Ecology and evolution

Limnology

Lecture 2

Outline

- Lab notebooks
- Quick and dirty ecology and evolution review

The Scientific Method

1. Develop hypothesis (general models)
   - Null hypothesis
   - Alternative hypothesis
2. Develop prediction (specific)
3. Perform test
4. Evaluate test results, update hypothesis
5. Rinse and repeat


UNREGI
STERED

The Scientific Method

1. Develop hypothesis (general models)
   - Null hypothesis
   - Alternative hypothesis
2. Develop prediction (specific)
3. Perform test
4. Evaluate test results, update hypothesis
5. Rinse and repeat

Models – hypothesis/prediction

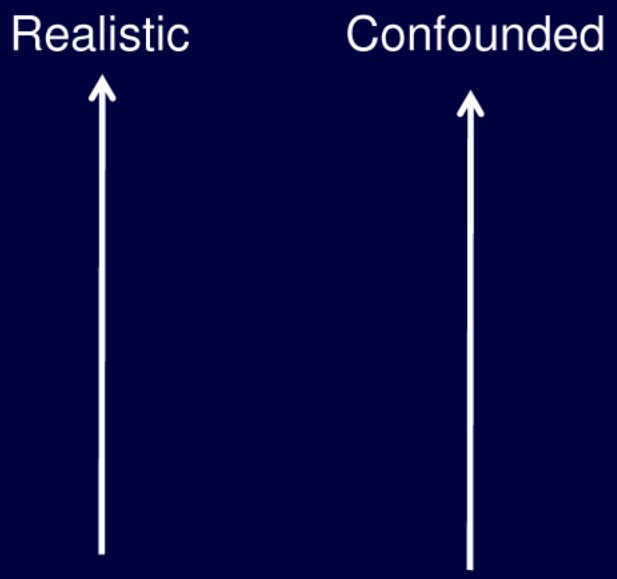
Model – simplified reconstruction of important components of nature

1. Descriptive
2. Predictive

Generality vs. predictability

Testing Predictions

- Natural observations
- Field experiments
- Lab experiments



No clear conclusion without manipulative experiments
Unrealistic experiments can and do give irrelevant results

What Causes Patterns?

- e.g. why do tadpoles survive in one pond but not another?
  - Proximate factor:
    - Predators ate all the tadpoles
  - Ultimate factor:
    - Tadpoles evolved greater fitness in predator-free habitat, have not adapted traits to survive predator

Ecology

- “Ecology is the scientific study of the interactions that determine the distribution and abundance of organisms”

Charles Krebs (1972)

