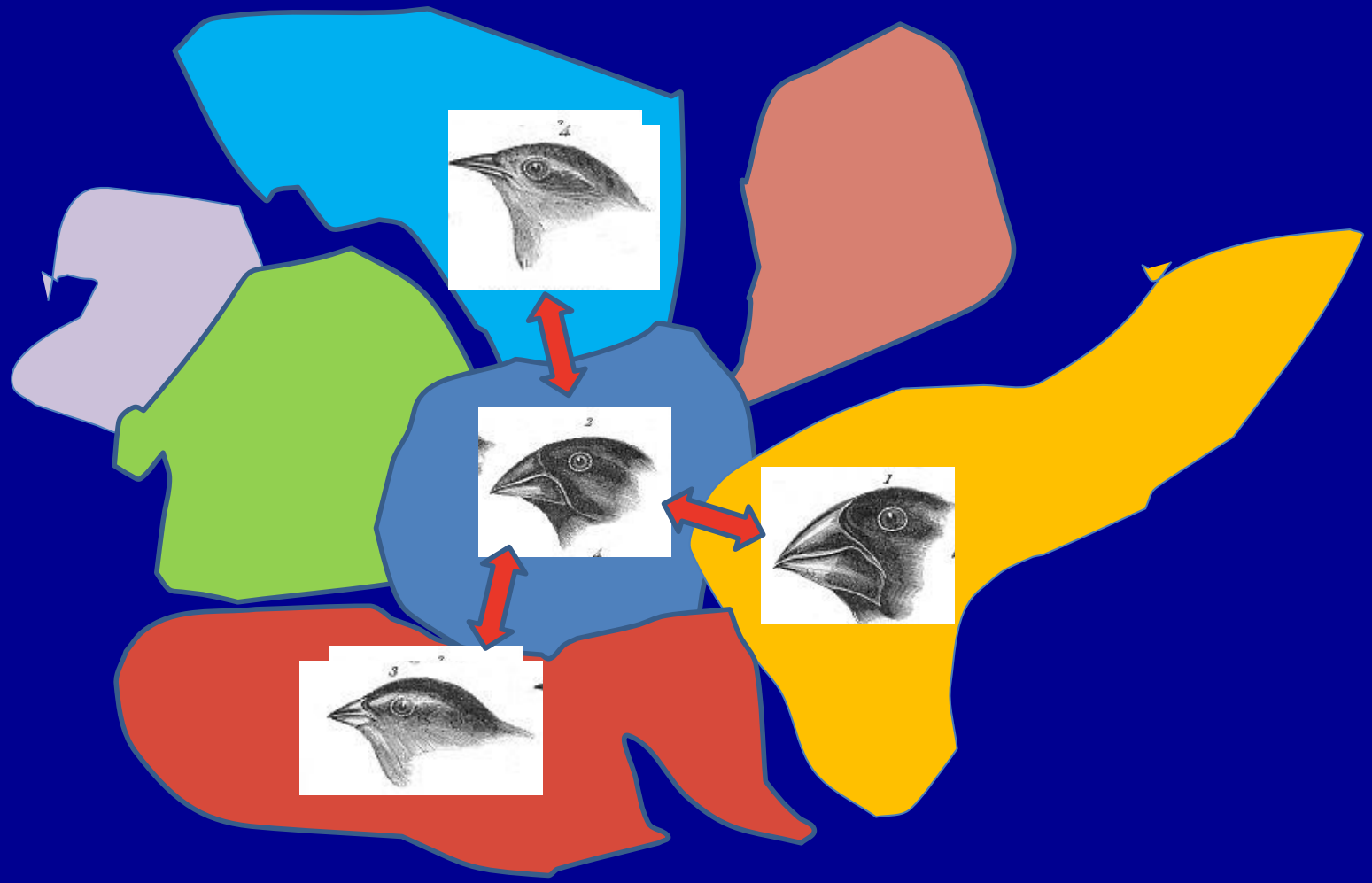
http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0101-81752005000100008

How might intraspecific competition and interspecific competition INCREASE the number of species?

