Competition

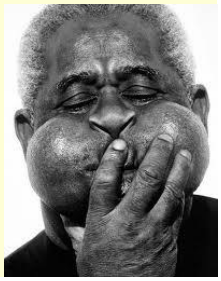
Limiting resources

Lecture outline

- Competition as a potentially important density-dependent factor
- **Intra**specific competition in animals and plants
- The niche and competition
  - Gause's principle
  - Hutchinson's *n*-dimensional hypervolume
- Competition and math—Lotka-Volterra equations
- Evidence for **inter**specific competition in the field

Competition

- Only occurs when …
- Intraspecific vs. Interspecific competition
- Types of competition:
  - **Exploitative** vs.
  - **Interference**



Potential outcomes

- Types of interspecific interactions

Type of interaction	Species 1	Species 2
Neutral	0	0
Mutualism	+	+
Commensalism	+	0
Amensalism	-	0
Parasitism	+	-
Predation	+	-
Competition	-	-

How would you test for competition?

Effects of intraspecific competition on animals

Prokelesia marginata on *Spartina*

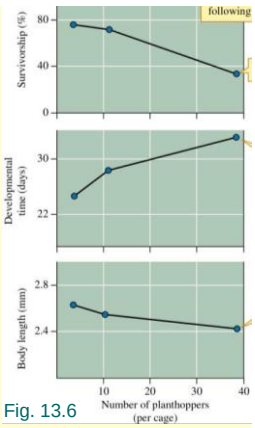


Fig. 13.6

Effects of intraspecific competition on plants

- Picture yourself as a pine tree through time…
- What happens?

Self-thinning

Alfalfa

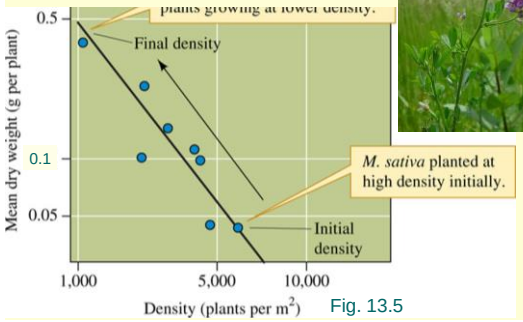


Fig. 13.5

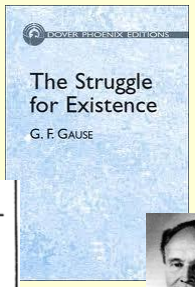
The niche

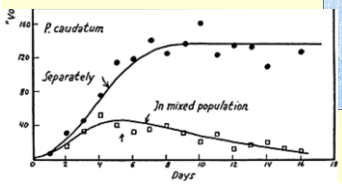
FINDING YOUR NICHE

- Incorporates many ideas over the years
- *Niche consists of…*
- Some interpretations:
  - E.P. Odum (1959):
    - Address vs. profession
  - M. Leibold (1995):
    - Resource vs. impact niche

Linking niches and competition

- **Gause's** or **competitive exclusion principle**
- Do we ever see this principle in action?

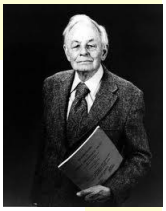


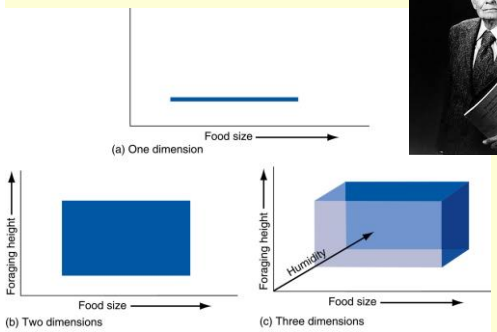


G.F. Gause

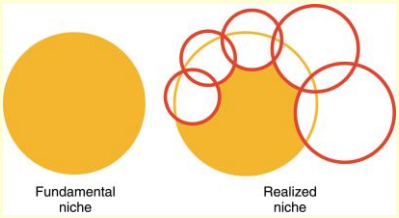
n-dimensional hypervolume

- Hutchinson (1957)





Effects of competition on the niche

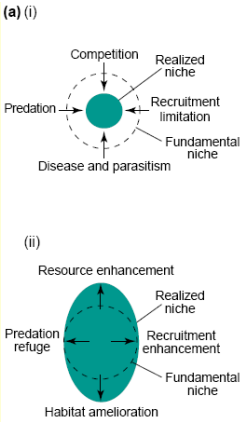


Bluegill
+
Green sunfish

Bluegill

What about the reverse?