Ecology

Description of natural history ~1900

Explanation of mechanisms ~2000

Ecology

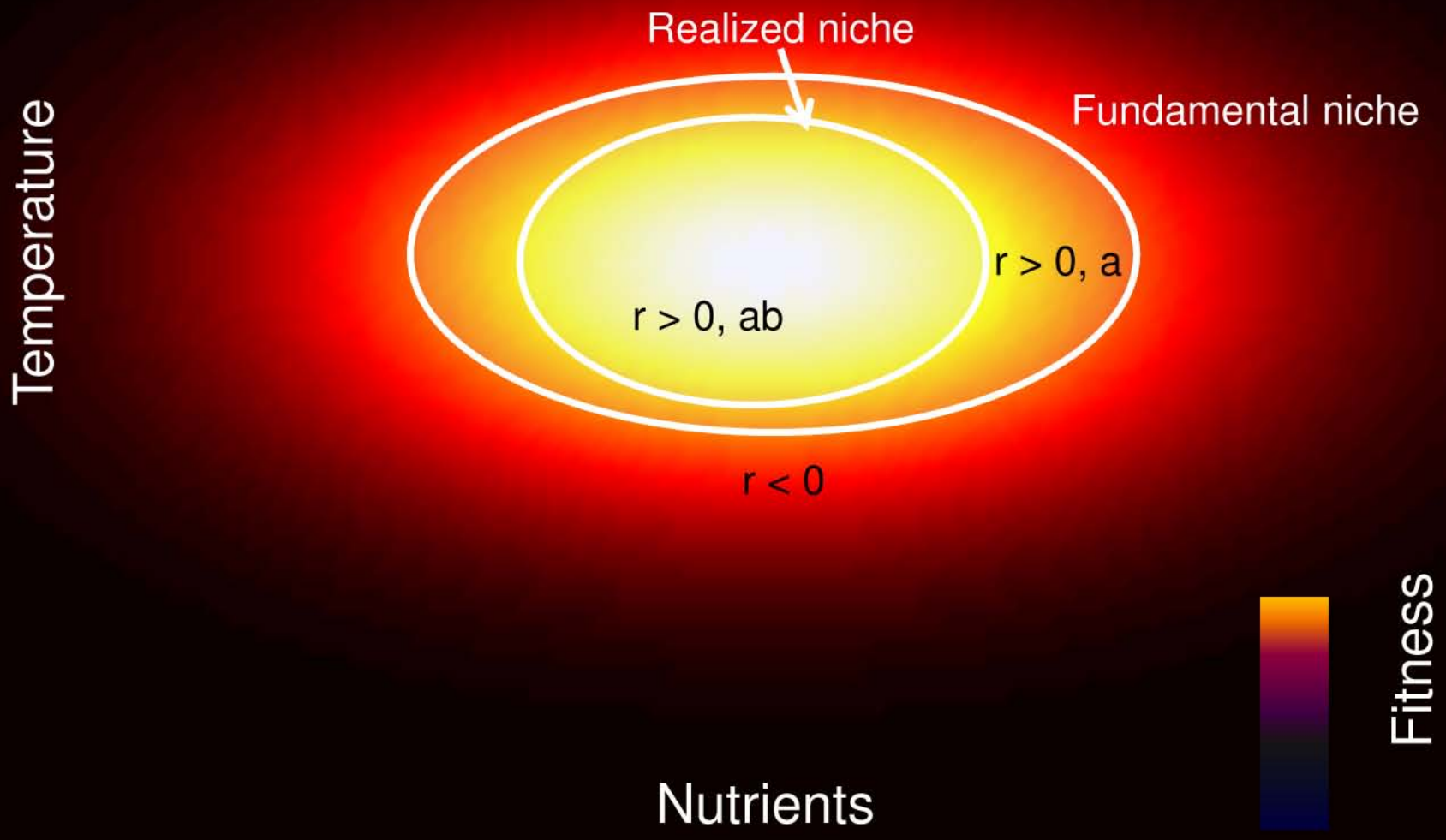
- Abundance and diversity of species over space and time
- Predict how many species of x occur at location y at time z
  - Often using trait variation, environmental variation, movement

Abiotic frame

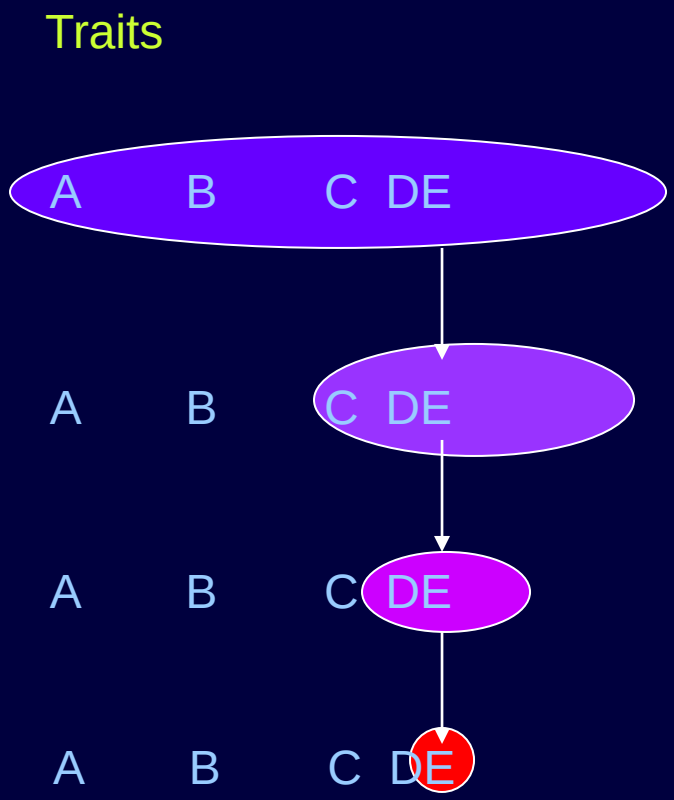
- Physical and chemical characteristics of an environment
- Varies in space and time
- Species differ in their abilities to live & reproduce in different abiotic environments