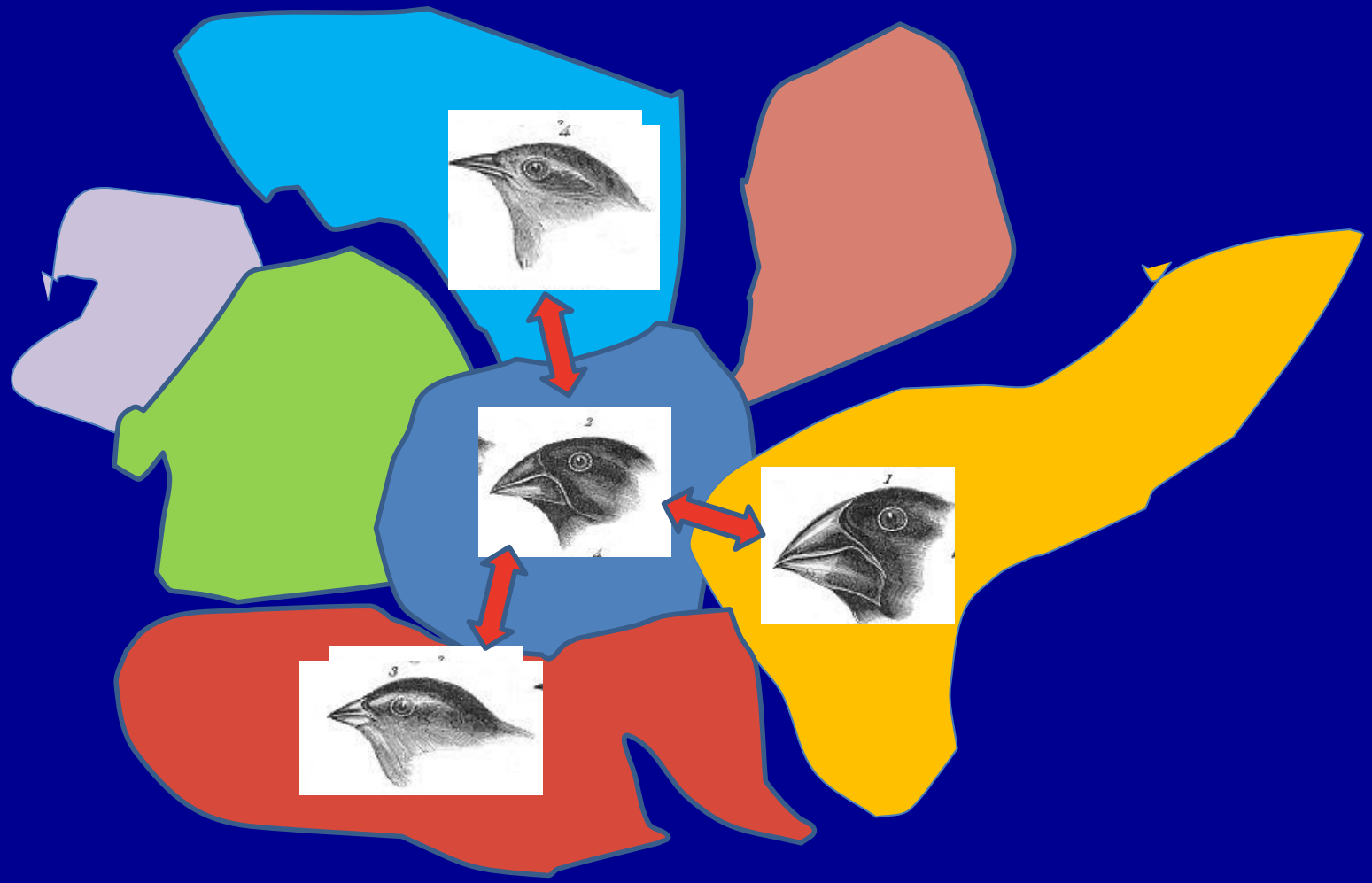
When INTRAspecific competition becomes sufficiently great, individuals move to new habitats

