

Ecology-Interspecific Interactions

Introduction

The **niche** is one of the most important concepts in ecology. Paradoxically, it is also one of the hardest to define (Ecology is still a young science). In essence, an organism's **niche** is how it makes a living: the environmental conditions it tolerates, the important resources it needs to survive, and its ways of obtaining those resources.

In obtaining energy, nutrients, etc., populations of one species frequently interact with populations of other species.

Types of Interspecific Interactions

Interaction	Effect on Species 1	Effect on Species 2
Neutralism	0	0
Competition	-	-
Commensalism	+	0
Amensalism	0	-
Mutualism	+	+
Predation, Parasitism, Herbivory	+	-

Neutralism is the most common type of interspecific interaction. Neither population affects the other. Any interactions that do occur are indirect or incidental.

Amensalism is when one species suffers and the other interacting species experiences no effect. This is sometimes viewed as a very asymmetric form of competition.

Mutualism is an interspecific interaction between two species, that benefits both members. Populations of each species grow, survive and/or reproduce at a higher rate in the presence of the other species. Mutualisms are widespread in nature, and occur among many different types of organisms.

Commensalism is an interspecific interaction where one species benefits and the other is unaffected. They are ubiquitous in nature. For example, birds nesting in trees are commensal. Commensal organisms frequently live in the nests, or on the bodies, of the other species.

Predators, parasites, parasitoids, and herbivores obtain food at the expense of their hosts or prey.

Predators tend to be larger than their prey, and consume many prey during their lifetimes.

Parasites and **pathogens** are smaller than their host. Parasites may have one or many hosts during their lifetime. Pathogens are parasitic microbes-many generations may live within the same host. Parasites consume their host either from the inside (**endoparasites**) or from the outside (**ectoparasites**).

Parasitoids hunt their prey like predators, but lay their eggs within the body of a host, where they develop like parasites.

Herbivores are animals that eat plants. This interaction may resemble predation, or parasitism.

Competition occurs when organisms in the same community seek the same limiting resource. This resource may be prey, water, light, nutrients, nest sites, etc. Competition among members of the same species is **intraspecific**. Competition among individuals of different species is **interspecific**. Individuals experience both types of competition, but the relative importance of the two types of competition varies from population to population and species to species

Types of Competition

Exploitation competition occurs when individuals use the same limiting resource or resources, thus depleting the amount available to others.

Interference competition occurs when individuals interfere with the foraging, survival, or reproduction of others, or directly prevent their physical establishment in a portion of a habitat.

Outcomes of Competition

Exploitation competition may cause the **exclusion** of one species. For this to occur, one organism must require less of the limiting resource to survive. The dominant species must also reduce the quantity of the resource below some critical level where the other species is unable to replace its numbers by reproduction.

Exploitation does not always cause the exclusion of one species. They may **coexist**, with a decrease in their potential for growth. For this to occur, they must **partition the resource**.

Interference competition generally results in the exclusion of one of the two competitors.

The Competitive Exclusion Principle

Early in the twentieth century, two mathematical biologists, A.J. Lotka and V. Volterra developed a model of population growth to predict the outcome of competition. Their models suggest that two species cannot compete for the same limiting resource for long. Even a minute reproductive advantage leads to the replacement of one species by the other. This is called the **competitive exclusion principle**.

A famous experiment by the Russian ecologist, G.F. Gause demonstrated that *Paramecium aurellia* outcompetes and displaces *Paramecium caudatum* in mixed laboratory cultures, apparently confirming the principle.

Interestingly, recent studies by other authors showed coexistence. The difference in outcomes may be due to the existence of something called a killer particle in Gause's strain of *P. aurellia*.) Subsequent laboratory studies on other organisms have generally resulted in competitive exclusion, provided that the environment was simple enough. Thomas Park showed that, via interference competition, the confused flour beetle and the red flower beetle would not coexist. One species always excluded the other.

Resource Partitioning

Species that share the same habitat and have similar needs frequently use resources in somewhat different ways - so that they do not come into direct competition

for at least part of the limiting resource. This is called **resource partitioning**.