  “niche”

Niche – n-dimensional hypervolume of environmental conditions in which a population has positive population growth



Landscape filters



Regional species pool

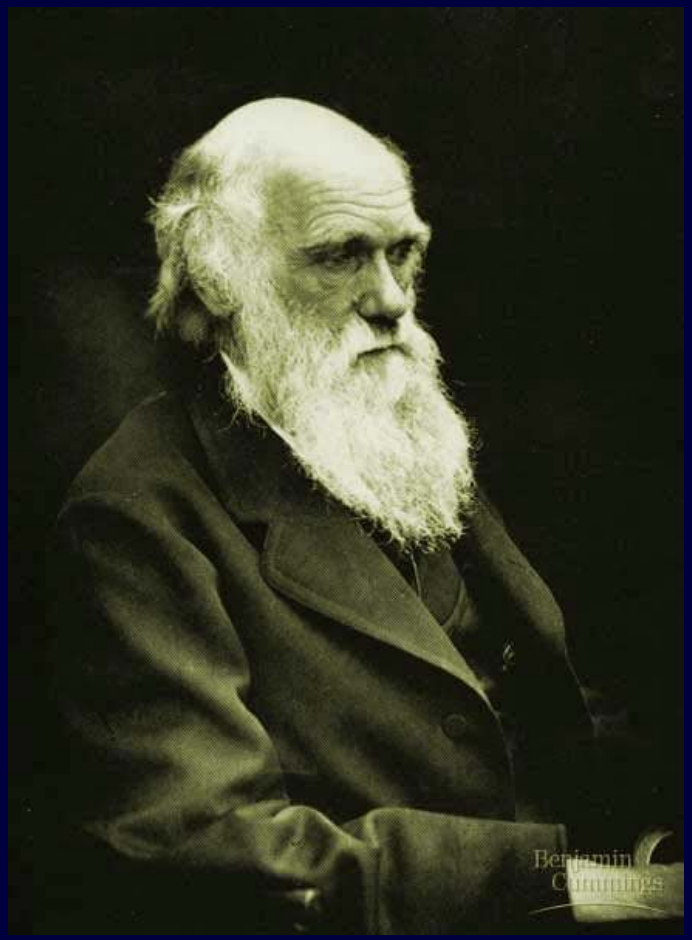
Dispersal

Abiotic

Biotic interactions

Poff, N. L. 1997. Landscape filters and species traits: towards mechanistic understanding and prediction in stream ecology. *JNABS*. 16(2): 391-409.

Evolution



"Nothing in biology makes sense except in the light of evolution"- Theodosius Dobzhansky

The Ecological Theater and the Evolutionary Play - G.E. Hutchinson (1965)

Evolution

Change in genetic frequencies across generations

1. Neutral (drift, random mutation)
2. Fitness (natural selection)

Individual fitness – an individual's contribution of offspring to future generations

~ lifetime reproduction

Evolution by natural selection

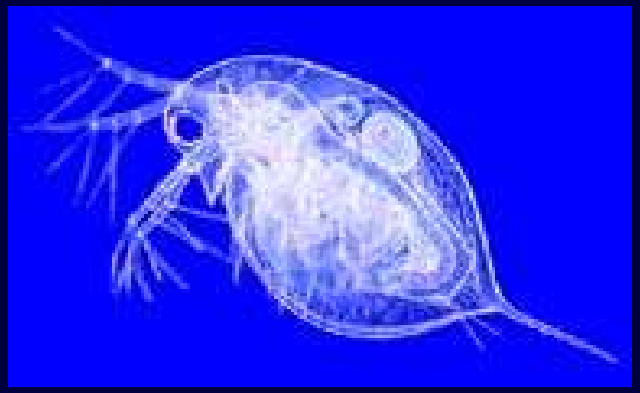
1. Phenotypic Variation

   Phenotype – outward appearance of an organism
2. Variation linked to Fitness differences