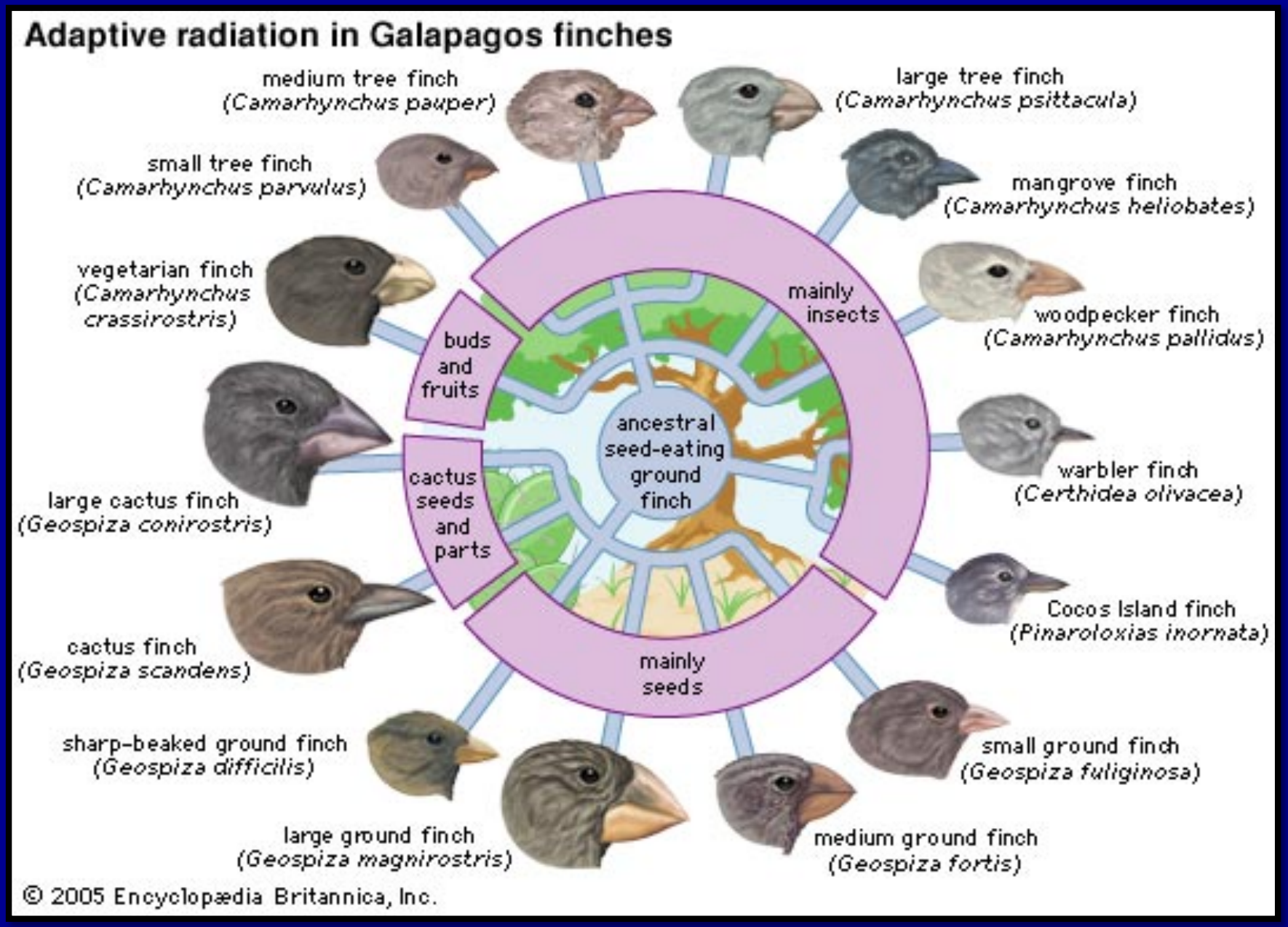


Through Natural Selection, evolve new characters



Then, INTERspecific competition maintains populations.




Adaptive radiation in Galapagos finches
medium tree finch
(Camarhynchus pauper)
large tree finch
(Camarhynchus psittacula)
small tree finch
(Camarhynchus parvulus)
mangrove finch
(Camarhynchus heliobates)
vegetarian finch
(Camarhynchus crassirostris)
mainly insects
woodpecker finch
(Camarhynchus pallidus)
buds and fruits
ancestral seed-eating ground finch
warbler finch
(Certhidea olivacea)
cactus seeds and parts
large cactus finch
(Geospiza conirostris)
Cocos Island finch
(Pinaroloxias inornata)
cactus finch
(Geospiza scandens)
mainly seeds
small ground finch
(Geospiza fuliginosa)
sharp-beaked ground finch
(Geospiza difficilis)
large ground finch
(Geospiza magnirostris)
medium ground finch
(Geospiza fortis)
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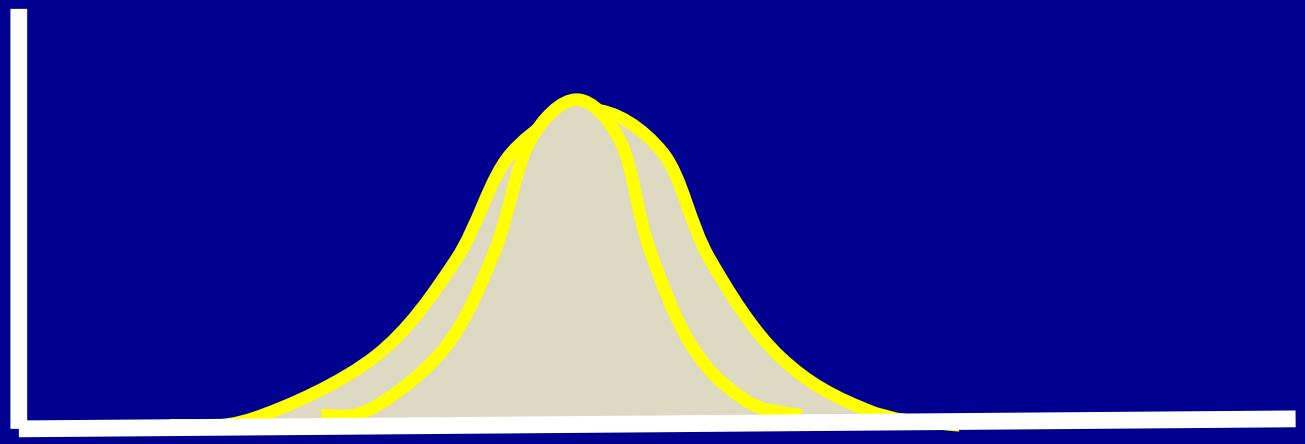
Interspecific competition and the niche

- Fundamental Niche – Niche without any other species
- Realized Niche – Niche with other species



Resource (e.g. space)