Resource partitioning obviates competitive exclusion, allowing the coexistence of several species using the same limiting resource.

In lab today, you begin an experimental study of the interaction between two species of unicellular algae. "Algae" is a general term for photosynthetic, aquatic organisms that are not vascular plants. Algae are predominantly unicellular or colonial organisms, although there are multicellular algae (seaweeds). They are predominantly eukaryotes, although cyanobacteria are sometimes considered to be algae. Many algae are true autotrophs, but others are mixotrophs or facultative heterotrophs (when there is no light, they revert to a predatory habit.)

Algae are tremendously diverse organisms. There are 10,000 species of diatoms (one group of algae) alone. A typical pond might harbor a hundred species. The existence of so many species of algae is considered to be a bit of a mystery in ecology. Algae have very similar metabolic and physiological requirements—light, water, and small amounts of nitrogen, phosphorus, iron, calcium, and silica (for diatoms). Some algae also require other nutrients, such as B vitamins. According to the principle of competitive exclusion, one might expect a given habitat to harbor a single species of algae, and yet this is not usually the case.

Some algae that you might see in your experiment include:

Euglena gracilis—This is a medium-sized algae belonging to the euglenozoa. This species is a mixotroph, and also a facultative heterotroph. They require certain nutrients from the environment to survive, including B vitamins. When light is not available, they revert to a predatory form. This species inhabits stagnant water.

Euglenoids move via a pair of whiplike flagella. They also exhibit creeping movements.

Closterium litorale—This is a large desmid. Desmids are green algae distantly related to vascular plants. They are true autotrophs, able to obtain energy and carbon from inorganic sources in their environment. They do require certain inorganic nutrients, including phosphorus and carbon.

This species doesn't move much.

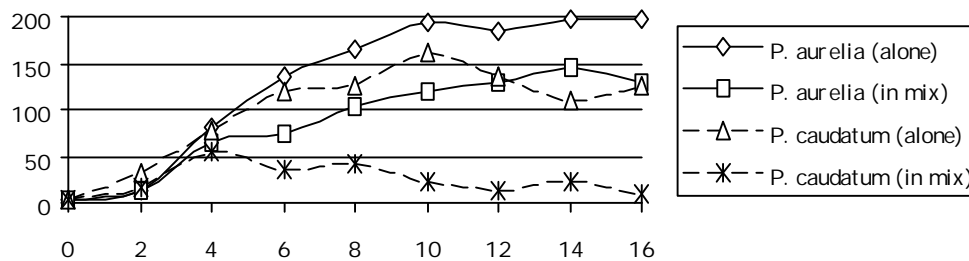
Pandorina species—This is a small colonial green algae. Like *Closterium*, they are true autotrophs. These colonies can be seen gyrating and rotating.

Pre-Lab Discussion

Answer the following questions before coming to discussion. Turn them in on a separate sheet of paper.

Below: The growth of *Paramecium caudatum* and *Paramecium aurelia* over 16 days when cultivated alone or in mixed populations on a buffered medium with the "one-loop" concentration of bacteria as food. From Gause, The Struggle for Existence (1934).

Number Paramecia (y) vs. Days (x)



1. Explain the similarities or difference in the curves **for the first 4 days**; **for the next 6 days**; and **for the remainder of the growth curve**.
2. For this experiment, does the growth of P. aurelia and P. caudatum together have more effect on the P. aurelia or P. caudatum , -or- is the effect equal, -or- is there no effect? Explain how the effects you noted may have occurred.
3. Draw a set of curves that would provide evidence of **coexistence**.
4. Ecologists view the type of population interaction based on its effect on population growth of each population. They compare populations growing alone vs. growing together. The effect of 1 population on the growth or survival of a 2nd can be positive (+), negative (-), or neutral (0). Name the population interaction that corresponds to the following:

Interaction	Effect of 1 on 2	Effect of 2 on 1	Example:
	+	+	
	+	-	
	-	-	
	+	0	
	-	0	
	0	0	

QUESTIONS FOR GROUP DISCUSSION

1. Give an example of each interaction:

predation
competition
mutualism
parasitism
commensalism

2. Name the different types of competition. Describe how they differ.

3. You will be studying competition among two species of algae in the laboratory. Draw a set of graphs to show a +/+ interaction.