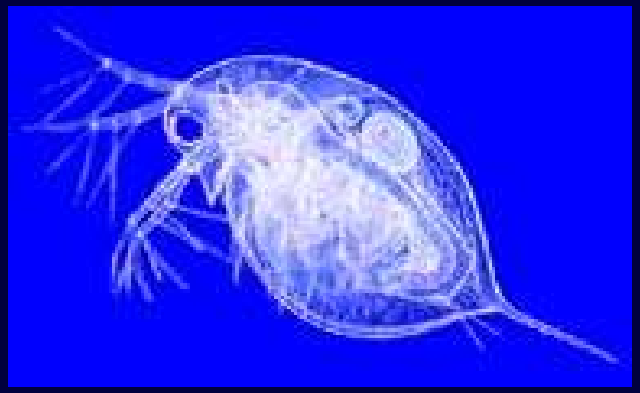
   (Natural selection)
3. Variation Inherited (genetic basis)

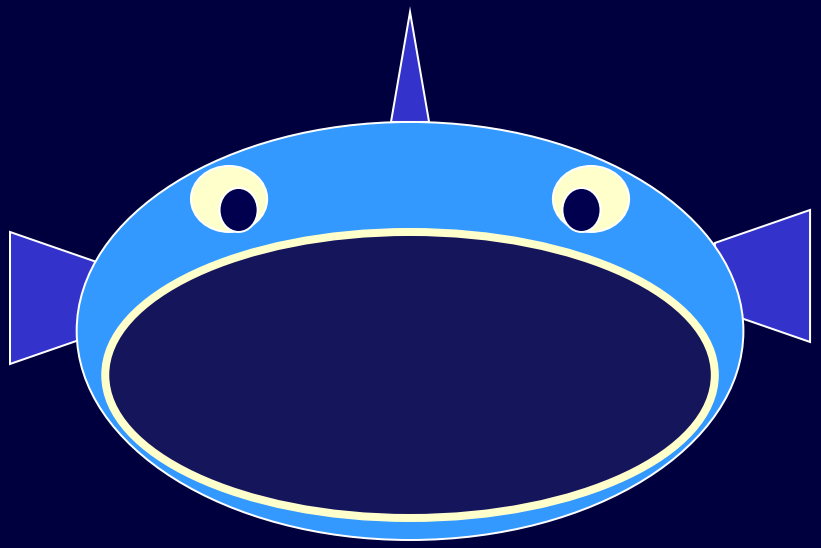
Evolution is Very FIne!