- Are there interactions that expand the hypervolume?



Bruno et al. (2003)

An example of the reverse

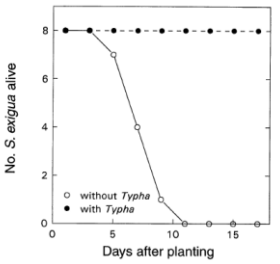


FIG. 2. Survival of cloned cuttings of *Salix exigua* when grown with and without *Typha latifolia* at substrate temperatures of 11°–12°C under greenhouse conditions. $n_{control} = 8$ cuttings, $n_{treatment} = 8$ cuttings.

Callaway and King (1996)

A reminder…

- Another form:

$$\frac{dN}{dT} = rN\left(\frac{(K-N)}{K}\right)$$

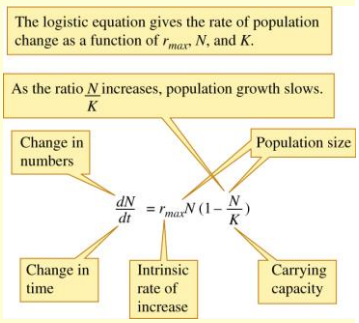


Fig. 11.13

Alfred Lotka

Vito Volterra

Competition theory

- **Lotka-Volterra model**
- Species 1: $dN_1/dt = r_1N_1((K_1-N_1-\alpha N_2)/K_1)$
- Species 2: $dN_2/dt = r_2N_2((K_2-N_2-\beta N_1)/K_2)$

- If αN_2 or $\beta N_1 = 0$, then population shows ? population growth

Lotka-Volterra competition outcomes

- Four possibilities:
  - Species 1 wins, species 2 goes extinct/excluded
  - Species 2 wins, species 1 goes extinct/excluded
  - It depends
  - Coexistence
- A reality check

Evidence for interspecific competition in the field

- Two older meta-analyses:
  - Connell (1983): 40% of studies; 50% of species
  - Schoener (1984): 90% of studies; 76% of species

OIKOS 35: 131–138. Copenhagen 1980

Diversity and the coevolution of competitors, or the ghost of competition past

Joseph H. Connell

Competition in the (really big) field

- James Brown et al.
  - 20 ha study site
  - 24 plots
  - Each plot is 50 m x 50 m

Chihuahuan Desert, AZ

Fig. 13.21

Competition in the field

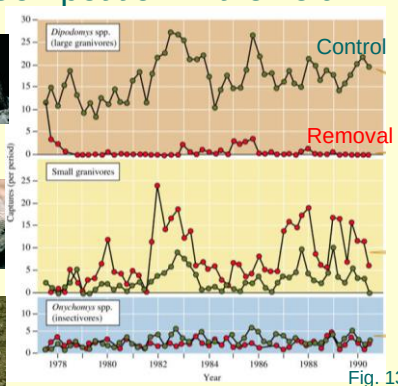


Fig. 13.23

Any other reasons to do long-term studies of rodents?

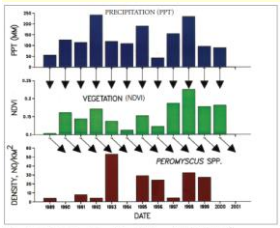


Figure 5. Sevilleta Long Term Ecological Research (LTER) data for fall–spring precipitation (September through May), spring maximum vegetation productivity (normalized difference vegetation indices [NDVI] from AVHRR [Advanced Very High Resolution Radiometer] satellite imagery), and spring Peromyscus *spp. densities (number per square kilometer [km²]) from the McKenzie Flats grasslands of the Sevilleta National Wildlife Refuge, New Mexico. Note the close correspondence of pattern dynamics between the temporal increases and decreases of precipitation and NDVI values.* Peromyscus *densities also display a significant 1-year lag relationship with precipitation.*

Yates et al. (2002)

Figure 3. Biologists from the University of New Mexico collect blood samples from marked, live-trapped rodents to test for hantavirus infections. Rodents are then released to monitor long-term patterns of population densities, demographics, and infection dynamics.

Michener et al. (2009)