Laboratory Exercise

Directions: Your lab instructor has been growing cultures of two algae.

- 1) Obtain a stock culture of each species and observe each of them. When sampling these cultures, use a separate tip for each of them. Do not dip a tip from one stock culture into the next, or you will contaminate the second culture. When in doubt, throw the tip away, they are inexpensive.
 - Draw five small circles on a plastic petri dish, number each circle. Place a sample of species 1 culture inside each circle.
 - Do the same for a second petri dish, using a separate pipette tip, with samples of your species 2 culture.
 - In the center of one dish, place a drop from your species 1 culture, then (using a different tip) add a drop of your species 2 culture. Verify that you can easily tell the 2 species apart.

- 2) Estimate the density of each species.
 - For each sample, count the number of individuals you see. If there are too many to count, use smaller samples.
 - For each species, find the average number per sample.
 - Divide this number by the size of your sample, this is the density. Find the density in ml.
For instance-If your samples were 100 microliters, and you had a mean of 6.4 algae per sample.
 $(6.4 \text{ algae/sample})/100 \text{ microliters/sample} = 6.4 \text{ algae}/100 \text{ microliters}$.
Since 100 microliters is $1/10^{\text{th}}$ of a ml, this is 64 algae/ml.

- 3) Set up your three stock cultures.
 - Find and label three test tubes, indicating 1) your section, 2) your TA, 3) Your Table #, 4) Your names. Use a small piece of tape.
 - Label one tube-Species 1, Label the second tube-Species 2, Label the third tube, MIX.
 - For tube 1, add 100 individuals of species 1. This volume is 100 divided by the density per ml.
For instance, if your density was 64 individuals per ml.
 $(100 \text{ individuals})/(64 \text{ individuals/ml}) = 1.56 \text{ ml}$.
 - For tube 2, add 100 individuals of species 2.
 - For tube 3, add 100 individuals of both species.

4) Add enough medium to top your tube off to 10ml. **For instance, if you added 1.56 ml of species 1, and 1.44 ml of species 2 to your MIX culture, you would need to add 7ml of medium. Be careful not to contaminate the medium with a pipette tip that has been used on an algae culture.**

5) Estimate the density today. The best method is to simply divide 100 individuals by the volume, which is 10ml. This gives about 10 individuals of each species per ml.

6) Over the course of the next three weeks, use the same sampling method to estimate the density of each species of algae in each of your cultures. As a group, you should obtain eight or more counts spread as evenly as possible. Divide up the work so each of the four lab partners does two counts.

STOCK CULTURES: Indicate the number of algae for each species, in each of the five samples of your stock cultures.

Sample #	Species name: Sample size:	Species name: Sample size:
1		
2		
3		
4		
5		
AVERAGE # of per sample AVERAGE density per ml		
Calculate the TOTAL volume necessary to deliver 100 individuals. (100/(density per ml))		
After adding this number of individuals, what is the density in your cultures?		

6. EXPERIMENTAL CULTURES: Enter the mean density per ml for each species.

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 MIX	Species 2 MIX
TODAY	Day= 0				

IMPORTANT NOTE: YOUR VALUE FOR THE DAY 0 DENSITY ABOVE SHOULD BE APPROXIMATELY 10/ml, IF YOU ARE MUCH HIGHER THAN THAT, YOU JUST LISTED THE CONCENTRATION OF THE STOCK CULTURE!

COUNT 1

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=

COUNT 2

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=

COUNT 3

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=

COUNT 4

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=

COUNT 5

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=

COUNT 6

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=

COUNT 7

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=

COUNT 8

Calendar Date	Counting Day	Species 1 ALONE	Species 2 ALONE	Species 1 in MIX	Species 2 in MIX
		1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=	1. 2. 3. 4. 5. average= density per ml=