Phenotypic Variation

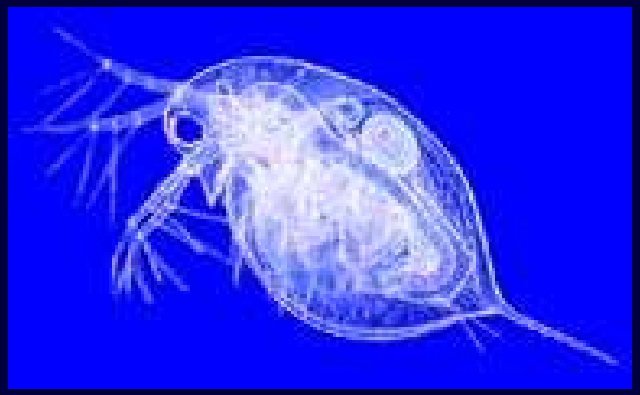


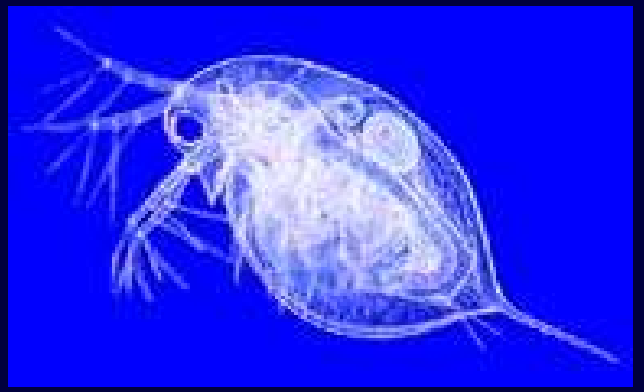
Phenotypic Variation



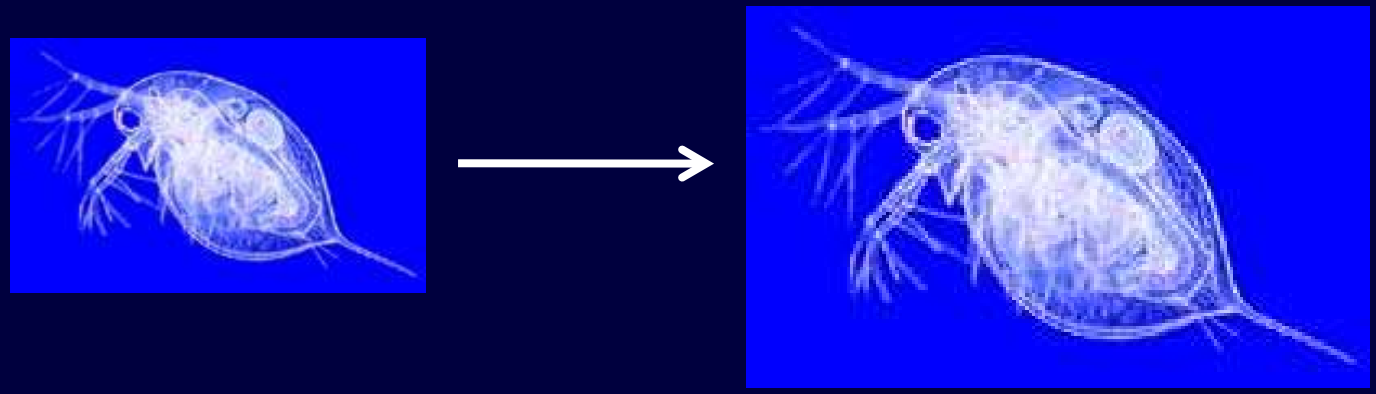


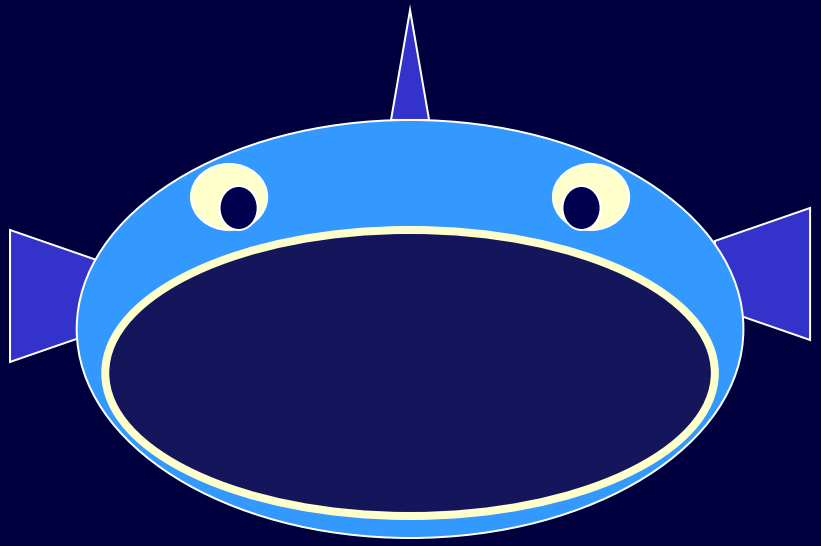
Heritability – degree to which offspring resemble parents in a trait





