Interactions

- **Intra-specific** = interactions among members of the same species/population.
- **Inter-specific** = interactions among members of different species.

How can you tell if organisms are influencing each other?

- Study the relationship between population growth rate and population density.
- If there is a relationship (either + or -), then assume that the organisms are influencing each other, if not, there is no interaction (neutralism).

### Effect of interaction on growth rate of:

<table>
<thead>
<tr>
<th>Name of Interaction</th>
<th>Population/Species A</th>
<th>Population/Species B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutralism (is this really interaction?)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Commensalism (table scraps)</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Mutualism or synergism</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ammensalism</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Parasitism, predation</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Competition</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Competition

A. Two major types:

1. **Interference competition** = Competition between two individuals/populations/species in which one physically or chemically excludes the other from a habitat.

2. Resource competition = Occurs when use of a resource by one individual/population/species reduces the availability of that resource to other individuals/populations.

Resource competition can only occur when population growth rates of both individuals/populations/species are limited by the same resource.

If no resources are in limiting supply, then competition does not occur.

Classic studies of resource competition by Gause (1934, 1935)

- **Paramecium aurelia**
- **Paramecium caudatum**
- **Paramecium bursaria**
Gause found that interactions between *Paramecium aurelia* and *P. caudatum* always ended in competitive exclusion.

Within 14 days *Paramecium aurelia* WON!

In contrast, *Paramecium bursia* and *P. caudatum* could coexist.

*Paramecium caudatum*  

**WHY?**

Because they inhabited different regions of the flask and ate different food.  

*P. bursia* fed on the bottom of the flask, and *P. caudatum* ate the bacteria in suspension.

In contrast, both *P. aurelia* and *P. caudatum* ate the bacteria in suspension.

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**Gause’s Principle (Law)**

When the niches* of two species overlap, there will be competition; and, if the overlap is extreme, there will be competitive exclusion.

* Niche = the ranges of conditions and resources within which an organism or species persists, often conceived as a multidimensional space.

**Gause’s Principle (Law)**

When the niches* of two species overlap, there will be competition; and, if the overlap is extreme, there will be competitive exclusion.

This is also called the **Competitive Exclusion Principle**

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**Competition is central to both evolutionary theory and ecological theory:**

- Competition can be a powerful selection pressure.
- Competition structures of communities.
\[ \mu = \mu_{\text{max}} \frac{S}{(K_m + S)} \]

- \( \mu_{\text{max}} \) = the maximum per capita growth rate under conditions of resource saturation
- \( S \) = the concentration of a growth-limiting resource
- \( K_m \) = resource concentration at which growth occurs at half the maximum rate.

\[ \mu = \mu_{\text{max}} S/(K_m + S) \]

Tilman, 1976:

- *Asterionella formosa*:
  - \( K_s \) for PO\(_4\) = 0.04
  - \( K_s \) for SiO\(_2\) = 3.9
- *Cyclotella meneghiniana*:
  - \( K_s \) for PO\(_4\) = 0.25
  - \( K_s \) for SiO\(_2\) = 1.4

Which species is the better competitor for PO\(_4\)?

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Which species is the better competitor for SiO\(_2\)?

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When more than one nutrient is limiting, the outcome of competition is also influenced by the ratio of the two limiting nutrients. Tilman’s microcosm data:

<table>
<thead>
<tr>
<th>Flow rate (volumes per day)</th>
<th>Nutrient ratio [SiO2]/[PO4]</th>
<th>Asterionella wins</th>
<th>Cyclotella wins</th>
<th>Stable co-existence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>97</td>
<td>10</td>
<td>5.6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Asterionella wins
Cyclotella wins
Stable co-existence

Interactions between microbes and other types of organisms: Cool mutualisms

Tube worm (Riftia pachyptila) grows up to 9 feet tall. Lives on Pacific Ocean floor near hydrothermal vents.

Survival depends on symbiotic relationship with bacteria that convert hydrothermal vent chemicals to worm food.

The tubeworm has no mouth – how do the bacteria get in?

Fish and crab feed off of red plume of tubeworm.

The trophosome contains specialized compartments called “bacteriocytes”, where the bacteria grow.

The bacteria fix CO₂ and oxidize H₂S. They then provide the worm with fixed C.

Nitrogen metabolism is also linked between these organisms, but details are scarce.
Fig. 3. Relative importance of foot fungicidal treatments to the body of a cutaneous mycosis in the sheep. Treatment with 20 ppm fosphenylphosphonate was effective compared to the control at a 28-day follow-up. The footpad and inguinal lymph nodes were examined for the remaining sheep.