Evolution by natural selection





Phenotypic plasticity

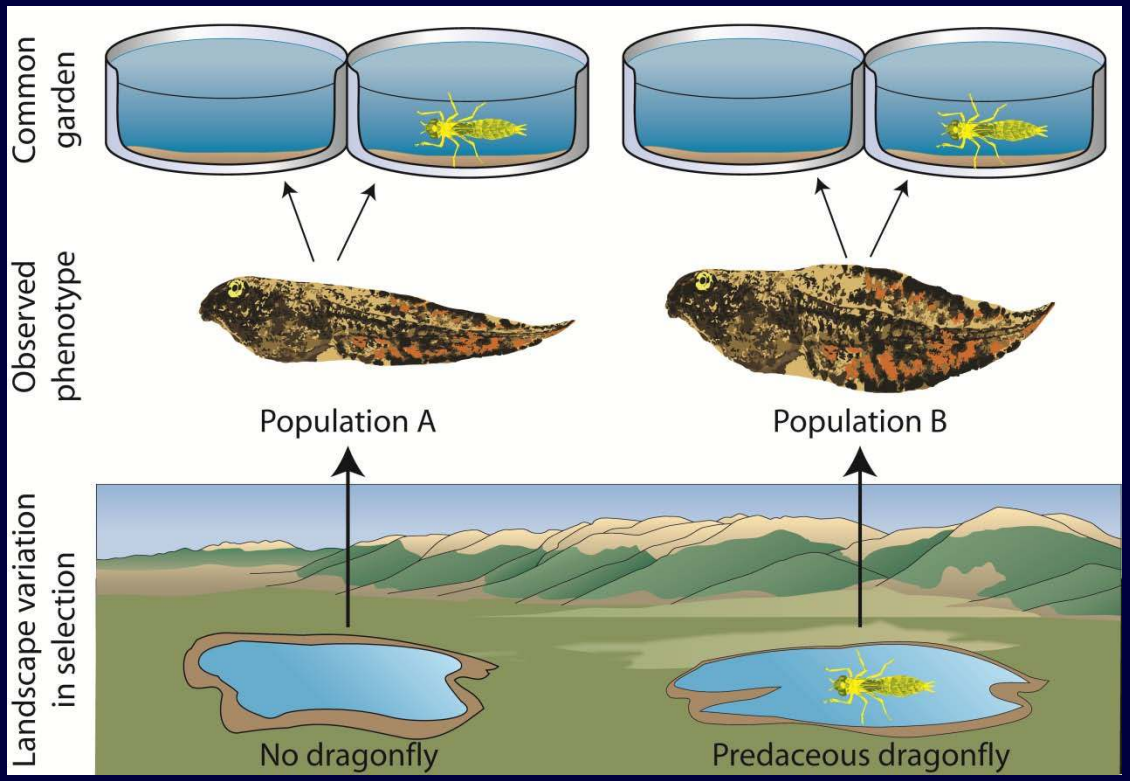
Environment-dependent response of individuals

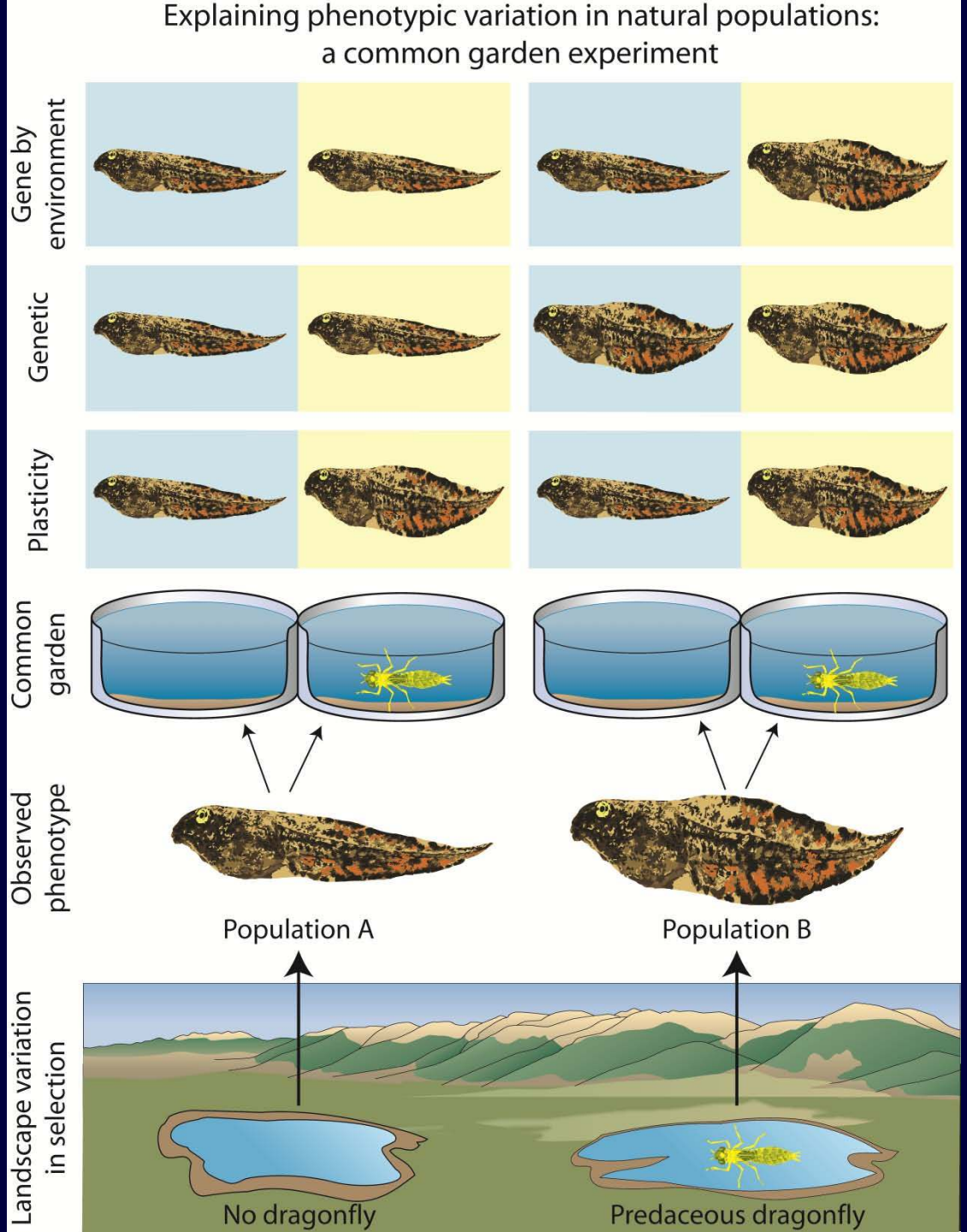
- non-genetic

Otto Ewald

Nature vs. nurture

Nature = genetics
Nurture = environment
Common garden experiment – raise individuals under same conditions





Mixture (evolved plasticity)

Each population has same response

Each population responds to environment


UNREGI
STERED


DRAX

Trade-offs in ecology and evolution

1. Tradeoff – organism/ species can’t be good at everything

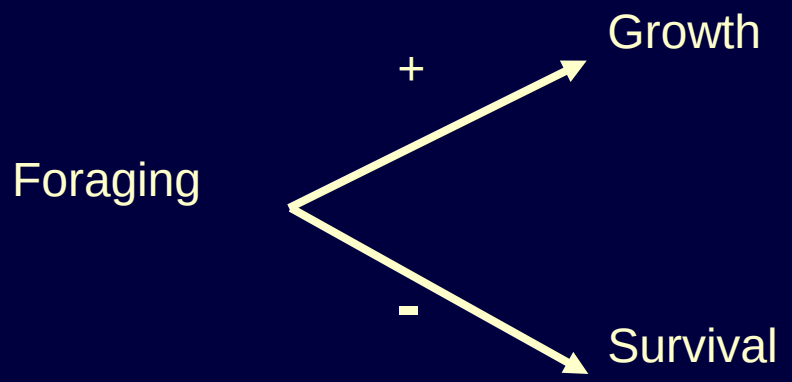
2. Environments differ

3. Tradeoffs determine distribution of species and phenotypes

Trade-offs in ecology and evolution

E.g., Growth/predation risk tradeoff

Predator present



Trade-offs in ecology and evolution

E.g., Egg number/size tradeoff

Limited reproductive energy output

- Many small eggs
- Few large eggs

Specialist vs. Generalist

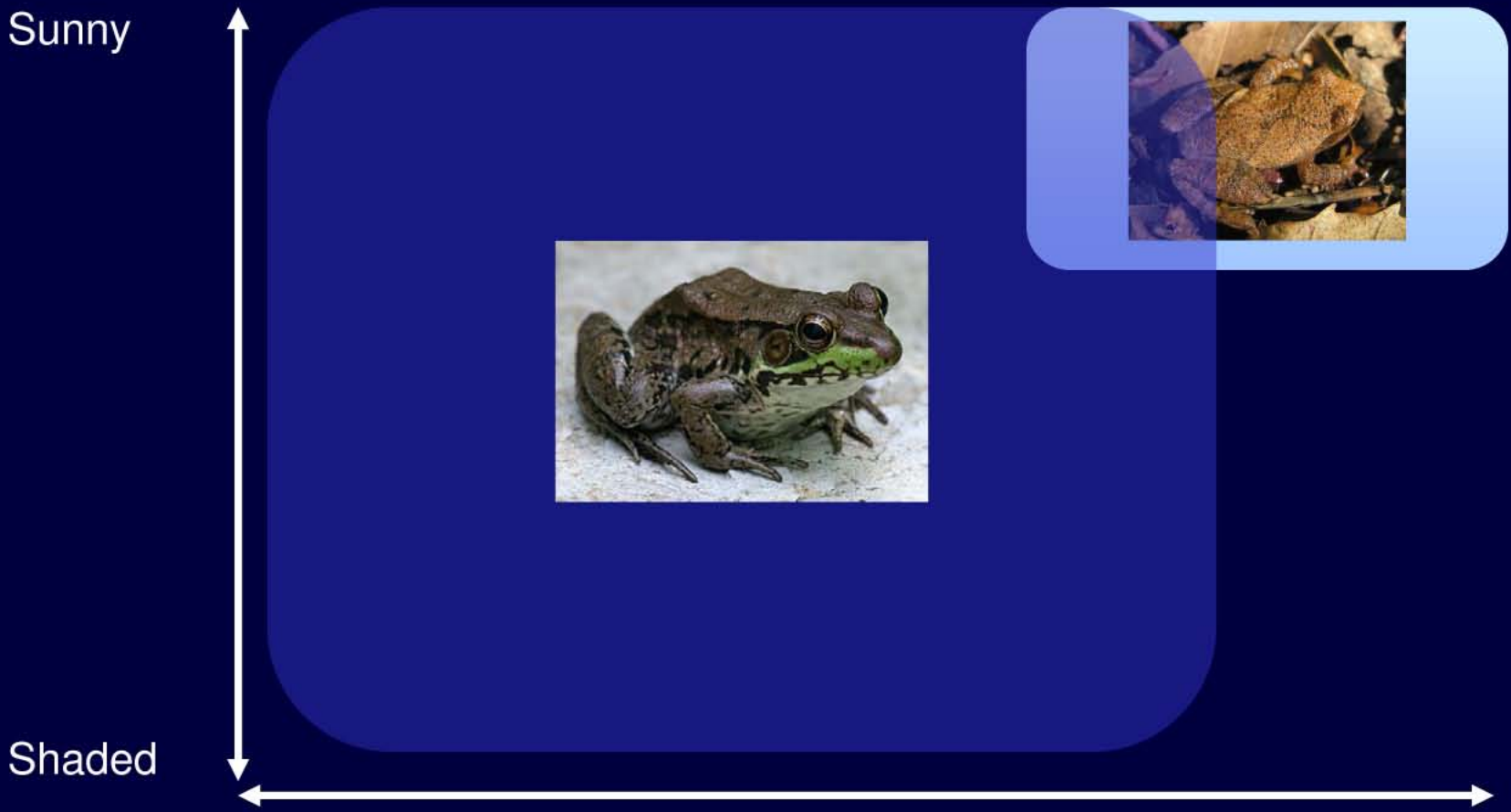
Jack of all trades, master of none

Tradeoffs mean that no species can be best at everything

Specialist – really good at one thing, crappy at all others

Generalist – okay at everything

Specialist vs. Generalist



Today:

Scientific method
Ecology
Evolution
Plasticity
Abiotic frame and landscape filters
Trade-offs
Specialist-Generalist

Next Week:

Lake origins

Lab – Dunham Pond physical chemical properties